CHEMICAL SAFETY REPORT

Legal name of applicant(s):	Boeing Distribution (UK) Inc. Henkel Ltd
Substances:	Strontium chromate (StC) EC 232-142-6 CAS 7789-06-2
Uses applied for:	Use 1: Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains

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Preliminary Remark

This Chemical Safety Report (CSR) has been prepared on behalf of the applicants by the Aerospace and Defence Chromates Reauthorisation (ADCR) Consortium.

Photos are for illustrative purposes only. PPE shown in the photos might be also driven by site-specific considerations and by exposures other than to chromates. PPE requirements are laid down in the Condition of Use tables.

Part A

1. SUMMARY OF RISK MANAGEMENT MEASURES

The risk management measures implemented for the use applied for are documented in detail in the exposure scenario in Chapter 9 of this CSR.

A succinct summary table of the risk management measures, and operational conditions is submitted with this application for authorisation.

2. DECLARATION THAT RISK MANAGEMENT MEASURES ARE IMPLEMENTED

Not applicable - as the applicants are not using the substance for this use (upstream application).

3. DECLARATION THAT RISK MANAGEMENT MEASURES ARE COMMUNICATED

We declare that the risk management measures described in the exposure scenarios in Chapter 9 of this CSR are communicated via safety data sheets in the supply chain.

Part B

This application for authorisation uses the dose-response relationship established by the ECHA Committee on Risk Assessment (RAC) (see below). In this case, Chapters 1-8 of the CSR do not need to be provided as described in the ECHA document 'How to apply for authorisation' (ECHA, 2021). Relevant physico-chemical and environmental fate data used for modelling are taken from the literature as documented in section 9.1.2.

9 EXPOSURE ASSESSMENT (AND RELATED RISK CHARACTERISATION)

9.1 Introduction

9.1.1 Structure of this dossier "Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains"

The Aerospace and Defence Chromates Reauthorisation (ADCR) Consortium on behalf of the applicants has developed several review reports and new applications for authorisation (AfA). These applications cover formulation and use of primer products containing chromates considered to be relevant by the ADCR consortium members (i.e., strontium chromate (StC), potassium hydroxyoctaoxodizincate dichromate (PHD), and pentazinc chromate octahydroxide (PCO)) in Great Britain. Although formally they are upstream applications submitted by manufacturers, importers or formulators of chromate-containing chemical products, the applications are based on sector-specific data and detailed information obtained from actors throughout the supply chain.

The ADCR consortium developed dossiers for these three substances with the following uses:

- Formulation of primer products with strontium chromate and/or potassium hydroxyoctaoxodizincate dichromate for use in aerospace and defence industry and its supply chains (Review Report)
- Use of bonding primers containing strontium chromate in aerospace industry and its supply chains (Review Report and New AfA)
- Use of wash primers containing potassium hydroxyoctaoxodizincate dichromate in aerospace industry and its supply chains (Review Report)
- Use of wash primers containing potassium hydroxyoctaoxodizincate dichromate and pentazinc chromate octahydroxide in aerospace industry and its supply chains (New AfA)
- Use of primer products other than wash or bonding primers containing strontium chromate and/or potassium hydroxyoctaoxodizincate dichromate in aerospace and defence industry and its supply chains (Review Report)
- Use of primer products other than wash or bonding primers containing strontium chromate and/or potassium hydroxyoctaoxodizincate dichromate and/or pentazinc chromate octahydroxide in aerospace and defence industry and its supply chains (New AfA)

Table 9-1 provides an overview on ADCR's dossiers for chromates in primer products used in aerospace and defence industry and its supply chains, together with applicants and the total EEA tonnages per substance and use.

This new AfA refers to the use "Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains".

This CSR follows largely the methodology and requirements as given under EU REACH. ADCR developed similar CSRs for these uses for the situation in the European Economic Area (EEA) with the same approach. Exposure data from the EEA were partly used in this report where suitable to support the assessment for Great Britain (GB) sites.

Table 9-1: Overview on ADCR new AfAs and review reports on chromates in primer products

Use	Submission type	Strontium chromate (StC)		Potassium hydroxyoctaoxodizincate dichromate (PHD)		Pentazinc chromate octahydroxide (PCO)	
Formulation of primer products	ARR	Indestructible Paint Ltd PPG Industries (UK) Ltd	**CBI**	PPG Industries (UK) Ltd	**CBI**		
Use of wash primers	ARR			PPG Industries (UK) Ltd	**0.02 tpa**		
	New AfA			Boeing Distribution (UK) Inc. Wesco Aircraft EMEA Ltd	**0.02 tpa**	Boeing Distribution (UK) Inc. Wesco Aircraft EMEA Ltd	**2.35 tpa**
Use of bonding primers	ARR	Cytec Engineered Materials Ltd in its legal capacity as Only Representative of Cytec Industries Inc Wesco Aircraft EMEA Ltd	**14.74 tpa**				
	New AfA	Boeing Distribution (UK) Inc. Henkel Ltd	**14.74 tpa**				

Use	Submission type	Strontium chromate (StC)		Potassium hydroxyoctaoxodizincate dichromate (PHD)		Pentazinc chromate octahydroxide (PCO)	
Use of primer products other than wash or bonding primers	ARR	Cytec Engineered Materials Ltd in its legal capacity as Only Representative of Cytec Industries Inc Wesco Aircraft EMEA Ltd Indestructible Paint Ltd PPG Industries (UK) Ltd	**51.22 tpa**	PPG Industries (UK) Ltd	**2.38 tpa**		
	New AfA	Akzo Nobel Car Refinishes B.V. Mapaero SAS Boeing Distribution (UK) Inc. Mankiewicz UK LLP in its legal capacity as only representative for Finalin GmbH	**51.22 tpa**	Boeing Distribution (UK) Inc. Wesco Aircraft EMEA Ltd	**2.38 tpa**	Boeing Distribution (UK) Inc. Wesco Aircraft EMEA Ltd	**4.01 tpa**

9.1.2 Introduction to the assessment

9.1.2.1 Classification of the substance

Strontium chromate (StC; Entry No. 29) has been included into Annex XIV of Regulation (EC) No 1907/2006 (EU REACH) due to its intrinsic property to be carcinogenic. Table 9-2 shows that StC is classified as carcinogenic Cat. 1B. According to Article 62 (4)(d) of this Regulation, the chemical safety report (CSR) supporting an Application for Authorisation (AfA) needs to cover only those risks arising from the intrinsic properties specified in Annex XIV. Therefore, only the human health risks related to the classification of the chromate as carcinogenic are addressed in this CSR. This requires investigating the potential exposure of workers as well as exposure of humans via the environment.

Table 9-2: Substance classification

Substance name	CAS No.	EC No.	Annex XIV Entry No.	Intrinsic properties referred to in Art. 57	Formula	Mol. weight [g/mol]	Cr(VI) mol. weight fraction
Cr(VI)	-	-	-		Cr^{6+}	52.00	1
Strontium chromate (StC)	7789-06-2	232-142-6	29	Carc. 1B [1]	CrO_4Sr [2]	203.61	0.26

The carcinogenicity of StC is driven by the chromate ion (with Cr in oxidation state +6 (or Cr(VI))), which is released when the substance solubilises and dissociates. Exposure to chromate is expressed in units of Cr(VI) (converted by using the ratio of the molecular weights of Cr and StC). Also, the exposure-risk relationships proposed by the Committee for Risk Assessment (RAC) express exposure as Cr(VI).

It has to be noted that some primer products may contain additional chromates, which can contribute to Cr(VI) exposure. This may be either a combination of several poorly soluble chromates covered by the ADCR consortium (i.e., a combination of StC/PHD/PCO) or a combination of one of these chromates with barium chromate (RAC Opinion for harmonised classification as carcinogenic, Cat. 1B, adopted in June 2023[3]). Barium chromate is currently not listed in Annex XIV of EU REACH.

9.1.2.2 Grouping approach for Cr(VI) compounds

A grouping approach with all the three poorly soluble carcinogenic chromates covered by the ADCR consortium, i.e. strontium chromate (StC; Entry No. 29), potassium hydroxyoctaoxodizincate dichromate (PHD; Entry No. 30) and pentazinc chromate octahydroxide (PCO; Entry No. 31) is used in the quantitative assessment presented in this CSR, because:

[1] C&L inventory on ECHA's website: https://echa.europa.eu/de/information-on-chemicals/cl-inventory-database/-/discli/details/53759; assessed in June 2023

[2] Formula and molecular weight for StC: https://www.chemicalbook.com/ChemicalProductProperty_EN_CB1184992.htm; assessed in June 2023

[3] Registry of CLH intention until outcome for barium chromate: https://echa.europa.eu/de/registry-of-clh-intentions-until-outcome/-/dislist/details/0b0236e1848d1fab; assessed in October 2023

- All substances share this common toxic moiety (chromate, measured as Cr(VI)), and are therefore expected to exert effects in an additive manner,
- At some sites several chromates may be used in parallel (e.g., because several chromates are contained in one product) or sequentially by a worker per shift (e.g., because different products containing diverse chromates are applied in sequence), leading to additive exposure for workers and additive environmental emissions.
- It is not possible to identify which chromate is present in the primed parts surface (e.g., for machining, blasting or sanding activities) contributing to worker exposure or environmental emissions.

As a consequence of this grouping approach, a larger database of worker exposure and environmental emission data is considered for this use. Data from exposure to various primer products containing StC, PHD, and PCO are therefore included in the present assessment for activities which are performed under the same conditions for bonding, wash or other types of primers. A correction factor taking into account the market shares of the chromates and primer types is then applied (for more details, see section 9.1.2.6.2 and Annex VII).

9.1.2.3 Exposure-risk relationships (ERRs) for carcinogenic effects used for the assessment

The hazard evaluation follows recommendations given by RAC (ECHA, 2015)[4] for assessing carcinogenic risk, exposure-risk relationships are used to calculate excess cancer risks.

ECHA published on December 4, 2013 the document "*Application for Authorisation: Establishing a reference dose response relationship for carcinogenicity of hexavalent chromium*"[5] (ECHA, 2013a), which states the opinion of RAC that hexavalent chromium is a non-threshold carcinogen. Consequently, demonstrating adequate control is not possible and the socioeconomic analysis (SEA) route is applicable. The exposure-risk relationships published in this document from ECHA (2013a) are used to calculate excess cancer risks associated with the use(s) of Cr(VI) covered by this application. However, the resulting risk estimates likely overestimate the cancer risk. RAC states in its publication of the ERR (ECHA, 2013a): "As the mechanistic evidence is suggestive of non-linearity, it is acknowledged that the excess risks in the low exposure range might be an overestimate".

The excess cancer risk characterisation for workers is solely based on inhalation exposure and the risk for lung cancer, as no information on the fraction of inhalable, but non-respirable particles is available, which prevents a differentiated consideration of inhalation and oral exposure of workers. This is also the standard procedure proposed by ECHA (2013a), as ECHA states: *"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, it is assumed that all Cr(VI)-bearing particles are of respirable sizes, and thus no oral exposure route is considered for worker inhalation. This is a conservative approach, since the potential lung cancer risk is at least an order of magnitude higher compared to the potential cancer risk for the digestive tract.

[4] *Amendment of the RAC note "Application for Authorisation: Establishing a reference dose-response relationship for carcinogenicity of hexavalent chromium" to include the intrinsic property "Toxic to reproduction" of the Cr(VI) compounds*: https://echa.europa.eu/documents/10162/21961120/rac_35_09_1_c_dnel_cr-vi-_en.pdf/8964d39c-d94e-4abc-8c8e-4e2866041fc6; assessed in June 2023

[5] ECHA Website: https://echa.europa.eu/documents/10162/13579/rac_carcinogenicity_dose_response_crvi_en.pdf/facc881f-cf3e-40ac-8339-c9d9c1832c32; assessed in June 2023

The following exposure-risk relationships are used for estimating excess lung cancer risks for workers (inhalation).

Table 9-3: Exposure-risk relationships for inhalation exposure of workers used for calculating cancer risks due to Cr(VI) exposure (from ECHA, 2013a)

TWA Cr(VI) inhalation exposure concentration [µg/m^3]*	Excess lung cancer risk in workers [x 10^{-3}]
25	100
12.5	50
10	40
5	20
2.5	10
1	4
0.5	2
0.25	1
0.1	0.4
0.01	0.04

TWA: Time-weighted average, expressed in micrograms of Cr(VI) per cubic meter of air

* Based on a 40-year working life (8h/day, 5 days/week).

For the general population, oral (via drinking water and food) and inhalation exposure is considered, following recommendations of RAC (RAC did not identify cancer risks after dermal exposure for workers or the general population). For inhalation exposure, RAC again presented an exposure-risk relationship for lung cancer, whereas for oral exposure the focus was on an increased risk for tumours of the small intestine (ECHA, 2013a). As considered above for the assessment of worker exposure, it is assumed that all particles are in the respirable size range for inhalation exposure of the general population.

The following exposure-risk relationships are used to characterise risks of the general population after exposure (over 70 years) of humans via the environment.

Table 9-4: Exposure-risk relationships for inhalation exposure of general population used for calculating cancer risks due to Cr(VI) exposure (from ECHA, 2013a)

Average Cr(VI) exposure concentration in ambient [µg/m³]*	Excess lung cancer risk in the general population [x 10^{-3}]
10	290
5	145
2.5	72
1	29
0.5	14
0.25	7
0.1	2.9
0.01	0.29
0.001	0.029
0.0001	0.0029

***** Based on an exposure for 70 years (24h/day, every day).

Table 9-5: Exposure-risk relationships for oral exposure of general population used for calculating cancer risks due to Cr(VI) exposure of humans via environment (from ECHA, 2013a)

Constant average oral daily dose of Cr(VI) [µg/kg bw/day]*	Excess small intestine cancer risk in the general population [x 10^{-4}]
10	80
5	40
2.5	20
1	8
0.5	4
0.1	0.8

***** Based on an exposure for 70 years (24h/day, every day)

9.1.2.4 Environment

Scope and type of assessment

StC is not listed in Annex XIV for endpoints related to concerns for the environment. Therefore, no environmental assessment has been performed. However, the applicants duly apply and communicate risk management measures derived by the registrants due to other substance properties, which they communicated via the Safety Data Sheets (SDS).

9.1.2.5 Exposure of humans via the environment

9.1.2.5.1 Scope and type of assessment

Exposure of humans to Cr(VI) via the environment (HvE) as a result of wastewater and air emissions from the sites of the applicants and downstream users covered by this CSR is considered in section 9.2.3.1. With regard to oral exposure of humans via the environment, it has to be acknowledged that Cr(VI) is rapidly reduced to Cr(III) in many environmental compartments (ECB, 2005). Therefore, exposure to Cr(VI), estimated based on the release of Cr(VI) into environmental compartments may significantly overestimate human exposure via the environment. Moreover, several of the parameters necessary for environmental modelling (in particular the partition coefficients) are based on the log of the octanol-water partition coefficient (Kow) of a given substance. This parameter is of no relevance for inorganic substances such as Cr(VI), and therefore the calculated partition coefficients are not applicable.

Apart from that, there is only limited data on the presence of Cr(VI) in food. In most cases, only total chromium was measured. According to a few studies, Cr(VI) generally amounts to less than 10% of total chromium (range 1.31-12.9%) (EFSA, 2014). Furthermore, some studies even indicate that foods of plant origin do not contain Cr(VI) at all and that the Cr(VI) levels measured are analytical artefacts (EFSA, 2014). The same may be the case with foods of animal origin. Based on these data, the EFSA-CONTAM Panel concluded 'that there is a lack of data on the presence of Cr(VI) in food' and 'decided to consider all the reported analytical results in food as Cr(III)' (EFSA, 2014). Furthermore, the CONTAM Panel concluded that it can be assumed 'that all the chromium ingested via food is in the trivalent form (i.e., Cr(III)), in contrast to drinking water where chromium may easily be present in the hexavalent state', primarily due to the use of strong oxidizing agents in the treatment of drinking water (EFSA, 2014). These considerations of the CONTAM Panel support the earlier evaluation of the EU Risk Assessment Report for chromates, in which the indirect oral exposure of HvE was assessed only on the basis of exposure via (drinking) water and the consumption of fish (ECB, 2005). The same approach is therefore followed here.

This assessment focuses primarily on the carcinogenicity of Cr(VI) released from the chromates as the most relevant endpoint and compares the exposure estimates with the exposure-risk relationship derived by the RAC for the general population, as shown below in Table 9-6.

Table 9-6: Type of risk characterisation required for humans via the environment

Route of exposure and type of effects	Endpoint considered and type of risk characterisation	Hazard conclusion Dose – response relationship
Inhalation: Systemic Long Term	Carcinogenicity Quantitative	RAC dose-response relationship based on excess lung cancer risk (ECHA, 2013a) For general population; based on 70 years of exposure; 24h/day: Exposure to 1 µg/m^3 Cr(VI) relates to an excess risk of 2.9x10^{-2} *
Oral: Systemic Long Term	Carcinogenicity Quantitative	RAC dose-response relationship based on excess cancer risk for tumours of the small intestine (ECHA, 2013a) For general population; based on 70 years of exposure: Exposure to 1 µg Cr(VI) /kg bw/day relates to an excess risk of 8x10^{-4}

* The cancer risk characterisation by inhalation for humans via the environment is solely considering risk for lung cancer, as no information on the fraction of inhalable, but non-respirable particles is available, which prevents a differentiated consideration of inhalation and oral exposure of humans via the environment.

9.1.2.5.2 Comments on assessment approach

In this section, we describe the approach to assess human exposure to Cr(VI) via the environment (HvE) resulting from the industrial use of the chromate covered in this CSR. Exposure via ambient air and oral exposure (through drinking water intake and consumption of fish) has been assessed at local levels. No regional assessment has been carried out as it can be assumed that Cr(VI) from any source will be reduced to Cr(III) in most environmental situations and therefore the effects of Cr(VI) as such are likely to be limited to the area around the source, as described in the EU Risk Assessment Report for chromates (ECB, 2005). The approach to not perform a regional assessment for human Cr(VI) exposure via the environment as part of AfAs for chromate uses was also supported in compiled RAC and SEAC (Socio-economic Analysis Committee) opinions on existing authorisations, as described for example in the *Opinion on an Application for Authorisation for the use of strontium chromate in primers applied by aerospace and defence companies and their associated supply chains* (assessed on ID 0117-01[6]). This states that regional exposure of the general population is not considered relevant by RAC due to the transformation of Cr(VI) to Cr(III) that will occur rapidly under most environmental conditions.

EUSES modelling of human exposure via the environment

The assessment of human Cr(VI) exposure via the environment is based on emission measurements in air and wastewater from representative sites. Distribution and exposure modelling are carried out with the European Union System for the Evaluation of Substances (EUSES) software (v. 2.1.2).

[6] RAC/SEAC *Opinion on an Application for Authorisation for the use of strontium chromate in primers applied by aerospace and defence companies and their associated supply chains*, consolidated version, 2018; https://echa.europa.eu/documents/10162/d2348195-b031-01bb-0ab8-04b9f7a53c44; assessed in December 2022

Release days

For the considered exposure pathways air, water, and fish, 365 release days are always assumed. This approach is considered justified, because:

- The air concentration (*annual average local "Predicted environmental concentration" (PEC) in air (total)*) and the concentration in fish (calculated from the bioconcentration factor in fish and from the *annual average local PEC in surface water (dissolved)*) are based on annual average PEC values, on which the number of release days has no impact.
- The Cr(VI) concentration in drinking water is based on the higher of the two values "*annual average local PEC in surface water (dissolved)"*, which is independent of the number of release days, as described above, and "*local PEC in pore water of agricultural soil"*, where fewer release days would lead to an intermittently higher PEC value. If the concentration in drinking water is based on the "*local PEC in pore water of agricultural soil"* and if this value is temporarily increased due to intermittent release (of sewage sludge to agricultural soil with temporarily higher Cr(VI) concentrations), the concentration in drinking water would be temporarily higher than under the assumption of 365 release days. This is a very unrealistic scenario since a spatial and temporal distance between pore water of agricultural soil and drinking water would compensate for variations in Cr(VI) drinking water concentrations due to intermittent release of Cr(VI) to wastewater. Furthermore, the use of an intermittently elevated drinking water concentration for the calculation of a lifelong cancer risk via drinking water consumption would be an overestimation of the realistic risk and therefore, by considering 365 release days, a stable concentration in drinking water is calculated.
- In this latter case, the "*local PEC in pore water of agricultural soil*" is simply equated by EUSES software with the "*local concentration in groundwater*", which is taken as the concentration in drinking water (if the concentration is higher than the one derived from surface water; see above). As noted in the EUSES background report, equating the soil pore water concentration with the groundwater concentration 'is a worst-case assumption, neglecting transformation and dilution in deeper soil layers'. This conservatism would increase the unrealistic nature of intermittent release further and the use of an annual average exposure estimate is considered more adequate in the present context.

Sewage treatment plant (STP)

For sites where wastewater is sent to a biological sewage treatment plant (STP), we have adjusted the default distribution of Cr(VI) in the sewage treatment plant (STP) used in EUSES (99.9% in water and 0.1% in sludge) to 50% in water and 50% in sludge. This is based on the description given in the EU Risk Assessment Report (ECB, 2005) that during biological treatment 50% of Cr(VI) are released into the effluent and 50% are absorbed to sewage sludge. The application of sludge on agricultural soil (rate: 5000 kg/ha/year) and grassland (rate: 1000 kg/ha/year) was considered according to the EUSES standard setting unless there was information to the contrary.

Oral uptake via drinking water and fish

The intake of pollutants via drinking water and fish, as modelled in EUSES, is unreasonably conservative and therefore, specific reduction factors are applied for risk calculations in the environmental contributing scenario (see section 9.2.3.1). The arguments why the EUSES calculations are overly conservative for these pathways, and derivation of reduction factors are described below:

- Drinking water

  a) Local concentration in drinking water based on the local PEC in surface water (“*annual average local PEC in surface water (dissolved)”)*:

  - The approach chosen is likely to ”*overestimate the actual indirect exposure as the conversion of Cr (VI) to Cr (III) is expected to occur under the vast majority of environmental conditions”* (ECB, 2005). This reduction is not considered in the exposure values calculated in EUSES.

  - EUSES typically specifies a “purification factor” that accounts for removal processes from surface water in deriving the concentration in drinking water, e.g., by evaporation or adsorption to suspended solids. However, the latter is estimated by log Kow and not by specific distribution coefficients. This approach is not feasible for inorganic substances and therefore the estimate does not account for adsorption to suspended particles as a removal process before and during drinking water purification. Although these effects are difficult to quantify, the value of 50% (i.e. reduction by factor 2) for adsorption to sewage sludge as applied in the EU RAR (ECB, 2005) (as described above) can serve as an indicator of the degree of Cr(VI) adsorption to suspended solids in surface water.

  - The local PEC in surface water is calculated for the mixing zone, neglecting the fact that for drinking water preparation additional water sources are added and dilution takes place.

  b) Local concentration in drinking water based on the “*local PEC in pore water of agricultural soil*”:

  - The Cr(VI) concentration in groundwater is taken directly from the pore water concentration in the soil, which in turn is modelled from the Cr(VI) concentration in the soil. Cr(VI) reduction in soil is a well-known process and the EU Risk Assessment Report states that “*chromium (VI) is reduced to chromium (III) by organic matter and this process occurs reasonably readily in soils*” and assumes “*chromium present in soil following application is in the form of chromium (III)*” (ECB, 2005). This reduction is not considered in EUSES modelling.

  - In addition, EUSES calculates the deposition (the main relevant pathway of groundwater contamination) for a circle around the source with a radius of 1000 m (RIVM, 2004), so that the resulting groundwater concentration only applies to the groundwater below this area.

  - EUSES modelling of the concentration in groundwater is based on a simple algorithm that equates the concentration of a substance in groundwater with its concentration in the pore water of the soil (RIVM, 2004). These authors state that “*this is a worst-case assumption, neglecting transformation and dilution in deeper soil layers*”.

  - Like for surface water, any additional dilution with other groundwater or surface water for drinking water preparation is not considered.

  Overall, the conservatism of EUSES with respect to exposure to drinking water is classified as “worst case” by the software developers (RIVM, 2004).

Against the background of these substance-specific and model-inherent considerations, the estimate for local exposure via drinking water is regarded as unreasonable. The effects of all these issues are not quantifiable, but a general reduction of the local Cr(VI) concentration in drinking water, calculated in EUSES, by a factor of 5 due to the above factors, seems to be appropriate. Still, this is considered to result in a conservative exposure estimate.

- Fish

1) In EUSES, a default consumption of 115 g fish per day is used, which overestimates the realistic human daily intake of fish on a long-term basis. According to the food consumption data for humans in Europe, as accessible in the *PRIMo – Pesticide Residue Intake Model*[7] (v.3.1) of the European Food Safety Authority (EFSA), the maximum of the mean consumption of fish (and fish- and marine-/freshwater-products) is 29.3 g per day[8]. This amount is approximately 4-fold lower (factor 3.9) than the default consumption used in EUSES, most likely due to the fact that it reflects a long-term estimate (i.e., most people do not eat fish every single day).
2) It must be noted, that "*(p)eople do not consume 100% of their food products from the immediate vicinity of a point source. Therefore, the local assessment represents a situation which does not exist in reality*" (ECHA, 2016a).

From argument 1) (almost) a reduction factor of 4 can be assumed and although argument 2) is not scientifically verifiable, it certainly makes up more than a factor of 1.25. Thus, combining these two arguments, a **total reduction factor of 5** can be derived, which is assumed to be sufficiently conservative to also cover, for example, that some countries have not indicated long-term consumption quantities to EFSA (and are thus not represented in the PRIMo Model). Adding further to the conservatism, it must be noted that the value derived from the data in the PRIMo model relate to the consumption of '*fish, fish products and other marine and freshwater food product'* and therefore include food items that are unlikely to be sourced from the immediate vicinity of the site assessed.

Inhalation exposure

The following must be considered for local inhalation risks: The concentration in air and deposition are estimated in EUSES with the Operational Priority Substances (OPS) model that is embedded in EUSES (de Bruin et al., 2010; Toet and de Leeuw, 1992). When EUSES was developed, conservative input values were chosen (e.g., stack height of 10 m, no excess heat of the plume emitted compared to environmental temperature and an ideal point source). For a stack height of 10 m, the maximum concentration is modelled at a distance of 100 m from the source and this distance was set as the default distance for the local PECair in EUSES. The developers of the OPS model at the Dutch RIVM analysed the impact of these conservative default settings on the estimated concentration in air and

[7] In the *PRIMo – Pesticide Residue Intake Model* (v.3.1) of the European Food Safety Authority (EFSA) food consumption data for individuals of different age groups in numerous European countries are listed. The model can be accessed via https://www.efsa.europa.eu/en/applications/pesticides/tools (accessed in December 2022).

More detailed information on the model is under the following links:
https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2018.5147 and
https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/sp.efsa.2019.EN-1605

[8] The value was provided for Germany (general population) based on the daily intake (reported in the PRIMo model in g/kg bw and day), multiplied by the body weight (reported in kg). The value represents the maximum of the mean values reported for different countries and population groups (e.g., children, adults, general population).

on the total deposition. For example, they noted that '*[i]ncreasing the stack height from 10 to 50 m lowers the maximum concentration by a factor 40*' and – considering all factors – concluded that '*air concentration and total deposition used for risk assessment purposes are likely to be overestimated due to over-conservative default settings used in the standard scenario in EUSES*'(de Bruin et al., 2010). In the light of these findings, the inhalation risk estimates presented in this report are highly conservative.

Site-specific release fractions

Data for monitoring of Cr(VI) releases to water and air are available from several sites. Release fractions for Cr(VI) emissions to water, air and soil were derived from the site-specific emission data and tonnages of used chromates. These releases are generally governed by, and comply with, local worker and environmental regulatory requirements.

For some sites, the calculated release fractions may be overestimated (e.g., because the site has emissions from spraying and from sanding of surfaces but does not itself spray the parts to be sanded (e.g., during aircraft repainting), so the site can only report tonnages for its spraying activities, that are used to calculate release fractions). In addition, for sites that only reported emission data but no tonnage (e.g., sites with emissions from removal or machining of surfaces) we used a placeholder tonnage to calculate the release fractions. For these sites it is indicated in the table in Annex III that the release fraction does not correspond to the actual tonnage used at the site and shall therefore be disregarded. It should be noted that the release fraction is in EUSES only used as a basis for entering the emission values and has no effect on the calculated exposure value (the emissions are the relevant parameters).

For some sites with Cr(VI) emissions from several chromates, we could allocate the measured emissions to the chromates used via the use quantities of the different products at the sites. However, for most sites this was not possible (e.g., because a breakdown of the use quantities per product could not be provided). For such sites, we used generic factors according to which we distributed the emission to the three chromates (StC, PHD, PCO). The factors are based on the market shares of each chromate and (primer-type specific) use in EEA. We also applied these factors for sites where sanding, machining or blasting of surfaces contributes to emissions because a) it is usually unknown to the site which precise chromates are present in the surface and b) the company measuring emissions from such sources cannot provide information on the amount of chromates used. The exact factors used for StC, PCO, and for PHD are reported in Annex VII of this CSR.

<u>Wastewater</u>

Wastewater containing Cr(VI) may occur for example from cleaning activities (i.e., rinsing water, water from gun cleaning station, in case of water-based primer products, water from spray hangar cleaning) and e.g., from extraction system with water curtain in a spray booth. At all sites wastewater is collected and then either

- sent to an external waste management company (licensed contractor) where it is treated as hazardous waste (this is the way it is done by most sites) or
- discharged into a special treatment facility.

The special treatment facility can be located on-site or external where the water is transferred via underground pipes. In the special treatment facility, the Cr(VI) in wastewater is reduced to Cr(III) by addition of a reducing agent (e.g., sodium metabisulphite, ferrous sulphate, or ferric chloride solutions) in excess of stoichiometry. Usually, reduction efficiency is measured by a redox probe. Following the reduction step, the wastewater pH is neutralized, and Cr(III) is precipitated. After monitoring of the Cr(VI) concentration in the reduced wastewater, the wastewater is usually mixed with other non-Cr(VI) containing waste solutions. The wastewater is then discharged to an external municipal wastewater/sewage treatment plant for further treatment prior to discharge to receiving waters (river, canal, or sea).

Air

Air from working areas where aerosols/dusts containing Cr(VI) arise (e.g., spray rooms/booths/hangars or extraction rooms/booths/cabins/benches for certain machining activities) is exhausted and treated in filters or wet scrubbers prior to external release.

Soil

There is no direct release to soil, based on equipment and procedures in place.

Waste

Solid waste containing Cr(VI) may arise for example in the form of empty chemical containers, cleaning materials (e.g., rags, wipes), contaminated equipment (e.g., filters or paint brushes), disposable PPE, paper/foil wall covers in spraying areas or masking tape. Waste materials containing Cr(VI) are classified and treated as hazardous wastes according to UK regulations. Any solid or liquid waste is collected by an external waste management company (licensed contractor) for disposal as hazardous waste.

Substance-specific input values

We use the substance-specific physico-chemical properties of StC as an input to model the behaviour of Cr(VI) with EUSES. A comparative EUSES assessment, where an identical example exposure scenario was calculated with the different substance-specific physico-chemical properties of StC, PHD, and PCO showed that the results were identical. Accordingly, EUSES modelling based on environmental emission measurements, where chromates other than StC contribute to the measured Cr(VI) concentration, allows a risk assessment to be performed with the physico-chemical parameters of StC, without underestimating the predicted environmental concentrations. The physico-chemical properties of PCO and PHD, which were used for modelling, and the results of the comparative EUSES assessment, are provided in Annex I of the CSR.

The physico-chemical properties of StC are used in this assessment to model the environmental release. For environmental fate modelling, data available for Cr(VI) are used, as the chromate ion is the moiety relevant for distribution via water and soil. Table 9-7 shows the physico-chemical properties of StC and the environmental fate properties of Cr(VI) required for EUSES modelling, as given in the EU Risk Assessment Report (ECB, 2005).

Table 9-7: Physico-chemical properties of StC and environmental fate properties of Cr(VI) required for EUSES modelling

Property	Description of key information	Value selected for EUSES modelling	Comment
Molecular weight	203.61 g/mol	100 g/mol	Refers to StC; value used in Annex XV dossier for StC (ECHA, 2013b)
Melting /freezing point	n/a, decomposes at ca. 500 °C into chromium (III) oxide	500°C	Refers to StC; value used in Annex XV dossier for StC (ECHA, 2013b)
Boiling point	n/a, decomposes at ca. 500 °C into chromium (III) oxide	500°C	Refers to StC; value used in Annex XV dossier for StC (ECHA, 2013b)
Vapour pressure	n/a: inorganic ionic compound	0.00001 Pa	n/a; dummy value entered
Log Kow	n/a: inorganic ionic compound	0	n/a; dummy value entered
Water solubility	ca. 1.2 g/L at 20 °C	1.2 g/L at 20 °C	Refers to StC, value used in Annex XV dossier for StC (ECHA, 2013b)
Kp *suspended matter*		1100 L/kg	Refers to Cr(VI); value for acidic and alkaline conditions given in ECB , mean value is used; see text below for details
Kp *sediment*		550 L/kg	Refers to Cr(VI); value for acidic and alkaline conditions given in ECB , mean value is used; see text below for details
Kp *soil*		26 L/kg	Refers to Cr(VI); value for acidic and alkaline conditions given in ECB , mean value is used; see text below for details
Bioconcentration factor fish	1 L/kg	1 L/kg	Refers to Cr(VI); value used in ECB

We derived the solids-water partition coefficients in suspended matter (Kp *suspended matter*), in sediment (Kp *sediment*) and in soil (Kp *soil*) for Cr(VI) from Table 9-7 as follows (see Table 9-8). In the

EU Risk Assessment Report for chromates (ECB, 2005), the Cr(VI) partition coefficients are given for suspended matter, sediment and soil under acidic and alkaline conditions. The mean value of the partition coefficients under acidic and alkaline conditions was calculated for each compartment because (a) it reflects the range of values and (b) the underlying data – especially for Kp *suspended matter* and Kp *sediment* – are not very well founded, which hinders a more reliable prediction of these parameters.

Table 9-8: Partition coefficients for Cr(VI) for suspended matter, sediment and soil under acid and alkaline conditions, as given in ECB

Partition coefficient *	Acid conditions (pH ≤5)	Alkaline conditions (pH ≥6)	Mean
Kp *suspended matter*	2 000 L/kg	200 L/kg	1 100 L/kg
Kp *sediment*	1 000 L/kg	100 L/kg	550 L/kg
Kp *soil*	50 L/kg	2 L/kg	26 L/kg

* All Kp values refer to partitioning between water and the solid phase indicated.

In the absence of any specific data for StC, we use these mean partition coefficients for EUSES modelling. However, we consider this to be a conservative approach due to the low water solubility of the three chromates (between 1.5 and 0.02 g/L), which would be expected to be associated with higher partition coefficients (the higher the solids-water partition coefficient, the less substance enters the water phase). The studies described in the EU Risk Assessment Report for chromates (ECB, 2005) are mostly related to total chromium and Cr(VI) in the environment but conclusions on the source chromate are usually not possible. Assuming, that the data available in the EU Risk Assessment Report include also the poorly water-soluble chromates, it can be expected that their partition coefficients are rather at the upper end of the range described in the EU Risk Assessment Report, i.e., more in the range of the partition coefficients described for acidic conditions.

To assess the impact of the selected partition coefficients, we conducted a sensitivity analysis with EUSES, where an exemplary exposure scenario (with use of biological STP) was carried out using (a) the coefficients for alkaline conditions, (b) the calculated mean values or (c) the coefficients for acidic conditions. Using the mean partition coefficients, a total risk (sum of dose from drinking, fish, and air) of 2.59E-05 was calculated, compared to a risk of 1.43E-05 using the highest partition coefficients (under acidic conditions). The detailed results are given in Annex II of this report.

9.1.2.6 Workers

9.1.2.6.1 Scope and type of assessment

No professional or consumer uses are applied for in this application for authorisation, and such uses are therefore not part of this chemical safety report (CSR).

StC has been included in Annex XIV of the REACH Regulation for its carcinogenic properties. As regards this toxicological effect, the assessment is limited to the inhalation exposure pathway: indeed, according to RAC "*there are no data to indicate that dermal exposure to Cr(VI) compounds presents a* *cancer risk to humans*” (ECHA, 2013). Therefore, the quantitative occupational exposure estimation and risk characterisation for carcinogenic effects focuses on inhalation exposure of workers.

Table 9-9: Type of risk characterisation required for workers

Route of exposure and type of effects	Endpoint considered and type of risk characterisation	Hazard conclusion DNEL/dose – response relationship
Inhalation: Systemic Long Term	Carcinogenicity Quantitative	RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a) For workers; based on 40 years of exposure; 8h/day; 5 days/week Exposure to 1 µg/m^3 Cr(VI) relates to an excess risk of 4x10^{-3} *

* The cancer risk characterisation for workers by inhalation is solely based on inhalation exposure and the risk for lung cancer, as no information on the fraction of inhalable, but non-respirable particles is available, which prevents a differentiated consideration of inhalation and oral exposure of workers.

A qualitative risk characterisation with respect to the skin sensitising properties of StC (classified as Skin Sens. 1 based on respective joint entries of registrants) is outside the scope of this CSR, as it has been included in Annex XIV to Regulation (EC) No 1907/2006 (REACH) solely due to its carcinogenic properties (see section 9.1.2.1). According to REACH, 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 applicants duly apply and communicate risk management measures derived by the registrants of the chromate due to other substance properties related to human health concerns, which they communicated via the Safety Data Sheets (SDS).

9.1.2.6.2 Comments on assessment approach

<u>General approach</u>

The potential for exposure depends on the specific tasks identified for each use, as described below in the respective sections. Based on the process characteristics and properties of StC as non-volatile substance, all potential inhalation exposure will be due to aerosols/dusts containing Cr(VI).

Machining on Cr(VI) treated surfaces (e.g., sanding, grinding) or parts (e.g., drilling, milling) may lead to Cr(VI) exposure via inhalation of fine dust particles that are generated. Therefore, these tasks are included in the assessment.

Inhalation exposure of workers is assessed via reliable and representative workplace air measurements. We have assigned exposed workers to “Similar Exposure Groups” (SEGs), which comprise groups of workers performing similar tasks and, hence, are assumed to experience similar exposures. Measured data covering main tasks of a certain SEG are pooled (e.g., monitoring values covering the task "Primer application by manual spraying in spray room" are considered for the SEG "Spray operators for manual spraying in spray room/booth"). Generally, worker monitoring data are assigned to all uses for which tasks were performed during measurements.

Note that some primer products contain barium chromate in addition to the chromate covered under the present use , which then contributes to Cr(VI) exposure of workers. Also, a worker might during a workplace air measurement sequentially apply primer products covered under the present use (e.g., worker sprays first bonding primers) and afterwards applies a product containing a different chromate (e.g., chromium trioxide during slurry coating). It is not possible to quantify and proportionally allocate part of the measurement according to each chromate used. Accordingly, measurement values with contributions of exposure from such chromates can lead to an overestimation of exposure from the present use.

Further, monitoring data considered for the present use also include measurements (at least partly) related to use of wash or protective primers containing StC, PHD or PCO covered by separate applications (either new AfAs or Review Reports). Differentiation of the measurement data according to uses is not possible. However, as the conditions of use between the different primer types are comparable, we consider these data not to have a discernible impact on the calculated exposure values (90^{th} percentiles) for workers.

Still, for the exposure assessment we consider that workers spend only part of their time on the present use (across all sites). After calculating the 90^{th} percentile based on exposure data for all three uses, we account for this by multiplying the exposure value by a factor based on market shares of the chromates and primer types covered under the present use (similar to the approach described in section 9.1.2.5.2). The exact factors used for StC, PCO, and for PHD are reported in Annex VII of this CSR.

Measurement methods with varying sensitivity are applied. For values below the limit of quantification (LOQ), EN 689:2018 (Workplace exposure – Measurement of exposure by inhalation to chemical agents – Strategy for testing compliance with occupational exposure limit values) recommends statistical approaches to estimate the arithmetic or geometric mean in case of values below LOQ. However, due to the heterogeneity of our datasets (which come from different sites, with measurements performed by different service providers) these approaches are not feasible. Two other methods for treating such values, the use of LOQ/√2 or LOQ/2, are discussed in literature. The use of LOQ/2 is preferred for data sets with a geometric standard deviation >3 and the use of LOQ/√2 is preferred for data sets with a geometric standard deviation <3 (Morton and Lion, 2016; Succop et al., 2004). The resulting values of both methods likely overestimate mean values but are expected to have no influence on the 90^{th} percentile of worker measurements considered in this CSR for exposure estimation. Since the use of LOQ/2 is a frequently used practical approach accepted by ECHA for the environmental part, we have used LOQ/2 for values <LOQ in the present exposure assessments (ECHA, 2016a; U.S. EPA, 2019).

For the assessment of inhalation exposure, we included individual exposure values provided by numerous sites either via Article 127H notification monitoring template (elaborated by previous consortia of initial AfAs under EU REACH) or the original monitoring reports. These exposure values are accompanied by varying degrees of contextual information (e.g. primer products names, tasks carried out during measurement, OC/RMMS, method of sampling, etc.). Where sites could not provide the individual data but only statistical determinants (e.g., geometric mean, MIN, MAX), we did not consider them in the assessment.

Personal monitoring data, with sampling heads in the worker's breathing zone and with sampling durations which allow to acquire sufficient analytical mass and interpret measured values as shift-average values are preferred for inhalation exposure assessment. **Stationary (also called static) measurements** are included in the descriptions of worker exposure but are only used as supporting information.

As the focus of the exposure assessment is on carcinogenic risks over a work life, the long-term average (chronic) exposure would be the most appropriate measure. ECHA Guidance on Information Requirements and Chemical Safety Assessment, R.14: Occupational exposure assessment recommends use of the 90th percentile, without differentiating between health endpoints (ECHA, 2016b). We have followed the recommendation in the ECHA guidance to use the 90th percentile, although this is considered very conservative (as the data reflect measurement uncertainty as well as day-to-day (intra-individual) and inter-individual variation of exposure).

Biological monitoring data are a requirement of the European Commission's implementing decisions on the initial authorisations for workers performing surface treatment by spraying (large parts) in purpose-designed room, surface treatment by spraying in spray cabin/spray booth, surface treatment by spraying outside of paint-booth, and machining or sanding operations. For this reason, we report biomonitoring data available for these tasks, but do not use them for quantitative exposure assessment because as biological indicators they have some limitations:

- The measure of chromium in erythrocytes is the only one which is specific to Cr(VI). However, the available literature data on the general population and on workers are insufficient to determine reference values and limit values for this indicator (ANSES, 2017). The German method provides a correlation between biomonitoring in erythrocytes and inhalation exposures but only for CrO_3 concentrations above 30 µg/m^3, which is above what is expected in these exposures (Greim, 2000). Additionally, few sites apply biomonitoring in erythrocytes, as it is an invasive method using blood sampling and is thus difficult to use consistently as a method of estimating exposure.
- Urinary biomonitoring does not allow a differentiation between Cr(III) and Cr(VI) (Drexler and Hartwig, 2009). A biological monitoring guidance value (BMGV) of 10 µmol Cr/mol creatinine was established in the UK to assess total chromium in urine (SEA, 2018).
- Finally, chromium levels in biomonitoring studies are influenced by factors other than occupational exposure (e.g., geographical region, smoking status, intake from food and drinking water etc.), making the interpretation of the measurements as regards their relation to occupational exposures difficult.

Therefore, we consider biological monitoring an additional exposure control tool allowing assessment of higher exposures via various pathways but do not use them for the quantitative exposure and risk assessment.

Comments on assessment approach related to toxicological hazard:

Dose-response relationships for carcinogenic effects as proposed by RAC are used for risk characterisation.

Comments on assessment approach related to physico-chemical hazard:

Physico-chemical hazards are not in the scope of this document.

General information on risk management related to toxicological hazard:

Information on risk management measures implemented and a comparison with obligations from previous applications for authorisation are provided in chapter 9.2.1.

General information on risk management related to physico-chemical hazard:

Physico-chemical hazards are not in the scope of this document.

9.1.2.7 Consumers

Consumer uses are not subject of this new AfA.

9.2 Use 1: "Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains"

9.2.1 Overview of use and exposure scenarios

9.2.1.1 Introduction

This new AfA covers the "Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains". It was prepared on behalf of the applicants by the Aerospace and Defence Chromates Reauthorisation (ADCR) consortium to cover uses of chromium (VI) compounds in their supply chains in GB. The CSR is based on sector-specific knowledge provided by companies operating within the aerospace and defence industry and its supply chains.

This CSR covers the use of StC in bonding primers but includes monitoring data on two other poorly soluble chromates, PCO and PHD in a grouping approach (see section 9.1.2.2 for the justification).

The exposure scenarios (ES) and contributing scenarios of this new AfA were elaborated in the following ways:

1) This new AfA follows a substance grouping approach (see section 9.1.2.2). At several sites, more than one chromate is used in parallel or in subsequent steps during the application of primer products. Exposure of workers and of humans via the environment may come from different substances and therefore, an assessment considering all of them is appropriate.
2) In this new AfA we have identified similar exposure groups (SEGs) of workers for the use considered here, and the SEGs are described in separate worker contributing scenarios.
3) Each contributing scenario covers the relevant processes and individual tasks performed by the respective group of workers in relation to the use and describes the operating conditions (OCs) and risk management measures (RMMs) for the individual tasks involving Cr(VI) exposure. The Cr(VI) exposure from these activities is quantified by personal air measurements. In this way, Cr(VI) inhalation exposures from all relevant tasks performed by a SEG during its daily work are considered and combined for risk assessment.
4) In the environmental contributing scenario of this new AfA the assessment of humans via the environment is considered via the inhalation route and the oral route. Emission data for releases to air and wastewater serve as a basis for EUSES modelling of human exposure via several environmental media (ambient air, drinking water, fish).

The exposure scenarios and contributing scenarios of this new AfA are shown below in Table 9-10.

9.2.1.1.1 Scope of use – supply chain considerations

This CSR covers the use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains. This use is performed in GB in exclusively industrial settings in the following levels of the supply chain:

- Original Equipment Manufacturer (OEM)
- Downstream user – Build-to-print fabricator
- Downstream user – Design-to-build manufacturer, and
- Maintenance, Repair and Overhaul (MRO) companies

The present use typically involves one environmental contributing scenario for the use of StC at an industrial site.

Table 9-10 lists all the exposure scenarios (ES) and contributing scenarios assessed in this chapter.

Table 9-10: Overview of exposure scenarios and their contributing scenarios

ES number	ES Title	Environmental release category (ERC)/ Process category (PROC)
ES1-IW1	Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains – use at industrial site	
Environmental contributing scenario(s)		
ECS 1	Use of bonding primers containing strontium chromate – use at industrial site leading to inclusion (of Cr(VI) or the reaction products) into/onto article	ERC 5
Worker contributing scenario(s)		
WCS 1	Spray operators for manual spraying in spray room/booth	PROC 5, PROC 7, PROC 8b, PROC 9, PROC 28
WCS 2	Operators performing brushing/rolling	PROC 10
WCS 3	Machinists	PROC 21, PROC 24
WCS 4	Sanders in a dedicated hangar	PROC 21, PROC 24
WCS 5	Workers performing media blasting in closed system	PROC 21, PROC 24
WCS 6	Workers performing media blasting in a room/hall	PROC 21, PROC 24
WCS 7	Maintenance and/or cleaning workers for spray area(s)	PROC 8b, PROC 28
WCS 8	Maintenance and/or cleaning workers (excluding spray areas)	PROC 28
WCS 9	Incidentally exposed workers	PROC 0
Exposure scenario for industrial end use at site: ES1-IW1		

9.2.1.1.2 Relationship between uses

Primer products are applied to metallic surfaces that may have been previously galvanically or chemically treated using chromates (e.g., by anodising or chemical conversion coating, using chromium trioxide or dichromium tris(chromate)). Such surface treatments have been subject of applications submitted previously by the ADCR Consortium for the use of water-soluble chromates and are not addressed in this application. The galvanic or chemical treatments are typically performed on individual components of aircraft and/or ground-based defence equipment at sites or site areas different from those applying primer products. The application of chemical conversion coating using touch-up pens may also be performed by the workers covered by the present use, for example during MRO work. Where necessary, this is typically carried out prior to the application of the primer layer(s).

Bonding primers with StC form part of a multilayer coating system. They are usually applied directly to a previously surface-treated substrate, which helps to facilitate adhesion of the primer. On top of the bonding primer, a subsequent adhesive layer is applied to bond another substrate to it. The sequence of treatment steps is shown in Figure 9-1.

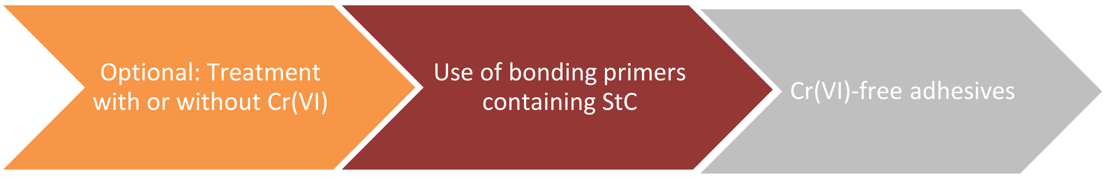

Figure 9-1: Sequence of treatment steps

9.2.2 Detailed information on use

9.2.2.1 Process description

A detailed description of processes and required functionalities is part of the report on the Analysis of Alternatives.

<u>Substrate(s)</u>

The substrates to which this use applies are typically metallic surfaces.

9.2.2.2 Teams and employees involved

For the present assessment, we have identified the following similar exposure groups (SEGs) for tasks with potential Cr(VI) exposure related to the use of bonding primers containing StC :

- Spray operators for manual spraying in spray room/booth
- Operators performing brushing/rolling
- Machinists
- Sanders in a dedicated hangar
- Workers performing media blasting in closed system
- Workers performing media blasting in a room/hall
- Maintenance and/or cleaning workers for spray area(s)
- Maintenance and/or cleaning workers (excluding spray areas)
- Incidentally exposed workers

9.2.2.3 Technical and organisational risk management measures

All sites using bonding primers containing StC within the ADCR supply chains are specialised industrial sites. They have rigorous internal safety, health, and environment (SHE) organisational plans. The sites adhere to best practices to reduce workplace exposures and environmental emissions to as low as technically and practically feasible and use automated processes to the extent possible. Workplaces are assessed regularly regarding the handling of hazardous substances according to the respective national schemes, i.e., according to the Control Of Substances Hazardous to Health (COSHH) Assessment rules in the UK.

The potential for (and the degree) automation related to spraying or machining activities can vary between different sites and depend, among other factors, on the geometrical structure of the part, the variability of the parts to be treated, the mechanical complexity of the machining task, the size of the site and the frequency with which the task is required.

It can be stated that companies are following the hierarchy of control principles:

- S: for a description of efforts to substitute primer products containing Cr(VI) see the AoA report
- T: various technical measures are in place; most importantly, LEV is implemented wherever technically feasible (see more detailed description below)
- O: organisational measure comprise restricted access to areas with Cr(VI) exposure and control of effectiveness of technical measures (see more detailed description below)
- P: for some workplaces technical and organisation measures alone are not sufficient to lower exposures to acceptable levels (e.g., during spraying or sanding); therefore, respiratory protection and other PPE are mandatory to be used at such workplaces.

The exposure scenarios developed take these conditions into account. The measurement data used for quantifying exposure and risks are discussed in detail (see sections 9.2.3.2 to 9.2.3.9.2.3) with regard to covering the various tasks performed by the SEGs as well as the conditions of use (e.g., duration and frequency, RMMs) relevant for the exposure scenarios (as laid down in the Conditions of Use (CoU) tables, see sections 9.2.3.2 to 9.2.3.9.2.3).

9.2.2.3.1 Spray facilities

The sites covered under the present use performing spraying tasks may have only one type of spray facility (e.g., spray rooms) or several (e.g., open spray booth, spray room). Some sites also have different facility types and several units of each type (e.g., several spray rooms, for instance at OEMs). Sites performing sanding of large surfaces containing Cr(VI) in a hangar also perform this task in a hangar with a setup as described below as a 'spray hangar'. It has to be noted that bonding primers are not sprayed on a whole aircraft but specifically on some parts, usually in dedicated spray facilities. Therefore, spraying in hangar is not relevant for the application of bonding primers. Illustrative photos of various spray facilities are shown in Annex VIII.

Open spray booth

Sites with open spray booths typically have a spray area equipped with mechanical ventilation, to which one or more open spray booth(s) are connected. An open spray booth has three closed sides. The fourth side is open, with no physical separation or air barrier. Spray booths have usually a moderate size of a few cubic meters, so the open side is only as large as necessary to allow components to be maneuvered into the booth while providing adequate spray distance between the component and the worker.

The sprayer standing at the open side of the booth sprays in the direction of the opposite wall, which is equipped with an exhaust air extraction system (typically wall extraction with horizontal laminar flow), so that the spray mist is extracted away from the worker. Filters in the back wall of the booth or wet scrubbers are installed for air abatement. The filters have a large surface area to trap airborne particles as the exhaust air is drawn through the filter.

During the spraying process, only the worker spraying is allowed in the area at the open side of the booth. This area is defined by coloured markings on the floor or by other signage.

Spray room

Sites with spray rooms usually have a spray area with one or more spray rooms adjacent to it. A spray room is a separate room with four physical walls or with three physical walls plus an air barrier. A clear boundary exists between the spray room and adjacent air bodies. Typically, spray rooms have negative pressure so that exposure to the external working environment is minimized. The size of spray rooms can be highly variable, ranging from a few cubic meters to several hundred cubic meters (very large spray rooms can also be the size of a dedicated spray hangar; see below).

The spray room has an exhaust system where the airflow is usually directed from the ceiling to the floor and/or to the side walls (laminar down flow or cross flow). The floor and/or the side walls of the spray room are equipped with filters, wet scrubbers or in rare cases water curtains for air abatement. The water curtain separates the particulates from the exhaust air by letting the airflow pass through a water pool.

Dedicated spray hangar

A dedicated spray hangar is a working hall with four physical walls that can fit entire aircrafts. The setup of a dedicated spray hangar is comparable to that of a spray room: it has an exhaust system where the airflow is usually directed from the ceiling to the floor and/or to the side walls (laminar down flow or cross flow). In dedicated spray hangars with floor extraction, the extraction slots are usually arranged in the silhouette of the aircraft to be able to effectively extract the contaminated air from work on the aircraft. The floor and/or the side walls of the spray hangar are equipped with filters through which the exhaust air is passed. Typically, dedicated spray hangars have negative pressure so that exposure to the external working environment is minimized. The size of dedicated spray hangars can be highly variable, ranging from a small hall e.g., fitting a helicopter to several thousand cubic meters fitting several airplanes.

In the case of bonding primers, dedicated spray hangars (or similarly equipped hangars) are relevant only for the activities of sanding whole aircrafts (see WCS 4, section 9.2.3.5) or media blasting of whole aircrafts (see WCS 6, section 9.2.3.7).

9.2.2.3.2 Workers

At all sites, risk management measures in accordance with the hierarchy of control measures set out in Article 5 of Directive 2004/37/EC are implemented as appropriate.

9.2.2.3.2.1 Technical measures

The technical measures implemented at the sites include:

- Best practices are implemented to reduce workplace exposure to the substance to as low a level as technically and practically feasible, using closed systems and automation whenever possible.
- Where possible, the sites use LEV systems that are designed, dimensioned, located, and maintained to capture and remove the substance where closed systems and automation are not possible.
- Where machining is performed in small work areas, mechanical ventilation is used for machining activities (unless use of mechanical ventilation would introduce risks or would not be technically and practically possible)
- In open spray booths, spray rooms and dedicated spray hangars technological installations are typically in place to either indicate malfunction of the extraction system to the worker (e.g., by light or audible signal) or to stop the spraying process in case of malfunction/breakdown.
- In all spray rooms and dedicated spray hangars negative pressure prevails during the spraying process, which prevents the spreading of particles in case the door is opened.
- For sanding in a dedicated hangar and machining on surfaces either on-tool extraction or a vacuum cleaner is used for local dust extraction or sanding/machining is performed under wet conditions (by wetting the sanded surface or the sanding tool, e.g., by use of a lubricant on the tool).

Efficiency of LEV

LEV systems used for specific tasks are designed, dimensioned, located, and maintained to capture and remove the substance.

The efficiency of the installed LEV system depends on the exhaust air flow rate of the system per time unit. The sites follow the manufacturer requirements as well as recommendations from national guidelines, where applicable, and perform preventative maintenance of equipment to maintain the stated efficiencies of the LEV systems.

Examples of LEV systems installed at sites, their maintenance and additional information on LEV efficiency or performance criteria are given in Annex VIII.

9.2.2.3.2.2 Organisational measures

The following organisational measures to reduce workplace exposure are implemented at sites:

- Access to all spray areas is restricted by means of access control systems and physical segregation from other work areas, signage, or through strict procedures during the activity and for a specific time after the operation has ceased.
- At spray rooms, controls (e.g., light signals) are in place to ensure access to the spray room is restricted when the system is operational to prevent other workers from entering, including adequate clearance time after completion of the spraying process.
- The areas in which machining activities are carried out are access controlled either physically by means of barriers/signage or through strict procedure during the activity and for a specific time after the operation has ceased.
- Effective cleaning practices are implemented to prevent surface contamination in the vicinity where machining activities take place.

- The appropriateness and effectiveness of RMMs and OCs in place are regularly reviewed and, as applicable, measures to further reduce exposure are implemented.
- Periodical checks and tests of LEV systems are performed to ensure full working order and records of these periodical checks and tests are kept.
- Where RPE is needed to control exposure to the substance, the sites use and maintain it in accordance with standard procedures. They perform periodical checks of RPE (including fit testing of RPE) and keep record of these periodical checks.
- Donning/doffing of protective clothing is performed in a separate changing room.
- Annual monitoring programmes are implemented for air monitoring of occupational exposure. The measurements are representative for the tasks undertaken (including e.g., spraying, maintenance and machining operations), and the OCs and RMMs used at the respective sites.
- Hazardous waste management procedures are in place.
- Adequate worker hygiene facilities are in place and workers must wash hands and face before eating, drinking, or smoking.
- LEV systems are inspected and maintained according to the manufacturer´s specification.
- The provision of PPE for the workers is organised by a designated responsible person.
- The conditions of the PPE are checked regularly.
- A program of PPE management is implemented on-site which includes PPE selection, training for correct wear/removal of the PPE, storage of PPE, cleaning or renewal and distribution of the PPE, communication via workplace signage or working instructions at the workplace.
- Training on chemical risks is periodically done for workers handling chemicals. Safety Data Sheets and/or instructions for hazardous chemicals handling are available.
- Training at the workplace is given periodically and work instructions are available on how to carry out specific tasks through standard operating procedures.
- Cleaning of company-supplied uniforms is organised by the site, or contaminated clothes are renewed.
- Chemical products are stored in a designated area.

9.2.2.3.2.3 Personal Protective Equipment

For all tasks with potential direct Cr(VI) exposure, standard operating procedures are available at the sites, wherein the appropriate PPE to be worn is specified (selected based on risks and in accordance with the exposure scenarios). The following PPE is applied for activities where exposure to Cr(VI) is possible, in order to control Cr(VI) exposures:

- Chemical protective clothing, where necessary (plus coveralls or aprons for specific tasks)
- Eye protection as per relevant risk assessment
- Chemical resistant gloves
- Respiratory protection is used as described in the respective WCS.

Gloves

Chemical-resistant gloves tested according to EN 374 are used when handling primer products containing chromates. As StC is poorly soluble and contained in the primer products in dispersed form (i.e. undissolved solid particles) its penetration through any kind of gloves material and through the skin is minimal. Therefore, the selection of material and thickness of gloves is driven by other substances in the primer products (e.g., solvents) and by other substances handled in parallel at the workplaces. Gloves and other PPE are selected based on a careful consideration of all conditions of a specific workplace as part of the companies' industrial hygiene exposure assessment.

Respiratory protection equipment (RPE)

- RPE is used for some specific activities involving primer products, as described in the respective WCS.

Use of Assigned Protection Factors (APFs) throughout this CSR

The European Standard EN 529 – "Respiratory protective devices. Recommendations for selection, use, care and maintenance" provides guidance on the selection and use of RPE. It also lists "Assigned protection factors" as recommended in various EEA countries and in the UK. APFs used in this report are given in Annex VI.

We noted that large differences exist in the APFs ambient air-independent breathing apparatuses in the UK and in EEA countries. HSG 53 gives APFs ranging from 40 to 2000, whereas much larger APFs are used in several EEA countries (see Annex VI). Examples:

- fresh air hose breathing apparatus (EN 138): UK: APF 40, Germany: APF 1000, Sweden: APF 500
- constant flow airline breathing apparatus with full mask (EN 14594): UK: APF 40, France: APF 250.

We asked HSE for assistance in choosing adequate APFs and were referred to the British Standards Institutions (BSI). BSI explained that these APFs were discussed many years ago and cited recent publications (Connell and Lynch, 2023). These authors describe some potential reasons for the differences, among them different types of data used (data from compliant and non-compliant programs were used according to Connell and Lynch (2023) in the UK) and the use of a safety factor. Considering these uncertainties and for the sake of a harmonised assessment of risks in the UK and the EEA based on the same type of data (an APF of 250 is used in respective ADCR EU applications for chromates in primer products, this being the lowest APF reported in an EEA country) in this report for various types of ambient air-independent breathing apparatuses (e.g. fresh air hose breathing apparatus, constant flow airline breathing apparatus with full mask or hoods/helmet demand valve compressed air breathing apparatus), an APF of 250 is used for calculating exposure concentrations.

The specific PPE for each task is described in detail in the worker contributing scenarios in sections 9.2.3.2 to 9.2.3.10.

9.2.2.3.3 Environment

9.2.2.3.3.1 Emissions to air

The following technical and organisational measures are implemented to reduce environmental air emissions to the maximum extent possible:

- Best practices are implemented to reduce substance emissions to the environment to as low a level as technically and practically feasible, using closed systems and automation whenever possible.
- The local exhaust air from spraying, sanding, machining, and media blasting tasks is led through filters or treated in wet scrubbers before it is released to the environment.
- Wash water in the wet scrubber is regularly exchanged when a certain threshold value of either conductivity, pH, or Cr(VI) concentration is exceeded. Regular replacement of the wash water helps to ensure that the cleaning performance of the wet scrubber does not decrease.
- The appropriateness and effectiveness of RMMs and OCs in place are regularly reviewed.
- Regular monitoring programmes for Cr(VI) emissions to air from LEV systems are implemented and are representative for the OCs and RMMs used at the individual sites where relevant measurements are carried out.
- Several sites operate under environmental permits issued by the Environment Agency for air emissions of Cr(VI). The permitted emission concentration in air is 5 mg/m³ for total chromium. Monitoring of air emission is carried out at least once per year according to the requirements given in the environmental permit. Some sites either do not have an environmental permit for air emissions because either the quantities of Cr(VI)-containing primers used and thus the emission at the site are negligible, the permit issued does not contain a limit for Cr(VI) emissions to air, or the Environment Agency has issued a permit which does not contain emission limits for Cr(VI) to any media because the site has demonstrated that negligible ('trivial') emissions occur and the emission limit has therefore been removed from the permit.

Efficiency of air emission abatement technology

- The usual way to check the performance of filters is to measure pressure loss.
- Wet scrubbers are regularly checked by measuring conductivity, pH, or Cr(VI) concentration, ensuring proper function.
- The efficiency of the filters or wet scrubbers can also be checked by comparative measurements with and without the use of the filter/wet scrubber or between the duct inlet and outlet. At sites where such measurements are performed, very high efficiencies for air abatement can be demonstrated. As an example, such measured values from one site show a purification of the exhaust air from Cr(VI) concentrations in the range of several mg/m^3 (before the filter) to a concentration below the detection limit of the measurement method used (after the filter).

9.2.2.3.3.2 Emissions to wastewater

Most sites produce no Cr(VI)-containing wastewater from the use of primer products. At sites where Cr(VI)-containing wastewater occurs it is gathered and either sent to an external waste management company (licensed contractor) or treated on-site in a reduction facility. The majority of sites producing

Cr(VI) wastewater uses the first possibility and does not emit any chromates from primers to wastewater.

Where it occurs, for the reduction of environmental emissions to wastewater to the maximum extent possible, the technical and organisational measures implemented at the sites include:

- At sites where Cr(VI)-containing particles are carried into wastewater (e.g., in dedicated spray hangars where sanding is performed) solid particles are separated from the water phase and disposed of as hazardous waste.
- Wastewater is sent to a reduction facility (typically on-site), where Cr(VI) in wastewater is reduced to Cr(III) by addition of a reducing agent (e.g., sodium bisulfite or ferrous sulfate). After the reduction process, Cr(III) is precipitated and separated from the wastewater by a filter press (the filter cake is disposed as waste), and the treated wastewater is discharged to a wastewater treatment plant (WWTP) or municipal sewage treatment plant (STP).
- Regular monitoring programmes for Cr(VI) emissions to wastewater are implemented and are representative for the OCs and RMMs used at the individual sites where relevant measurements are carried out.
- Of the few sites, emitting Cr(VI) to wastewater, some work under environmental permits issued by the Environment Agency for Cr(VI) water emissions. The permitted maximum emission concentration in wastewater is between 1 and 7 mg/L for total chromium. In addition, consents from regional authorities are also issued (e.g., water boards or water companies) with, for example, emission limits of 5 mg/L for total chromium or 10 mg/L for chromium individually or in total with other elements (e.g., Cu, Pb, Be). The frequency of monitoring is annually according to a standard method (e.g., BS EN 1233).

9.2.2.3.3.3 Emissions to soil

The indoor and outdoor surfaces where chemicals are handled are sealed. Chemicals and solid waste containing Cr(VI) are stored in closed containers, either inside or outside.

9.2.2.3.4 Solid waste

Solid Cr(VI)-contaminated waste generated at the sites may include contaminated linings of floors and walls, masking material, filters, wipes, rags, equipment (e.g., brushes), disposable PPE, empty chemical containers, dust from dust collectors or dried primer residues. In order to avoid any emissions, the Cr(VI)-contaminated solid waste is stored in closed and sealed drums or containers in designated areas, ready to be collected by an external waste management company (licensed contractor) for disposal as hazardous waste. Depending on the site’s level activity, waste is regularly collected by the waste contractor.

The filter cake from the filter press of a reduction facility (at sites having a reduction facility for wastewater) only contains Cr(III). It is stored in closed containers and collected by an external waste management company (licensed contractor) for disposal as waste.

In the majority of cases, collected waste is incinerated with energy recovery by the waste management company. In rare cases, recovery of waste has been reported by companies (e.g. landfill of filter cake).

9.2.2.4 Tonnages and mass balance considerations

9.2.2.4.1 Tonnages

The tonnages reported below are based on information provided by sites using bonding primers with StC. Eleven GB sites and 38 EEA sites provided tonnage information. The eleven GB sites use considerably lower volumes than the EEA sites (up to 120 kg StC). However, we are not aware of any plausible reasons why the use amount per site should be different between GB and EEA and thus assume that this difference may be due to the low sample size of GB sites. Therefore, to increase the representativeness of the data, we report here the maximum use amount per site based on the information from all sites (GB + EEA). In case the actual maximum use at GB sites should be lower, the presented tonnages are conservative for the situation in GB.

Assessed tonnage for the present use:

0.1 to 230 kg Cr(VI)/year per site based on 0.1 to 900 kg of StC used per year per site.

9.2.2.4.2 Mass balance considerations

Application on surfaces

When coating with primer products by spraying or e.g., brushing or rolling, most of the primer used remains on the surface. The quantities of Cr(VI) applied to surfaces are not quantified by the sites.

Cr(VI) in primer products applied to surfaces may ultimately end up as solid waste and (to a small extent) environmental emissions at other sites when removed e.g., by sanding, media blasting or machining activities.

Amount of Cr(VI) discharged as solid waste

In spray applications, depending on the geometry of the component, overspray may occur to a large extent, so that considerable amounts of primer product remain on (linings of) floors and walls, masking material and in filters. Residues of primers also remain in empty chemical containers. Dust containing Cr(VI) from machining, sanding and blasting activities is collected in dust collectors, filters and vacuum cleaners. Cr(VI) contamination of other equipment and PPE represents a negligible part of the overall mass balance. Although it can be assumed that relevant quantities of Cr(VI) are discharged with the hazardous solid waste, these quantities are difficult to quantify, and solid waste is not analysed for Cr(VI) content by the sites. A rough estimation of 10 to 20 % of chromated primers lost to waste, or caught in filters, rags and on PPE has been reported by companies.

Amount of Cr(VI) discharged as liquid waste

Relevant quantities of primer products remain after the spraying process in the hoses that supply the spray guns with paint. Also spray guns and on other tools and equipment used for mixing application of primer products remain residues of primer products. The primer residues in the hoses and in spray guns, on tools and equipment are removed by cleaning with water or solvents. The cleaning solution is disposed of as hazardous liquid waste. Some sites also discharge (part of) their Cr(VI) wastewater as liquid waste by sending it to an external waste management company (licensed contractor). In case of primer products with passed expiry dates, these are also disposed of as hazardous waste by the waste management company. Although it can be assumed that relevant amounts of Cr(VI) are discharged with the hazardous solid waste, they are not quantified by the sites.

Amount of Cr(VI) released to the atmosphere

The exhaust air from spray applications and from sanding and machining tasks is led through filters or treated in wet scrubbers before release. The wash water from wet scrubbers is collected as wastewater and thus the Cr(VI) fraction washed off in a wet scrubber contributes to the Cr(VI) fraction discharged as liquid waste or released to wastewater. The exhaust air released via stacks is between <0.01 and 3.04 kg Cr(VI) per year per site (as described in Annex III).

Amount of Cr(VI) released via fugitive emissions

No measurement data is available for fugitive emissions. However, due to the low vapour pressure of the chromates at room temperature at which spray applications are performed, such emissions are expected to be low.

Amount of Cr(VI) released to wastewater

Only at few sites Cr(VI) wastewater occurs from use of primer products. At these sites only a minor share of the total amount of Cr(VI) used at the site is entering the wastewater path. The Cr(VI) concentration in wastewater prior to reduction is not measured at the sites. During the reduction step Cr(VI) is converted to Cr(III) and after precipitation collected in a filter press.

As the concentration of Cr(III) in the filter cake is not measured, the amount of chromium leaving the process via the filter cake cannot be assessed.

The residual Cr(VI) in wastewater after reduction, which is released to an STP or WWTP, is between 0 and 1.06E-03 kg Cr(VI) per year (as described in Annex III).

9.2.3 Exposure scenario 1 for Use 1: "Use of bonding primers containing strontium chromate in aerospace and defence industry and its supply chains"

Market sector: -

Sector of use: Other: Aerospace and defence industry and its supply chains

Article categories: not relevant

Environment contributing scenario(s): ERC 5

Worker/Consumer contributing scenario(s): PROC 0, PROC 5, PROC 7, PROC 8b, PROC 9, PROC 10, PROC 21, PROC 24, PROC 28

Subsequent service life exposure scenario(s): not relevant (see below)

Description of the activities and technical processes covered in the exposure scenario:

The exposure scenario covers the use of bonding primers containing StC by spraying or brushing/rolling applications (e.g., touch-up or swabbing). It further covers machining of parts or surfaces treated with primer products, as well as sanding and media blasting of surfaces treated with primer products (see detailed use information in section 9.2.2).

Explanation on the approach taken for the ES:

We established the exposure scenario based on sector-specific information provided by sites performing these activities.

Exposure from service life of treated articles:

Primer products containing StC are applied to the surface of parts of various sizes. Concentrations are expected to be well below 0.1% Cr(VI) (w/w), which is the concentration above which notifications of Candidate List substances in articles according to REACH Art. 33 (ECHA, 2017) are required. Also, bonding primers are typically covered by a subsequent layer of film adhesive and thus located in lower layers of the surface. Therefore, exposure from parts coated with bonding primers is negligible. In consequence, no service life scenario for use of parts where bonding primers are applied is required.

9.2.3.1 Environmental contributing scenario 1

As StC is not listed in REACH Annex XIV due to environmental effects, no environmental exposure assessment is performed here. However, we assess the exposure of humans via the environment in the following sections.

9.2.3.1.1 Conditions of use

Table 9-11: Conditions of use – Environmental contributing scenario 1

Product (article) characteristics
Product A: Bonding primer products containing StC (water-based or solvent-based); max. 19% StC; max. **4.85% Cr(VI)**
Amount used, frequency and duration of use (or from service life)
Product A: Bonding primer products containing StC (water-based or solvent-based) ▪ Annual use at a site: up to 230 kg/year [as Cr(VI)] ▪ Batch process ▪ 365 days/year (see section 9.1.2.5)
Technical and organisational conditions and measures
All products: ▪ **Technical measures** o Air - Exhaust air from LEV systems (in spray booths/rooms/hangars, machining/sanding/media blasting workplaces, on-tool extraction, mobile LEVs) is led through filters or treated in wet scrubbers before being released o Wastewater - is either gathered and sent directly to an external company certified for disposing of liquid hazardous waste or - treated on-site in a reduction facility, where Cr(VI) in wastewater is reduced to Cr(III) by addition of a reduction agent (e.g., sodium bisulfite or ferrous sulfate), followed by neutralisation and precipitation of Cr(III) (reduced wastewater is sent to a wastewater treatment plant (WWTP) or municipal sewage treatment plant (STP) (depending on local regulatory requirements)) - Cr(VI)-containing particles in wastewater (e.g., in dedicated spray hangars where sanding is performed) are separated from the water phase and disposed of as hazardous waste o Soil - The indoor and outdoor surfaces where chemicals are handled are sealed and if chemicals and solid waste containing Cr(VI) are stored outside then it is only in closed containers ▪ **Organisational conditions and measures** o Air - Cr(VI) air emission measurements are performed regularly

o Wastewater - Reduction of Cr(VI) in wastewater is controlled regularly by Cr(VI) measurements - Batches of reduced wastewater are discharged only after confirmation of Cr(VI) reduction to a concentration below the permitting limit (in accordance with the local regulatory requirements)
Conditions and measures related to sewage treatment plant
All products: ▪ Biological (municipal) STP: Standard STP or on-site treatment plant (removal rate: 50% to sludge assumed, see description in section 9.1.2.5) ▪ Sludge application to agricultural soil: unknown; for a conservative assessment sludge application is assumed ▪ Discharge rate STP: 2 000 m^3/day (by model default) ▪ Dilution factor for receiving water body: 10 (by model default)
Conditions and measures related to treatment of waste (including article waste)
All products: ▪ Solid waste contaminated with Cr(VI) such as filters, linings of floors and walls, masking material, wipes, equipment (e.g., brushes), empty chemical containers, PPE, dried primer residues or dust from dust collectors is stored in closed drums or containers and collected by an external waste management company (licensed contractor) for disposal of as hazardous solid waste. ▪ Filter cake from the wastewater reduction plant only contains Cr(III) (since, even if the reduction were incomplete, residual Cr(VI) is readily soluble in water and would be found in the water phase) and is collected by an external waste management company (licensed contractor) for disposal as waste. ▪ Liquid Cr(VI) waste such as expired primer products or cleaning/rinsing solutions is stored in closed containers and is collected by an external waste management company (licensed contractor) for disposal as hazardous liquid waste.
Other conditions affecting environmental exposure
All products: ▪ All processes where primers are used or where machining, sanding or media blasting on surfaces/parts treated with primers is performed are carried out inside and at room temperature.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
▪ None

The use of bonding primers containing StC is carried out at small to large sites. The sites operate between 8 and 24h per day, on 5-7 days per week and up to 365 production days per year. Some sites have one or several annual shutdowns (of the whole site or of individual departments), while other sites are continuously running.

Air emissions

Spraying of primer products is performed at room temperature. Also sanding, machining, or media blasting tasks on parts/surfaces treated with primer products are applied at room temperature. The maximum Cr(VI) concentration in primer products is 4.85% (as shown in Table 9-11). Cr(VI) air emissions generated during spraying, sanding, machining or media blasting processes are captured by LEV systems. The exhaust air is led through filters or treated in wet scrubbers before it is released via stacks. Air emissions are typically monitored in regular intervals at the sites.

Exhaust air from dedicated decanting and mixing areas may also contribute to the air emissions of a site. However, due to the low frequency of such aliquoting processes, these emissions are negligible.

At many sites the monitored stack(s) also receive exhaust air from use of primer products not covered under the present use (e.g., wash primers).

Wastewater emissions

Cr(VI) wastewater may occur from use of primer products (e.g., from cleaning activities). At most sites where Cr(VI) wastewater arises, it is sent directly to an external company certified for disposing of liquid hazardous waste.

At few sites the wastewater is sent to an on-site reduction plant, where Cr(VI) is reduced to Cr(III) by addition of a reduction agent (e.g., sodium bisulfite or ferrous sulfate) in excess, to ensure Cr(VI) reduction to a concentration below the permitting limit. Afterwards the wastewater is neutralised, and Cr(III) is precipitated. The precipitated Cr(III) is then separated from the wastewater by a filter press and the filter cake is disposed by a certified waste handling company. In the reduced wastewater the Cr(VI) content is measured to confirm sufficient reduction in accordance with the permitted limit before the wastewater is sent either to a wastewater treatment plant (WWTP) or municipal sewage water treatment plant (STP).

As described above for the air emissions, also for wastewater, usually diverse sources contribute to the Cr(VI) emissions.

Soil emissions

There is no direct release to soil, based on equipment and procedures in place.

9.2.3.1.2 Releases

The release fractions to water and air are calculated from the annual amount of Cr(VI) used at the sites and the amounts of Cr(VI) emitted to water and air. The site-specific release fractions are used as input for EUSES modelling of the environmental concentrations and human exposure via the environment.

In total five GB sites using bonding primer products provided site-specific emission data.

Due to the small amount of GB data, we report below also emission data from EEA sites operating under comparable conditions of use. In total, data from 38 EEA sites are available.

Table 9-12 shows ranges of release fractions and total emissions from the sites, separately for GB sites and the total database (GB + EEA sites).

GB sites that provided emission data use an overall lower tonnage per site (MAX 85 kg Cr(VI) per year) than EEA sites providing data (MAX 1372 kg Cr(VI) per year).

Therefore, the upper range of releases calculated for all sites (GB + EEA) may be conservative for the GB sites. However, since only for five out of approximately 50 sites in GB emission data are available, it cannot be excluded that some GB sites may have similarly high usage volumes and corresponding emissions.

Note that for sites not providing the amounts of substance used the calculated release fractions (by use of placeholder amounts) are artificial and are not included in the numbers presented in the below table. Also, for sites providing emission data for activities covering sanding, machining or media blasting, the calculated release fractions are artificial (as use amount and emission amount do not correlate since e.g., no primer is used during sanding) and thus not included in the below table.

One site provided air concentration measurements only for total chromium (site 21 EEA), which were set equal to Cr(VI). However, this is not expected to lead to a particular overestimation of the emission, since for primer applications it is not to be assumed that any other form than Cr(VI) can be present.

For sites with Cr(VI) wastewater the release fractions to wastewater refer to emissions after the on-site reduction step. It has to be noted that all GB sites that provided emission data reported no release to wastewater.

We point out that these results represent the overall releases of the sites, among which in each case only a certain share is assigned to the present use. Site-specific information on tonnages, releases, and emission shares relevant for the present use is given in Annex III of this CSR.

Table 9-12 Local releases to the environment

Release route	Release fraction (N = 24; 4 for GB + 20 for EEA) [a]	Release [kg/year] (N = 43; 5 for GB + 38 for EEA) [a]	Explanation/Justification
Air [b]	GB 9.80E-05 – 4.93E-02 90th percentile = n.a. AM = 1.25E-02 Total 4.05E-05 – 4.93E-02 90th percentile = 3.57E-02 AM = 1.06E-02	GB 4.02E-05 – 1.41E-01 90th percentile = n.a. AM = 3.55E-02 Total 4.02E-05 – 13.6 90th percentile = 1.90 AM = 1.23	Measured release (site-specific data)
Water [b]	GB 0 90th percentile = n.a. AM = n.a. Total 0 90th percentile = n.a. [c] AM = n.a. [c d]	GB 0 90th percentile = n.a. AM = n.a. Total 0 – 5.10E-03 90th percentile = 0 [e] AM = 1.94E-04 [e]	Measured release (site-specific data)
Soil [b]	0	0	No release to soil

n.a. = not available. 90th percentiles were only calculated if data for at least ten sites were available.

[a] The indicated ranges of release fractions to wastewater, air and soil are based on recent release data and tonnages provided by sites that are representative to cover the whole release spectrum relevant for this use.

[b] For values <LOQ a value corresponding to LOQ/2 was used, as described in ECHA´s Guidance on Information Requirements and Chemical Safety Assessment. Chapter R.16: Environmental exposure assessment (ECHA, 2016a). For wastewater emissions this is very likely an overestimation, since the upstream redox process leads to the almost complete conversion of Cr(VI) into Cr(III).

[c] Since only two sites reported Cr(VI) emissions to wastewater no AM or 90th percentile could be calculated.

[d] For the two sites having water emissions the release fraction is artificial.

[e] Since only 2/43 sites have water emissions to wastewater and the other sites have zero release to wastewater the AM is 0.000194 kg/year, while the median and the 90th percentile are 0 kg/year

For four GB sites and 20 EEA sites, real release fractions to air are available. For the remaining one GB site and 18 EEA sites, we have assumed placeholder tonnages, resulting in artificial release fractions and/or the emission data from the site also cover sanding, machining or media blasting (in which case the calculated release fractions are also artificial). We have not included these in the statistics because they are not meaningful.

For the release fractions to air, for GB sites the AM is 1.25E-02. The AM for the release to air at GB sites is 3.55E-02 kg/year.

For the total database (GB + EEA sites) the 90th percentile of release fractions to air is 3.57E-02 and the AM is 1.06E-02. The 90th percentile of releases to air is 1.90 kg/year and the AM is 1.23 kg/year. The site with the highest release fraction to air (Site 1 - GB) is a site with a low release to air (0.141 kg/year), due to the low Cr(VI) tonnage used at the site.

Only two sites (EEA sites) reported emissions to wastewater (Sites 15 - EEA and 26 - EEA). Most sites either produce no Cr(VI) containing wastewater or gather all contaminated water and send it to an external waste management company (licensed contractor) for disposal (see Annex III). For both sites the release fractions are artificial and thus not included in the above table. The releases are 0.00324 kg/year (Site 15 - EEA) and 0.00510 kg/year (Site 26 - EEA).

The release to soil is zero for all sites since there are no direct releases to soil.

Releases to waste

Solid wastes are disposed of as described above by certified companies specialised in hazardous waste disposal. No emissions from solid wastes are expected.

Release fraction to waste from the process: 0

9.2.3.1.3 Exposure and risks for the environment and humans via the environment

The modelled exposure concentrations for humans via the environment (on a local scale) per site are shown in Annex III. The EUSES modelling protocols can be provided upon request.

As described above, at many sites Cr(VI) primer products are also used which are not covered under the present use (e.g., wash primers). Use of these primer products also contributes to air and water emissions at a site. We account for this by applying a factor on the predicted environmental concentrations accounting for the share of emission assigned to the present use. For sites where detailed information is available on the part of the emission that can be assigned to the present use and other uses (via shares of the Cr(VI) consumption quantity between the primer products covered under the present use, wash primers and primer products other than wash or bonding primers), we apply this site-specific share. For most sites, however, this information is not available, so we calculate the part of the emission for the present use on the basis of factors derived from the market share of the different primer types. More detailed information on these factors is provided in Annex VII.

The calculation of the emission share from use of bonding primers containing StC is performed after the EUSES calculation. The shares for the individual sites are shown in Annex III.

All sites also use primer products not covered under the present use that contribute to environmental emissions. However, the contribution from the present use is always between 11.8% and 22.3% for GB sites and between 0.14 % and 22.3 % for EEA sites (see Table Annex III-1).

The calculated PECs and cancer risks from use of bonding primers containing StC for humans via the environment are shown below in Table 9-13. Note that even for sites without emission to wastewater EUSES calculates oral exposure via deposition from air.

Table 9-13: Excess cancer risk estimates for humans via the environment (general population, local assessment) assigned to use of bonding primers containing StC

	Inhalation			Oral			
Site	**Local Cr(VI) PEC in air [µg/m³]**	**Excess lung cancer risk [1/(µg/m³)] [a]**	**Inhalation risk**	**Oral exposure (water and fish) [µg Cr(VI)/kg x d]**	**Excess cancer risk for tumours of the small intestine [1/(µg/kg bw/day)] [b]**	**Oral risk**	**Combined risk**
1 - GB	2.26E-05	2.90E-02	6.55E-07	1.11E-07	8.00E-04	8.88E-11	6.55E-07
2 - GB	2.16E-06	2.90E-02	6.27E-08	1.06E-08	8.00E-04	8.51E-12	6.27E-08
4 - GB	3.62E-09	2.90E-02	1.05E-10	1.78E-11	8.00E-04	1.43E-14	1.05E-10
5 - GB	5.32E-05	2.90E-02	1.54E-06	2.62E-07	8.00E-04	2.10E-10	1.54E-06
7 - GB	1.95E-06	2.90E-02	5.66E-08	9.62E-09	8.00E-04	7.70E-12	5.66E-08
8 - EEA	3.86E-05	2.90E-02	1.12E-06	1.90E-07	8.00E-04	1.52E-10	1.12E-06
9 - EEA	5.85E-08	2.90E-02	1.70E-09	2.89E-10	8.00E-04	2.31E-13	1.70E-09
10 - EEA	9.35E-06	2.90E-02	2.71E-07	4.61E-08	8.00E-04	3.69E-11	2.71E-07
11 - EEA	1.31E-05	2.90E-02	3.81E-07	6.49E-08	8.00E-04	5.19E-11	3.81E-07
12 - EEA	5.09E-08	2.90E-02	1.48E-09	2.51E-10	8.00E-04	2.01E-13	1.48E-09
13 - EEA	3.84E-06	2.90E-02	1.11E-07	1.90E-08	8.00E-04	1.52E-11	1.11E-07
14 - EEA	2.32E-06	2.90E-02	6.74E-08	1.15E-08	8.00E-04	9.20E-12	6.74E-08
15 - EEA	1.49E-05	2.90E-02	4.33E-07	3.35E-06	8.00E-04	2.68E-09	4.36E-07
16 - EEA	1.43E-04	2.90E-02	4.15E-06	7.07E-07	8.00E-04	5.66E-10	4.15E-06
17 - EEA	7.17E-05	2.90E-02	2.08E-06	3.53E-07	8.00E-04	2.82E-10	2.08E-06
18 - EEA	1.07E-04	2.90E-02	3.10E-06	5.28E-07	8.00E-04	4.22E-10	3.10E-06
19 - EEA	2.22E-04	2.90E-02	6.43E-06	1.09E-06	8.00E-04	8.74E-10	6.43E-06
20 - EEA	4.42E-05	2.90E-02	1.28E-06	2.18E-07	8.00E-04	1.74E-10	1.28E-06
21 - EEA	7.56E-05	2.90E-02	2.19E-06	3.72E-07	8.00E-04	2.97E-10	2.19E-06

	Inhalation			Oral			
Site	**Local Cr(VI) PEC in air [µg/m³]**	**Excess lung cancer risk [1/(µg/m³)] [a]**	**Inhalation risk**	**Oral exposure (water and fish) [µg Cr(VI)/kg x d]**	**Excess cancer risk for tumours of the small intestine [1/(µg/kg bw/day)] [b]**	**Oral risk**	**Combined risk**
22 - EEA	1.23E-03	2.90E-02	3.58E-05	6.09E-06	8.00E-04	4.87E-09	3.58E-05
23 - EEA	9.01E-06	2.90E-02	2.61E-07	4.43E-08	8.00E-04	3.55E-11	2.61E-07
24 - EEA	1.13E-03	2.90E-02	3.27E-05	5.55E-06	8.00E-04	4.44E-09	3.27E-05
25 - EEA	1.22E-06	2.90E-02	3.55E-08	6.04E-09	8.00E-04	4.83E-12	3.55E-08
26 - EEA	1.96E-05	2.90E-02	5.67E-07	6.12E-06	8.00E-04	4.90E-09	5.72E-07
27 - EEA	2.75E-04	2.90E-02	7.97E-06	1.36E-06	8.00E-04	1.09E-09	7.97E-06
28 - EEA	8.27E-07	2.90E-02	2.40E-08	4.07E-09	8.00E-04	3.26E-12	2.40E-08
29 - EEA	5.98E-07	2.90E-02	1.73E-08	2.95E-09	8.00E-04	2.36E-12	1.73E-08
30 - EEA	8.32E-05	2.90E-02	2.41E-06	4.10E-07	8.00E-04	3.28E-10	2.41E-06
31 - EEA	1.53E-06	2.90E-02	4.43E-08	7.53E-09	8.00E-04	6.02E-12	4.43E-08
32 - EEA	2.05E-06	2.90E-02	5.94E-08	1.01E-08	8.00E-04	8.09E-12	5.94E-08
33 - EEA	4.02E-05	2.90E-02	1.17E-06	1.98E-07	8.00E-04	1.59E-10	1.17E-06
34 - EEA	1.91E-04	2.90E-02	5.55E-06	9.46E-07	8.00E-04	7.57E-10	5.55E-06
35 - EEA	2.32E-03	2.90E-02	6.74E-05	1.15E-05	8.00E-04	9.17E-09	6.74E-05
36 - EEA	2.35E-06	2.90E-02	6.80E-08	1.16E-08	8.00E-04	9.27E-12	6.81E-08
37 - EEA	9.31E-05	2.90E-02	2.70E-06	4.58E-07	8.00E-04	3.66E-10	2.70E-06
38 - EEA	5.41E-04	2.90E-02	1.57E-05	2.66E-06	8.00E-04	2.13E-09	1.57E-05
39 - EEA	7.40E-04	2.90E-02	2.14E-05	3.65E-06	8.00E-04	2.92E-09	2.15E-05
40 - EEA	5.03E-07	2.90E-02	1.46E-08	2.48E-09	8.00E-04	1.99E-12	1.46E-08
41 - EEA	6.89E-05	2.90E-02	2.00E-06	3.40E-07	8.00E-04	2.72E-10	2.00E-06
42 - EEA	8.51E-07	2.90E-02	2.47E-08	4.19E-09	8.00E-04	3.35E-12	2.47E-08
43 - EEA	9.21E-05	2.90E-02	2.67E-06	4.55E-07	8.00E-04	3.64E-10	2.67E-06
44 - EEA	1.58E-05	2.90E-02	4.57E-07	7.77E-08	8.00E-04	6.22E-11	4.57E-07

	Inhalation			Oral			
Site	**Local Cr(VI) PEC in air [µg/m³]**	**Excess lung cancer risk [1/(µg/m³)] [a]**	**Inhalation risk**	**Oral exposure (water and fish) [µg Cr(VI)/kg x d]**	**Excess cancer risk for tumours of the small intestine [1/(µg/kg bw/day)] [b]**	**Oral risk**	**Combined risk**
45 - EEA	3.82E-07	2.90E-02	1.11E-08	1.88E-09	8.00E-04	1.50E-12	1.11E-08
GB sites							
MIN	3.62E-09		1.05E-10	1.78E-11		1.43E-14	1.05E-10
MAX	**5.32E-05**		**1.54E-06**	**2.62E-07**		**2.10E-10**	**1.54E-06**
90th percentile	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.
Median	2.16E-06		6.27E-08	1.06E-08		8.51E-12	6.27E-08
AM	1.60E-05		4.63E-07	7.86E-08		6.29E-11	4.63E-07
Total (GB + EEA)							
MIN	3.62E-09		1.05E-10	1.78E-11		1.43E-14	1.05E-10
MAX	2.32E-03		6.74E-05	1.15E-05		9.17E-09	6.74E-05
90th percentile	**4.88E-04**		**1.41E-05**	**3.59E-06**		**2.87E-09**	**1.41E-05**
Median	1.96E-05		5.67E-07	1.90E-07		1.52E-10	5.72E-07
AM	1.79E-04		5.19E-06	1.10E-06		8.79E-10	5.19E-06

n.a. = not available. 90th percentiles were only calculated if data for at least ten sites were available.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of 2.9×10^{-2} for the general population, based on 70 years of exposure; 24h/day.

[b] RAC dose-response relationship based on excess cancer risk for tumours of the small intestine (ECHA, 2013a): Exposure to 1 µg/kg bw/day Cr(VI) relates to an excess risk of 8×10^{-4} for the general population, based on 70 years of exposure; daily exposure.

GB

For the risk assessment of the use of bonding primers containing StC for GB sites, the MAX for the PEC in air is 5.32E-05 µg/m^3 and the MAX for the inhalation risk is 1.54E-06. The MAX for oral exposure is 2.62E-07 µg Cr(VI)/kg per day and the MAX for the oral risk is 2.10E-10. **The MAX for the combined risk of humans via the environment from inhalation and oral exposure is 1.54E-06.** Risks from oral exposure are consistently lower than risks from inhalation for all GB sites.

Total (GB + EEA sites)

For the risk assessment of the use of bonding primers containing StC for the total database (GB + EEA sites), the 90th percentile for the PEC in air is 4.88E-04 µg/m^3 and the 90th percentile for the inhalation risk is 1.41E-05. The 90th percentile for oral exposure is 3.59E-06 µg Cr(VI)/kg per day and the 90th percentile for the oral risk is 2.87E-09. **The 90th percentile for the combined risk of humans via the environment from inhalation and oral exposure is 1.41E-05.** The AM for inhalation risk (5.19E-06) and for combined risk (5.19E-06) are by approximately factor three lower than the 90th percentile values. Risks from oral exposure are consistently lower than risks from inhalation for all sites.

Risks span a range of four (GB sites) to five (GB+EEA sites) orders of magnitude, caused by differences in the size of the sites, amounts of substances used, losses due to overspray and filter/wet scrubber efficiency. The variation in the risks per site may also be related to uncertainties existing for some measurements since for instance for several sites the amount of substance used at the site was unknown (e.g., for many Art. 66 datasets) or the information on operational hours was uncertain.

The combined risks of the sites with higher air emissions (EEA sites 22, 35, 38, and 39; all have air emissions > 5 kg/year) in the range between 1.57E-05 and 6.74E-05 are all close to the 90th percentile of calculated combined risks for all sites.

The combined risks of the two sites with water emissions (combined risks of 4.36E-07 for Site 15 and 5.72E-07 for Site 26 – EEA) are well within the range of calculated risks.

The MAX combined risk of GB sites (1.54E-06) is approximately one order of magnitude lower than the combined risk calculated for the 90th percentile emission data for all sites (GB + EEA) (1.41E-05). This can be explained by the lower amounts of Cr(VI) which are used at the GB sites providing emission data, leading ultimately to lower emissions and risks. However, it can be assumed that this difference comes from the small sample of GB sites and that in practice no lower quantities are used at GB sites than at EEA sites. **Thus, the risks calculated for the total database (GB + EEA) are considered representative for GB sites.**

Note that the modelling of local air concentrations with EUSES is generally acknowledged as being overly conservative, as described in detail in section 9.1.2.5.2.

Conclusion on risk characterisation:

Carcinogenicity

Combined risks of cancer by inhalation and by the oral route from the local assessment result in a 90th percentile for the excess cancer risk of **1.41E-05**. These theoretical cancer risks are based on a conservative, linear ERR. Further, due to the overly conservative nature of the predictions of the EUSES model for the local air concentrations the risk level can be considered an overestimation.

Based on the gathered information and considering the implemented RMMs we conclude that risk of exposure is minimised.

9.2.3.2 Worker contributing scenario 1 – Spray operators for manual spraying in spray room/booth

Spray operators for manual spraying in spray room/booth are usually involved in numerous activities related to the painting process. Most of their working time is spent in a paint area where the spray room(s) and/or booth(s) are located, either on activities with direct or indirect Cr(VI) exposure. Typical tasks with possible direct Cr(VI) exposure performed by these operators are:

<u>Main tasks</u>

- Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 8b, PROC 9)
- Task 2: Primer application by manual spraying in open spray booth (PROC 7)
- Task 3: Primer application by manual spraying in spray room (PROC 7)
- Task 4: Primer application by spraying outside spray room/booth/hangar (PROC 7)
- Task 5: Cleaning of spray gun(s) and equipment (PROC 28)

<u>Secondary tasks</u>

- Task 6: Primer application by brushing/rolling (PROC 10)
- Task 7: Handling of solid and/or liquid waste (PROC 8b)
- Task 8: Maintenance and cleaning of spray area(s), including filter change (PROC 8b, 28)
- Task 9: Machining on surfaces on an extraction bench/room/booth, including cleaning (PROC 21, 24)
- Task 10: Machining on surfaces in large work areas (e.g., workshop, hall, room), including cleaning (PROC 21, 24)

As tasks 6 to 10 are main tasks performed by other SEGs, they are described in detail in the respective worker contributing scenarios ‘Operators performing brushing/rolling’ (task 6; see section 9.2.3.3, ‘Maintenance and cleaning workers for spray area(s)’ (tasks 7 and 8; see section 9.2.3.8) and ‘Machinists’ (tasks 9 and 10; see section 9.2.3.4).

It should be noted that automated spray systems/spray robots are not used with bonding primers.

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.2.1 Conditions of use

Table 9-14 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by spray operators for manual spraying in spray room/booth.

Table 9-14: Conditions of use – Worker contributing scenario 1 – Spray operators for manual spraying in spray room/booth

Product (article) characteristics	
1: Primer products containing StC (water-based or solvent-based)	
Maximum concentration of StC [%] (w/w):	19
Concentration of Cr(VI) from StC [%] (w/w):	4.85
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 8b, PROC 9)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Amount of product [L/shift]:	0.01 - 12
Duration of task [min/shift]:	5 - 90
Frequency of task [days/year]:	24 - 240
Task 2: Primer application by manual spraying in open spray booth (PROC 7)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Amount of product [L/shift]:	0.3 - 2
Duration of task [min/shift]:	30 - 240
Frequency of task [days/year]:	24 - 240
Task 3: Primer application by manual spraying in spray room (PROC 7)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Amount of product [L/shift]:	0.1 - 8
Duration of task [min/shift]:	5 - 480
Frequency of task [days/year]:	4 - 240
Task 4: Primer application by spraying outside spray room/booth/hangar (PROC 7)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Amount of product [L/shift]:	0.2 - 2
Duration of task [min/shift]:	5 - 60
Frequency of task [days/year]:	<1 - 48

Task 5: Cleaning of spray gun(s) and equipment (PROC 28)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Duration of task [min/shift]:	<1 - 60
Frequency of task [days/year]:	7 - 240
Technical and organisational conditions and measures	
Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)	
LEV:	No
Type of LEV:	-
Type of general ventilation in working hall:	If not performed in a spray area with LEV, the working hall has mechanical ventilation
Air changes per hour (ACH) of general ventilation:	≥ 3
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Task 2: Primer application by manual spraying in open spray booth (PROC 7)	
LEV:	Yes
Type of LEV:	Enclosing hood - horizontal laminar flow booth
Type of general ventilation in working hall:	Mechanical ventilation
Air changes per hour (ACH) of general ventilation:	≥3
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. During spraying, only persons involved in the spraying process are allowed in the area of the open spray booth.
Task 3: Primer application by manual spraying in spray room (PROC 7)	
LEV:	Yes
Type of LEV:	Spray room - laminar down-flow or cross-flow (≥10 ACH)
Type of general ventilation in working hall:	n.a.
Air changes per hour (ACH) of general ventilation:	n.a.

Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. During spraying, only persons involved in the spraying process are allowed in the spray room.
Task 4: Primer application by spraying outside spray room/booth/hangar (PROC 7)	
LEV:	No (not at all sites; where use of LEV is technically not feasible a battery powered filtering device or a device with external air supply is used)
Type of LEV:	-
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Enclosure of the area to be sprayed or, if this is not possible, spraying performed at times when only the sprayers are present in the work area
Task 5: Cleaning of spray gun(s) and equipment (PROC 28)	
LEV:	Yes, at least for blow-out and for the removal of extensive contamination, if not performed in a closed system [a]
Type of LEV	LEV system installed in spray booth/room or cleaning room
Type of general ventilation in working hall:	n.a.
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Cleaning performed in a closed system. Where this is technically not feasible, restriction of access by means of signage or physical segregation or through strict procedure.
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
Chemical resistant gloves according to EN 374 as per relevant risk assessment must be worn during all tasks.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	

Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)	
RPE: Protection clothes:	Yes, at least half mask with P3 filter if not performed under LEV or extraction hood/bench/booth Yes, chemical protective clothing/coverall
Task 2: Primer application by manual spraying in open spray booth (PROC 7)	
RPE:	Yes, at least full mask with P3 filter (including combined gas-particle filter)
Protection clothes:	Yes, chemical protective coverall
Task 3: Primer application by manual spraying in spray room (PROC 7)	
RPE:	Yes, at least full mask with P3 filter (including combined gas-particle filter)
Protection clothes:	Yes, chemical protective coverall [b]
Task 4: Primer application by spraying outside spray room/booth/hangar (PROC 7)	
RPE:	Yes, where use of LEV is technically not feasible, a battery powered filtering device or a device with external air supply is used. Where LEV is used, half- or full-face mask with P3 filter (including combined gas-particle filter).
Protection clothes:	Yes, chemical protective coverall
Task 5: Cleaning of spray gun(s) and equipment (PROC 28)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms RPE use is required
Protection clothes:	Yes, chemical protective coverall
Other conditions affecting workers' exposure	
Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)	
Place of use:	Indoors
Temperature:	Room temperature
Task 2: Primer application by manual spraying in open spray booth (PROC 7)	
Spray technique:	Spraying with no or low compressed air [c] Horizontal and downward spraying
Place of use:	Indoors
Temperature:	Room temperature

Task 3: Primer application by manual spraying in spray room (PROC 7)	
Spray technique:	Spraying with no or low compressed air [c]
Place of use:	Indoors
Temperature:	Room temperature
Task 4: Primer application by spraying outside spray room/booth/hangar (PROC 7)	
Spray technique:	Spraying with no or low compressed air [c]
Place of use:	Indoors
Temperature:	Room temperature
Task 5: Cleaning of spray gun(s) and equipment (PROC 28)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

[a] At very few sites and infrequently (max. 1x/month) cleaning of aerograph is performed without LEV, but RPE is used.

[b] For small volume spraying (<100 mL) in a three-sided open spray booth a disposable lab coat can also be used.

[c] Compressed air of up to max. 7 bar.

9.2.3.2.2 Exposure and risks for workers

Between individual sites, the number of spray operators for manual spraying in spray room/booth is variable, depending on several factors such as the size of the site, the organisation of the spraying area (one individual room/booth vs. several room(s)/booth(s), possibly organised in different departments), the distribution and throughput of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of spray operators for manual spraying in spray room/booth typically ranges between one and 14 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average, **ten sprayers** (five per shift, two shifts) at 100% sites are engaged per day per site in this use.

Below we describe in detail the relevant tasks with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-14 apply to these tasks.

<u>Task 1: Decanting/mixing of liquid primer and filling of guns/cups/small containers</u>

This task covers decanting/mixing of primer products and filling of vessels used for spraying or for brushing/rolling applications. In a dedicated area, the primer products are decanted from the containers and mixed. The dedicated area is either a specific work area in a workshop with mechanical ventilation, or e.g., a preparation cabin/hood/bench or worktable (see Figure VIII-6 in Annex VIII), all of which may be equipped with LEV.

Usually, one to two workers perform this task at the same time. The worker first homogenizes the closed containers of primer products (bottles or buckets) by placing it on a shaking or rotating device.

The worker then transfers the required amount of primer into a mixing vessel, either by careful pouring or by using a disposable device (e.g., a syringe). The mixing vessel is typically a disposable cup/bucket or a bucket with a disposable inner liner that is discarded after use. At some sites also a reusable cup/bucket is used which is then cleaned afterwards. In the mixing vessel, the worker usually adds to the primer solution a defined amount of activator and/or diluent solution. Then the worker mixes the solutions (using e.g., a spatula or metal stirrer). Typically, after mixing, the worker checks the viscosity of the mixture at least once (e.g., by pouring above the mixing vessel a small amount of the mixture through a sieve with a defined pore size and determining the viscosity based on the time it takes for the volume to flow through the pores) and readjusts, if necessary, by adding diluent solution followed by further mixing.

After mixing, the closed mixing vessel is transported to the place of use (small containers are carried manually, larger containers are transported on a trolley). If the solution is used for spraying applications, the worker connects the vessel to the spraying system. Often, smaller vessels can be connected directly to a cup spray gun without the need to open the container. Larger vessels the worker positions at the spraying unit and carefully inserts a hose into the vessel through which the solution is pumped into the spraying system.

At some sites, the entire filling and mixing process is largely automated, and the paint is fed directly from the packaging drums into the spray system via closed lines. Very little interaction by the operator is required at these sites.

For the preparation of primer solutions for brushing/rolling, in addition to the procedure described above, workers may also use ready-to-use solutions where they combine separately packaged, small volumes of primer solution and activator. Viscosity testing is usually not required for these products.

Paint residues and empty chemical containers are collected in a special waste container for hazardous waste. Contaminated equipment is also collected in a container for hazardous waste. Paint residues, empty chemical containers and contaminated equipment are collected by an external waste management company (licensed contractor) for disposal of as hazardous waste. When cleaning of equipment after decanting/mixing is required, the wash solutions (water or solvent) are disposed of externally by a licensed contractor.

Note that if the work area is not equipped with an LEV, the worker wears RPE.

Task 2: Primer application by manual spraying in open spray booth

At several sites, parts are sprayed in an open spray booth. According to the information provided by the sites, overall, spraying in an open spray booth is less frequent than in a spray room (task 3). A description of the setup of an open spray booth is given in section 9.2.2.3.1.

For spraying the worker stands at the open side of the booth and sprays in the direction of the opposite wall. They use either a cup spray gun or a spray gun into which paint is fed via a pump system. The worker can move the parts to be sprayed within the booth as they are either suspended from rotatable carriers or positioned on a (rotating) table so that the worker can spray them evenly from all sides.

Task 3: Primer application by manual spraying in spray room

A description of the setup of a spray room is given in section 9.2.2.3.1. During the spraying process, the worker is inside the spray room. They use either a cup spray gun, an airbrush (small cup-spray gun enabling very precise spraying) or a spray gun into which paint is fed via a pump system. The part(s) is/are positioned on a rack. Typically, the worker moves along and around the part(s) so that they can spray the part(s) evenly from all sides. It may also be possible for the worker to move the components within the room if they are suspended or positioned on movable carriers.

Task 4: Primer application by spraying outside spray room/booth/hangar

Spraying outside a spray room or a spray hangar is only performed at very few sites and with low frequency. In such cases, spraying is carried out in a regular workshop or hangar without exhaust ventilation. Typically, this task is required when spraying on a large part (e.g., an entire helicopter or aircraft) is necessary and it is technically not feasible to place the part into a spray room or dedicated spray hangar (for example, when an aircraft is being repaired and mechanically worked on in a workshop without LEV and only minor touch-ups to the primer layer are subsequently required by spraying). Only isolated areas of surfaces are being sprayed in these cases (i.e., not the whole surface is sprayed).

For spraying outside spray room/booth/hangar, the surface to be sprayed is either temporarily enclosed (e.g., by a tent specially designed for this purpose) and a mobile exhaust air extraction system is set up in the enclosure, or, at sites where this is technically not possible, spraying is carried out only at times when no other workers are present in the workshop (e.g., at night). These measures are taken to minimize the exposure of non-involved workers. Typically, only one worker performs the spraying. The worker stands on the floor or on a scaffold and sprays the area to be treated using a cup spray gun, or an airbrush.

Figure 9-2: Example for a "tent" with mobile LEV installed in a working hall to perform spraying outside of a spray room/booth/hangar directly on the aircraft

Task 5: Cleaning of spray gun(s) and equipment

The spray gun and equipment used for spraying or brushing/rolling are cleaned after the process of primer application is completed.

Cleaning of spraying equipment is performed after all spraying scenarios, but the procedure can be different, depending on the spraying system used at the site. The spray gun and equipment are cleaned e.g., within the LEV-equipped spraying area (spray booth/room), in a fume hood, on a vacuum table, in a paint mixing room or in a closed system. Typically, cleaning is performed by one worker per spray gun. To remove most of the paint the worker empties the spray gun, cleans it, and blows it with compressed air, typically within the LEV-equipped spraying area (spray booth/room/hangar), in a fume hood, or on a vacuum table. For further cleaning they use a solvent-based or water-based wash solution (depending on the base of the primer used).

When using a spray gun into which paint is fed via a pump system, the worker usually blows it out it in the spray booth/room. They connect the spray gun to a tank with wash solution and typically clips the gun head into a designated vessel (e.g., a bucket). At the station where the vessel with wash solution is standing, the worker controls the supply and drain of the wash solution into the system. They pump the wash solution through the system for a certain period to clean the lines and the spray gun from the inside. At some sites, instead of draining the used wash solution into a vessel, the worker sprays it with the gun into the exhaust system of the spray unit. After cleaning, the wash solution left in the system remains therein until the spray gun is used the next time.

If a cup gun or airbrush is used, the operator may blow it out it by manually filling the wash solution into the cup gun/airbrush and spraying the wash solution into a designated vessel or in the direction of the exhaust system of the spray booth/room.

All types of spray guns can be further cleaned, which may be performed outside the spraying area, e.g., in the paint mixing room, a fume hood or on a vacuum table or in a cleaning system. At several sites the worker rinses the spray gun with wash solution or immerses (parts of) the spray gun in wash solution. It may be necessary that they disassemble the spray gun prior to cleaning and, in case of larger paint residues on the gun, that they use a brush for cleaning. At other sites, the worker places the spray head of the spray gun (assembled or disassembled) in a dedicated automatic gun washing machine wherein it is then washed. The washing machine is a closed system, from which the worker does not experience exposure during the cleaning process (see Figure VIII-5 in Annex VIII).

Cleaning of brushing/rolling equipment (e.g., brushes) is also performed e.g., in the paint mixing room, a fume hood or on a vacuum table by rinsing or immersing the equipment in wash solution. The brushing/rolling equipment can also be cleaned in an automatic cleaner with closed loop (located in a dedicated place in the paint shop area).

The wash solutions are collected by an external waste management company (licensed contractor) for disposal of as hazardous waste.

9.2.3.2.2.1 Inhalation exposure

Measured inhalation exposure concentration

In total, 144 personal monitoring data and 12 stationary data are included in the inhalation exposure assessment for this SEG. Of the 144 personal monitoring data, 33 are long-term (≥2h)[9], shift-representative and 111 are short-term (<2h) measurements. The 12 stationary measurements can be divided in eight long-term measurements and four short-term measurements.

The personal monitoring data come from 20 sites in GB. About 55% of the data (79 values, including 67 short-term and 12 long-term measurements) are <LOQ and 45% (65 values, including 44 short-term and 21 long-term measurements) are >LOQ.

The 12 stationary data come from six sites in GB. About 58% of the stationary measurements (seven values, including two short-term and five long-term measurements) are <LOQ and 42% (five values, including two short-term and three long-term measurements) are >LOQ.

Table 9-15 gives an overview of the available data for spray operators for manual spraying in spray room/booth.

[9] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

Table 9-15: Overview of available inhalation exposure measurements for WCS 1 – Spray operators for manual spraying in spray room/booth at GB sites

	Total	>LOQ	<LOQ
Personal			
- Long-term (≥2h)	33	21	12
- Short-term (<2h)	111	44	67
Stationary			
- Long-term (≥2h)	8	3	5
- Short-term (<2h)	4	2	2

The measurements were performed on workers carrying out tasks with primer products containing StC and/or PCO and/or PHD. During some measurements, the workers also may have had Cr(VI) exposure from primer products not covered under the present use (e.g., from spraying of wash primers or bonding primers) or from uses of other chromates (e.g., when performing slurry coating with chromium trioxide). Note that the chromate used during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements, several chromates may have been used. In some reports, no information was given on the substance used. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, no substance-specific differences in exposure levels were observed from the available data.

Further, it has to be considered that the initial applications did not explicitly distinguish between "open booth" and "room" in the exposure scenario. The wording used in the initial applications was "spraying in spray cabin/spray booth". Consequently, the sites submitting measured values did in most cases do not specify whether spraying was performed in an "open booth" or in a "room”. We only assigned those measurement data to spraying in open spray booth where it was explicitly described in the data documentation that the spray facility was an open spray booth (for example, it was described that the booth is "open"). We did not consider the sole use of the term "booth" as a reason for assigning the data to open spray booth, since the word “booth” can be used universally for both spraying facilities. Due to these stringent criteria for the assignment of the measurement data to the open spray booth, it is likely that certain measurement data were counted for spraying in the spray room, although actual spraying in an open spray booth was performed, if the latter could not be clearly understood from the documentation. Accordingly, the number of measurement values cannot be used to conclude the distribution of spraying activities in either open booth or room.

Table 9-16 shows the summary statistics of workplace measurements for spray operators. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. Measurements are from the period 2017-2022. Further, specific evaluations analyse the role of individual tasks or differences between individual substances. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-16: Summary statistics of inhalation exposure measurements for WCS 1 – Spray operators for manual spraying in spray room/booth at GB sites

Personal – long-term (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	33	100	2.99	4.32	1.10	5.00
Specific evaluations:						
- Spray room	31	93.9	3.03	4.43	1.10	5.00
- Tasks without spraying	2	6.06	n.a.	n.a.	n.a.	n.a. (MAX = 4.45) [a]
Personal – short-term (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	111	100	37.8	89.2	2.5	101
Specific evaluations:						
- Spray in open spray booth	5	4.50	3.94	n.a.	n.a.	n.a. (MAX = 7.00)
- Spray room	63	56.8	62.3	112	3.80	259
- Tasks without spraying	43	38.7	5.83	16.1	2.50	3.00
Stationary – long-term (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	8	100	1.04	n.a.	n.a.	n.a.
Specific evaluations:						
- Spray room	4	50.0	1.63	n.a.	n.a.	n.a. (MAX = 6.00)
- Tasks without spraying	4	50.0	0.445	n.a.	n.a.	n.a. (MAX = 0.980)
Stationary – short-term (measurement period 2021)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	4	100	5.0	n.a.	n.a	n.a. (MAX = 9.50)
Specific evaluations:						
- Spray room	4	100	5.0	n.a.	n.a.	n.a. (MAX = 9.50)

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual values are 4.45 and 0.500 µg/m³ (<LOQ and reflects ½ LOQ).

Personal measurements – long-term

The 90th percentile over all long-term personal measurements is 5.00 µg/m³. Out of the 33 total measurements 31 (93.9%) cover spraying in a spray room, no measurement was performed during spraying in an open spray booth. Therefore, no statement about the similarity or difference in exposure from spraying in an "open booth" or room can be made based on this data set.

The 31 measurements cover next to the primary tasks (i.e., decanting/mixing of liquid primer and filling of guns/cups/small containers (task 1) and/or cleaning of spray gun(s) and equipment (task 5)) also secondary tasks, which were performed by spray operators (i.e., Primer application by brushing/rolling (task 7), Handling of solid and/or liquid waste (task 8), Maintenance and cleaning of spray area(s), including filter change (task 9), Machining on surfaces on an extraction bench/room/booth, including cleaning (task 10), Machining on surfaces in large work areas (e.g., workshop, hall, room), including cleaning (task 11)). The 90th percentile for these measurements is 5.00 µg/m³.

No personal long-term measurements are available for spraying in open spray booth or for spraying outside spray booth/room/hangar. Presumably, a reason why no long-term values have been provided for these tasks may be that spraying in open spray booth is performed less frequently and rather short-term (see section below) than spraying in room. Furthermore, spraying outside of spray booth/room/hangar is usually performed only for a short duration.

Use of RPE was reported for all measurements covering spraying tasks and for most measurements covering task 1 and/or 5.

Personal measurements – short term

A total of 111 personal short-term measurements were taken while the workers performed the main tasks, partly also including secondary tasks of spray operators for manual spraying in spray room/booth. The number of measurements presented below cover the individual main tasks. Note that in several cases the worker carried out more than one task during the measurement (so these data are counted more than once in the list).

- Decanting/mixing of liquid primer and filling of guns/cups/small containers (task 1): 63 (GB)
- Primer application by manual spraying in open spray booth (task 2): 5 (GB)
- Primer application by manual spraying in spray room (task 3): 63 (GB)
- Primer application by spraying outside spray booth/room/hangar (task 4): 31 (EEA; no GB data)
- Cleaning of spray gun(s) and equipment (task 5): 50 (GB)

The 90th percentile of all short-term measurements is 101 µg/m³. Out of the 111 short-term measurements, only five (4.50%) cover spraying in an open spray booth (task 2) with an AM of 3.94 µg/m³. With 63 values (56.8%) most of the measurements cover spraying in a spray room (task 3). The 90th percentile of spraying in a spray room is 259 µg/m³, showing that this spraying task has a strong impact on the 90th percentile of the total short-term data.

No spraying activity but the main tasks decanting/mixing of liquid primer and/or filling of guns/cups/small containers (task 1) and cleaning of spray gun(s) and equipment (task 5) and/or secondary tasks (e.g., Primer application by brushing/rolling (task 7), Handling of solid and/or liquid waste (task 8), Maintenance and cleaning of spray area(s), including filter change (task 9), Machining on surfaces on an extraction bench/room/booth, including cleaning (task 10), Machining on surfaces in large work areas (e.g., workshop, hall, room), including cleaning (task 11)) were performed during 43 measurements (36.8%), for which the 90th percentile is 3.00 µg/m^3.

Use of RPE was reported for all measurements covering spraying tasks and for most measurements covering task 1 and/or 5.

Stationary measurements – long-term

For the eight long-term stationary measurements the AM is 1.04 µg/m^3. As described above for the personal monitoring data, we have assigned values to spraying in a spray room if it was not unambiguous from the activity description of the data, that spraying was performed in an open spray booth. No stationary long-term measurements are available for primer application by spraying in open spray booth and spraying outside spray booth/room/hangar.

Four values (50.0%) cover spraying in spray room. Out of these four values, two values cover spraying in spray room exclusively, while the other two values representing spraying in a spray room in combination with e.g. cleaning of spray gun(s) and equipment (task 5). The remaining four measurements were taken while the workers exclusively performed decanting/mixing of liquid primer and filling of guns/cups/small containers (task 1).

Stationary measurements – short-term

The four stationary short-term measurements were taken while the workers performed the main tasks of spray operators for manual spraying in spray room/booth. Decanting/mixing of liquid primer and filling of guns/cups/small containers (task 1) and Cleaning of spray gun(s) and equipment (task 5)), in combination with secondary tasks (i.e., Primer application by brushing/rolling (task 7) and Maintenance and cleaning of spray area(s), including filter change (task 9)). The AM of the four values (two sites) is 5.00 µg/m^3 (range: 0.400 µg/m^3 to 9.50 µg/m^3), which is considerably lower than the AM (62.3 µg/m^3) and the 90th percentile (259 µg/m^3) of the personal short-term values (N = 63; 16 sites) covering spraying in a spray room. This can be due to the circumstance that the stationary sampling devices may have been set up at a further distance from the emission source than where the worker is typically acting during personal sampling. However, a clear statement cannot be made based on only four data points.

Primer application by spraying outside spray room/booth/hangar

For task 4, Primer application by spraying outside spray room/booth/hangar, no data from GB sites are available. Therefore, we report in Table 9-17 data from EEA sites using this task as a proxy for GB data. As it is expected that the conditions of use in GB are comparable to those in EEA, we consider it appropriate to use these data for the exposure assessment of task 4 in GB.

Table 9-17: Summary statistics of inhalation exposure measurements for WCS 1 – Spray operators for manual spraying outside open spray booth/room/hangar at EEA sites

Personal – short-term (measurement period 2017 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
- Spraying outside open spray booth/room/hangar	31	6.11	486	461	354	967
Stationary – short-term (measurement period 2018 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
- Spraying outside open spray booth/room/hangar	2	3.64	n.a.	n.a.	n.a.	n.a. (MAX = 3450) [a]

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual values are 706 and 3450 µg/m³.

Spraying outside a spray booth/room/hangar is performed only at a few sites in EEA and with low frequency. In total, 31 personal short-term and two stationary short-term measurements are available. The 90th percentile for the personal monitoring data is 967 µg/m³. For the two measurements covering spraying outside of spray booth/room/hangar, the individual values are 706 (application of basic primer PAC 33, PHD) and 3450 µg/m³ (application of wash primer P99, PHD). Both measurements were taken for 30 min, 1 m away from the worker applying the primer. It has to be noted that the use of wash primer is not covered by this use and that the measurement from the use of wash primer is formally not part of this use. However, as described in section 9.1.2.6.2, for the assessment of this use it is not possible to exclude values covering exposure from other uses.

The monitoring data for task 4 are considerably higher than the monitoring data for spraying in a spray room since no exhaust ventilation is used in the area where spraying is performed.

Risk characterisation is based on the complete set of long-term personal measurements from GB sites. Table 9-18 shows the resulting long-term inhalation exposure concentration for spray operators for manual spraying in spray room/booth used for risk assessment, based on the 90th percentile of personal sampling values.

RPE is worn for all spraying tasks and, also for task 1 and task 5, at least if they are not performed under LEV. Therefore, use of RPE is considered in the exposure assessment. Since the 90th percentile of long-term measurements is dominated by spray applications, for which RPE is always worn, we consider it appropriate to account for its use (even though some sites performed individual low-exposure tasks without RPE, according to the site's industrial hygiene exposure assessment). Accordingly, an APF of 20 is applied to the exposure value.

At most sites the workers do not spend their whole work shift on Cr(VI) tasks related to manual spraying in a room or booth (e.g., they also spray Cr(VI)-free products or perform masking during their work shift). However, for a conservative assessment, we consider that 100% of their working time are spent on Cr(VI) tasks related to manual spraying in a room or booth. Accordingly, no correction is made in the assessment for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 1.00).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-18: Measured inhalation exposure concentration for WCS 1 – Spray operators for manual spraying in spray room/booth at GB sites

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m^3]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m^3]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m^3]
Personal	33	5.00	20	0.250	1.00	0.210	0.0525

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] RPE is used, see above.

[c] Since the workers spend 100% of their working time on Cr(VI) tasks a time correction factor of 1.00 is used.

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

Note that spraying outside of spray booth/room/hangar leads to high exposure values, which are not considered by the 90th percentile of long-term measurements, since only short-term measurements are available for this task. However, based on data from EEA sites, it can be considered that this task is performed at maximum for 60 min 1x/week, and that RPE with APF 40 was worn (battery-powered filtering device (APF 40) or device with external air supply (APF 250)), long-term exposure from this task would be 0.127 µg/m^3 (967 µg/m^3 x (60 min/480 min) = 121 µg/m^3/shift, 121/5 = 24.2 µg/m^3/week, application of APF 40 = 0.604 µg/m^3, considering GB market share correction factor of 0.210 = 0.127 µg/m^3).

Accordingly, for workers performing spraying outside of spray booth/room/hangar, exposure from this task contributes to their long-term exposure, if they perform it in addition to the other tasks listed above. For these workers, long-term exposure is 0.179 µg/m^3 (0.0525 + 0.127 = 0.179 µg/m^3). However, we would like to emphasize that this activity is only carried out at very few sites by a small number of workers.

9.2.3.2.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-19 shows the risk characterisation for carcinogenicity for spray operators for manual spraying in spray room/booth. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-19: Risk characterisation for carcinogenicity for WCS 1 – Spray operators for manual spraying in spray room/booth

Route of exposure and type of effects	Long-term exposure [µg/m^3]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m^3]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term (for workers **not** also spraying outside of spray booth/room/hangar)	0.0525	4.00E-03	2.10E-04
Inhalation: Systemic Long Term (for workers **also** spraying outside of spray booth/room/hangar)	0.179	4.00E-03	7.17E-04

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m^3 Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for spray operators for manual spraying in spray room/booth is 2.10E-04 for sprayers not performing spraying outside of spray booth/room/hangar and 7.17E-04 for sprayers also performing spraying outside of spray booth/room/hangar.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- these measurements were not corrected for their duration but assumed to be shift representative values.

In GB on average, we assume that **ten sprayers** are engaged per day per site in this use **at sites where no spraying outside of spray booth/room/hangar is performed**. There are no GB data for spraying outside of spray booth/room/hangar. Therefore, EEA data are used. In EEA at sites carrying out spraying outside of spray booth/room/hangar, **one sprayer** per day per site (20% of sites) is engaged in this use. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.2.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For this WCS biomonitoring data are available from nine sites in GB, sampled in the years 2017-2022. The data cover the main tasks of spray operators for manual spraying in spray room/booth and some measurements additionally cover main tasks performed by:

- Spray operators for manual spraying in a dedicated spray hangar
- Machinists

Biomonitoring data were reported by companies either as individual values or as results for groups of workers and are reported here accordingly (see Annex V). The following table shows the summary statistics for the individual values and an overview of the available group entries.

Table 9-20: Biomonitoring data for WCS 1 – Spray operators for manual spraying in spray room/booth

Individual values	
N	54
AM [µmol Cr/mol creatinine]	1.51
Median [µmol Cr/mol creatinine]	0.851
90th Perc. [µmol Cr/mol creatinine]	2.04
N > 10.0 µmol Cr/mol creatinine	1
% of data with > 10.0 µmol Cr/mol creatinine	1.85%

All exposure values rounded to three significant figures for presentation.

In total, 54 individual values are available, with an AM of 1.51 µmol Cr/mol creatinine and a 90th percentile of 2.04 µmol Cr/mol creatinine. Only one value exceeds 10.0 µmol Cr/mol creatinine (UK BMGV) with 11.09 µmol Cr/mol creatinine.

Overall, the reported biomonitoring data confirm that the body burden of spray operators for manual spraying in spray room/booth exceeded the recommended UK BMGV value in GB only on one occasion.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.3 Worker contributing scenario 2 – Operators performing brushing/rolling

Brushing/rolling operators are workers who perform brushing/rolling as their main exposure task. At many sites, brushing/rolling is a secondary task e.g., for spray operators or sanders in a dedicated hangar (for details see sections 9.2.3.2 and 9.2.3.5). However, the main exposure tasks for these SEGs are spraying activities or sanding in a dedicated hangar. Accordingly, these workers are not covered by the present SEG.

Typical tasks with possible Cr(VI) exposure performed by these operators are:

Main tasks

- Task 1: Primer application by brushing/rolling (PROC 10)

Secondary tasks

- Task 2: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)
- Task 3: Handling of solid and/or liquid waste (PROC 8b)
- Task 4: Machining on surfaces in large work areas (e.g., workshop, hall, room), including cleaning (PROC 21, 24)
- Task 5: Machining on parts in large work areas (e.g., workshop, hall, room), including cleaning (PROC 21, 24)
- Task 6: Cleaning of spray gun(s) and equipment (PROC 28)

As tasks 2 to 6 are main tasks performed by other SEGs, they are described in detail in the respective worker contributing scenarios 'Sprayers for manual spraying in spray room/booth' (task 2 and 6; see section 9.2.3.2), 'Maintenance and cleaning workers for spray area(s)' (task 3; see section 9.2.3.8) and 'Machinists' (tasks 4 and 5; see section 9.2.3.4).

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.3.1 Conditions of use

Table 9-21 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by operator performing brushing/rolling.

Table 9-21: Conditions of use – Worker contributing scenario 2 – Operators performing brushing/rolling

Product (article) characteristics	
1: Primer products containing StC (water-based or solvent-based)	
Maximum concentration of StC [%] (w/w):	19
Concentration of Cr(VI) from StC [%] (w/w):	4.85
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Primer application by brushing/rolling (PROC 10)	
Maximum Cr(VI) concentration handled [%] (w/w):	4.85
Amount of product [L/shift]:	0.05 - 10
Duration of task [min/shift]:	<5 - 480
Frequency of task [days/year]:	<1 - 240

Technical and organisational conditions and measures	
Task 1: Primer application by brushing/rolling (PROC 10)	
LEV:	No
Type of LEV:	-
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	-
Other RMMs in place:	No
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
Chemical resistant gloves according to EN 374 as per relevant risk assessment must be worn during all tasks.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Primer application by brushing/rolling (PROC 10)	
RPE:	No
Protection clothes:	Yes, chemical protective clothing *
Other conditions affecting workers' exposure	
Task 1: Primer application by brushing/rolling (PROC 10)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

* Except where use of small volumes makes skin contact unlikely.

9.2.3.3.2 Exposure and risks for workers

Between individual sites, the number of operators performing brushing/rolling is variable, depending on several factors such as the site size, its role in the supply chain (e.g., MRO companies perform more brushing/rolling activities than OEMs), the distribution and throughput of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of operators performing brushing/rolling ranges between one and 52 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average, **18 brushing/rolling operators** (9 per shift, two shifts) are engaged in this scenario per site per day.

Below we describe in detail the main task "Primer application by brushing/rolling". The use conditions specified in Table 9-21 apply to this task.

Task 1: Primer application by brushing/rolling

This task covers application of liquid primer products by brushing/rolling. Usually, the brushing/rolling solution is prepared by spray operators for manual spraying as described in detail in section 0 (task: decanting/mixing of liquid primer and filling of guns/cups/small containers) but at some sites it may also be prepared by the operators performing brushing/rolling. In addition, also ready-to-use touch-up kits are available, where separately packaged small volumes of primer and activator only need to be combined. The mixing of these ready-to-use kits is usually performed by the brushing/rolling operators themselves.

The application of liquid primer products by brushing/rolling is performed with various tools (e.g., art brush, bended brush, cotton bud, touch-up pen, sponge, roll, etc). Usually, very small surfaces are treated by brushing using e.g., art brush, or cotton bud. Small to middle sized surfaces are typically treated by rolling.

The brushing/rolling process can be performed in various working areas e.g., in a dedicated spray hangar, spray room, composition workshop, assembly line, or MRO workshop. The working area may depend on the size of the surface area for which brushing/rolling is necessary and on the size of the part to be worked on. Brushing/rolling can be performed in the course of various working processes, e.g., after machining or repair work, where small surfaces require recoating, where surface treatment by brushing is advantageous compared to spraying, for touching up transport damage or if attachment points in the fixtures have remained uncoated during spraying.

When primer is applied by brushing/rolling to a small surface area, the operator dips the brushing/rolling tool into the liquid primer paint, braces the excess paint from the brushing/rolling tool and applies the paint to the areas to be (re-)painted.

Brushing/rolling of larger surface areas may also be performed by rolling if spraying is not the preferred approach (e.g., when an air intake shaft (appr. 50 cm in diameter) of an aircraft is treated because exposure is too high due to poor ventilation outside the spray room/hangar in the confined space). When painting is performed by rolling, the roller tool is dipped into the vessel, containing the primer followed by rolling over the surface area to be treated.

Primer application by rolling is applied less frequently at the sites than primer application on very small surfaces with e.g., a brush.

After the brushing/rolling activity is finished, used vessels and brushing/rolling equipment (e.g., cups, brushes, etc.) are either discarded as solid hazardous waste or cleaned with water or solvent (see description for task cleaning of spray gun(s) and equipment (PROC 28), as described in section 9.2.3.2).

9.2.3.3.2.1 Inhalation exposure

Measured inhalation exposure concentration

For operators performing brushing/rolling 13 personal monitoring data and five stationary data from GB sites are available for the inhalation exposure assessment. The 13 personal monitoring data can be divided into five long-term (≥2h)[10], shift-representative and eight short-term (<2h) measurements. Of the five stationary measurements, four are long-term measurements and one is a short-term measurement.

In total five GB sites reported personal monitoring data and three GB sites provided stationary monitoring data.

About 92% of the personal monitoring data (12 values, four long-term and all short-term measurements) are <LOQ and 8% (one long-term measurement) are >LOQ. About 60% of the stationary monitoring data (two long-term and one short-term measurements) are <LOQ and 40% (two long-term measurements) are >LOQ.

Due to the small amount of GB data, we report below also measurement data for operators performing brushing/rolling from EEA sites operating under comparable conditions of use.

From EEA sites, 217 personal monitoring data and 31 stationary data are available for the inhalation exposure assessment for this SEG. Of these 217 personal monitoring data, 85 are long-term (≥2h)[11], shift-representative and 132 are short-term (<2h) measurements. The 31 stationary measurements can be divided into 21 long-term and ten short-term measurements.

The personal monitoring data are from 61 sites in 12 countries in the EEA (considering also data provided via Art. 66 notification for which either an indication of the country and the site was given (42 measurements) or no information on the country or site was given (three measurements)). About 49% of the data (107 values, including 80 short-term values) are <LOQ and 51% (110 values, including 52 short-term values) are >LOQ.

The stationary data are from 13 sites in five countries in the EEA (including data submitted via Art. 66 notification, for which the country and in three cases the site were given (five measurements). About 84% of the stationary measurements (26 values, including eight short-term values) are <LOQ and 16% (five values, including two short-term values) are >LOQ.

Table 9-22 gives an overview of the data included in the assessment for operators performing brushing/rolling.

Table 9-22: Overview of available inhalation exposure measurements for WCS 2 – Operators performing brushing/rolling at GB and EEA sites

	Total	**>LOQ**	**<LOQ**
Personal at GB sites			
- Long-term (≥2h)	5	1	4
- Short-term (<2h)	8	0	8
Personal at EEA sites			
- Long-term (≥2h)	85	58	27

[10] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

[11] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

- Short-term (<2h)	132	52	80
Stationary at GB sites			
- Long-term (≥2h)	4	2	2
- Short-term (<2h)	1	0	1
Stationary at EEA sites			
- Long-term (≥2h)	21	3	18
- Short-term (<2h)	10	2	8

The measurements were taken at workers performing the main task with primer products containing StC and/or PCO and/or PHD. During some measurements, the workers also may have had Cr(VI) exposure from primer products not covered under the present use (e.g., brush application with wash primers) or from uses of other chromates (e.g., when performing chemical conversion coating on small surfaces with dichromium (tris)chromate using a touch-up pen). Note that the chromate used during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements several chromates may have been used. In some reports, no information was given on the substance used. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, no substance-specific differences in exposure levels were observed from the available data.

Table 9-23 shows the summary statistics of workplace measurements for operators performing brushing/rolling. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2017-2023. Further, specific evaluations analyse the role of individual tasks or differences between individual substances. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-23: Summary statistics of inhalation exposure measurements for WCS 2 – Operators performing brushing/rolling at GB and EEA sites

Personal – long-term at GB sites (measurement period 2019 and 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	5	100	0.0420	n.a.	n.a.	n.a. (MAX = 0.130)
Specific evaluations:						
- brushing/rolling application exclusively	4	80.0	0.0400	n.a.	n.a.	n.a. (MAX = 0.130)

Personal – short-term at GB sites (measurement period 2019 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	8	100	0.0389	n.a.	n.a.	n.a. (MAX = 0.135)
Specific evaluations:						
- brushing/rolling application exclusively	5	62.5	0.0563	n.a.	n.a.	n.a. (MAX = 0.135)
Stationary – long-term at GB sites (measurement period 2019 and 2021)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	4	100	0.196	n.a.	n.a.	n.a. (MAX = 0.400)
Stationary – short-term at GB sites (measurement period 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	1	100	n.a.	n.a.	n.a.	n.a. [a]
Personal – long-term at EEA sites (measurement period 2018 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	85	100	0.250	0.490	0.0850	0.620
Specific evaluations:						
- brushing/rolling application exclusively	63	74.1	0.199	0.438	0.0700	0.316
Personal – short-term at EEA sites (measurement period 2017 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	132	100	0.503	1.38	0.102	0.816
Specific evaluations:						
- brushing/rolling exclusively	78	59.1	0.546	1.38	0.130	1.12
Stationary – long-term at EEA sites (measurement period 2017, 2019 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	21	100	0.120	0.168	0.0500	0.500

Stationary – short-term at EEA sites (measurement period 2017, 2019 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	10	100	0.158	0.162	0.100	0.360

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual value is 0.0100 µg/m³ (<LOQ and reflects ½ LOQ).

Personal measurements – long-term

At GB sites, for operators performing brushing/rolling, the AM for the five long-term personal measurements is 0.0420 µg/m³. Due to the small database calculation of the 90th percentile is not reasonable. The main task of brushing/rolling primers is covered by all five measurements. In addition to the main task, the secondary task of decanting/mixing liquid primer and filling guns/cups/small containers (task 2) was also performed by operators while one measurement (20.0%) were taken. Four measurements are available during which the operator exclusively performed brushing/rolling activities. The AM of these values is 0.0400 µg/m³, which is comparable to the AM of the total long-term measurements (0.0420 µg/m³) at GB sites.

At EEA sites, the AM over the total long-term personal measurements for operators performing brushing/rolling is 0.250 µg/m³ and the 90th percentile is 0.620 µg/m³. All 85 measurements cover the main task brushing/rolling application of primers. Twenty-two (25.9%) of the 85 long-term measurements also cover secondary tasks of these workers, e.g., decanting/mixing of liquid primer and filling of guns/cups/small containers (task 2), handling of solid and/or liquid waste (task 3), machining on parts in large work areas (task 4), cleaning of spray gun(s) and equipment (e.g., brush, task 6). Six of these values also cover activities with indirect Cr(VI) exposure (e.g., transportation of parts to oven or drying/self-/heat-curing). The AM of long-term values from EEA sites is by a factor of 6.0 higher than the AM of total long-term values from GB sites (0.0420 µg/m³).

Of the 85 long-term measurements from the current assessment at EEA sites, only 28 values are clearly assignable to very small parts/touch-ups and seven values to small and medium sized parts/touch-ups. For the 28 values the AM is 0.298 µg/m³ and the 90th percentile is 0.593 µg/m³. For the small and medium sized parts/touch-ups, the AM is 0.0532 µg/m³, but this value is based on six measurements only and thus no comparison can be made for differences in exposure from brushing/rolling parts of different sizes.

Sixty-three long-term measurements are available while the operator exclusively performed brushing/rolling activities at EEA sites. For these measurements, the AM is 0.199 µg/m³ and the 90th percentile is 0.316 µg/m³. In comparison to the total long-term measurements at EEA sites (0.620 µg/m³), the 90th percentile of performing brushing/rolling exclusively is approximately by factor two lower, indicating that the additional tasks performed during the 22 other measurements lead to higher exposure than brushing/rolling exclusively. The AM for brushing/rolling exclusively at EEA sites (0.199 µg/m³) is comparable to the AM for brushing/rolling exclusively at GB sites (0.132 µg/m³).

Depending on the site, its organisation and which parts or aircrafts are treated by brushing/rolling activities and based on their internal assessments, the operators wear RPE or not.

Personal measurements – short-term

There is a total of eight personal short-term measurements available from GB sites while the operator was performing brushing/rolling applications of primers containing StC, PCO or PHD. The AM is 0.0389 µg/m³, but all measurements were below the LOQ (1/2 LOQ was considered) During three measurements (37.5%), the operator performed the secondary task handling of solid and/or liquid waste (task 3) in addition to the main task brushing/application of primers. Five of the short-term measurements (62.5%) cover the main task brushing/rolling of primers exclusively, with an AM of 0.0563 µg/m³, which is comparable to the AM of the total short-term measurements (0.0389 µg/m³) at GB sites.

At EEA sites, 132 personal short-term measurements were taken while the workers performed the main task primer application by brushing/rolling. During several measurements the workers performed also secondary tasks. Note that in several cases the worker carried out more than one task during the measurement (so these data are counted more than once in the list).

- Decanting/mixing of liquid primer and filling of guns/cups/small containers (task 2): 49 values
- Cleaning of spray gun(s) and equipment: three values
- Handling of solid and/or liquid waste (task 3): four values
- Machining on surfaces on an extraction bench/room/booth, including cleaning: one value
- Machining on surfaces in large work areas (e.g., workshop, hall, room), including cleaning: six values

For the total personal short-term measurements at EEA sites, the AM is 0.503 µg/m³ and the 90th percentile is 0.816 µg/m³. In comparison the AM of total personal short-term measurements at EEA sites is approximately one order of magnitude higher than the AM of total personal short-term measurements at GB sites (0.0389 µg/m³). Plausible reasons for this difference are that all short-term measurements from GB sites are below the LOQ and come from only five sites, whereas the database from EEA sites is much larger and more heterogeneous. However, the small number of data from GB sites does not allow a meaningful analysis of differences in exposure.

From the 132 short-term measurements at EEA sites, 55 values are clearly assignable to very small parts/touch-ups with an AM of 0.502 µg/m³ and a 90th percentile of 0.500 µg/m³. For small to medium parts/touch-ups 23 values are available with an AM 1.12 µg/m³ and a 90th percentile of 1.73 µg/m³.

Out of the 132 short-term values from EEA sites, 78 measurements (59.1%) were monitored while the operator exclusively performed brushing/rolling activities. The 90th percentile for brushing/rolling exclusively is 1.12 µg/m³, which is comparable to the 90th percentile of the total short-term data (0.816 µg/m³) at EEA sites.

Stationary measurements – long-term

Only four stationary long-term measurements from GB sites are available. For these measurements the AM is 0.196 µg/m³, which is similar to the AM of total personal long-term measurements from GB sites (0.173 µg/m³).

For the 21 total stationary long-term measurements at EEA sites, the AM is 0.120 µg/m³ and the 90th percentile is 0.500 µg/m³. Thereof, 20 measurements (80.0%) cover the main task exclusively. One measurement (4.76%) was taken while also secondary tasks were performed, e.g., decanting/mixing of liquid primer and filling of guns/cups/small containers (task 2), handling of solid and/or liquid waste (task 3), and cleaning of spray gun(s) and equipment (task 6).

The 90th percentile of the stationary long-term measurements is comparable to the 90th percentile of the total database for personal long-term measurements at EEA sites (0.620 µg/m³). The AM of the stationary long-term measurements from EEA sites is comparable to the AM of the stationary long-term data from GB sites.

Stationary measurements – short-term

From GB sites, only one short-term stationary measurement is available (0.0100 µg/m³).

For EEA sites, ten stationary short-term measurements were sampled while operators performed primer application by brush or swab at EEA sites. The 90th percentile for these measurements is 0.360 mg/m³. Eight of the ten values (80.0%) cover brushing/rolling activities only. In addition, two stationary short-term measurements cover also the secondary tasks, e.g., decanting/mixing of liquid primer and filling of guns/cups/small containers (task 2), handling of solid and/or liquid waste (task 3), and/or cleaning of spray gun(s) and equipment (task 6).

Due to the small database from GB sites and the comparable exposure values between GB and EEA monitoring data, the complete set of long-term personal measurements during which the operator exclusively performed brushing/rolling activities from GB and EEA sites combined was used for the risk characterisation (90th percentile: 0.308 µg/m³, see table below).

Table 9-24: Summary statistics of personal long-term inhalation exposure measurements for WCS 3 – Operators performing brushing/rolling exclusively at GB and EEA sites

Personal – long-term at GB sites and EEA sites in total (measurement period 2020 - 2023)					
	N	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	67	0.189	0.427	0.0700	0.308

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

Table 9-25 shows the resulting long-term inhalation exposure concentration for operators performing exclusively brushing/rolling activities used for risk assessment, based on the 90th percentile of personal long-term sampling values from GB and EEA sites combined.

RPE may be worn by the operators during specific brushing/rolling activities as its use was documented for some of the measurements. However, it is assumed that RPE is worn during certain time periods of the shift only. Therefore, no RPE is considered in the exposure assessment.

At most sites, the operators who perform brushing/rolling do not spend their entire work shift on this Cr(VI) task (e.g., they also perform brushing/rolling with Cr(VI)-free products or perform masking during their work shift). However, for a conservative assessment, we consider that 100% of their working time is spent on this use. Accordingly, no correction is made in the assessment for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 1.00).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types.

Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-25: Measured inhalation exposure concentration for WCS 2 – Operators performing brushing/rolling

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m³]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m³]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m³]
Personal	67	0.308	1	0.308	1.00	0.210	0.0647

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] No RPE is used, see above.

[c] No time correction factor is used in this assessment.

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.3.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-26 shows the risk characterisation for carcinogenicity for operators performing brushing/rolling. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-26: Risk characterisation for carcinogenicity for WCS 2 – Operators performing brushing/rolling

Route of exposure and type of effects	Long-term exposure [µg/m³] [a]	Risk characterisation: Excess lifetime lung cancer risk [b] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [c]
Inhalation: Systemic Long Term	0.0647	4.00E-03	2.59E-04

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] Calculated value, which is based on 90th percentile of long-term measurements while the operator exclusively performed brushing/rolling activities.

[b] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a) : Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[c] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for operators performing brushing/rolling is 2.59E-04.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- these measurements were not corrected for their duration but assumed to be shift representative values,
- no correction for wearing RPE was applied although workers may wear RPE under certain conditions for some brushing/rolling activities.

On average, we assume that **18 brushing/rolling operators** are engaged in this scenario per day per site. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.3.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For operators performing brushing/rolling one GB site provided biomonitoring data sampled in 2017 and 2019. The data cover the main task of operators performing brushing/rolling application of primers. For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-27: Biomonitoring data for WCS 3 – Operators performing brushing/rolling at GB sites

Individual values	
N	2 [a]
AM [µmol Cr/mol creatinine]	4.75
Median [µmol Cr/mol creatinine]	n.a.
90th percentile [µmol Cr/mol creatinine]	n.a.
N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] Individual values are 0.801 and 8.70 µmol Cr/mol creatinine.

The presented biomonitoring data show that the body burden of operators performing brushing/rolling at GB sites did not exceed the UK BMGV in a single case.

A plausible reason for the small database for this WCS may be that sites reported the biomonitoring data for operators performing brushing/rolling applications of primers under a different WCS, as the operator may also be involved in other tasks with a higher potential for chromate exposure than the brushing/rolling application during their workweek (e.g., spraying or machining and if necessary and touch-up activities).

For this WCS biomonitoring data are available from 19 sites in five EEA countries, sampled in the years 2019-2022. The data cover the main tasks of operators performing brushing/rolling and some measurements additionally cover main tasks performed by:

- Spray operators for manual spraying in a spray room/booth
- Machinists
- Sanders in a dedicated hangar

Biomonitoring data were reported by companies either as individual values or as results for groups of workers and are reported here accordingly (see Annex V). The following table shows the summary statistics for the individual values and an overview of the available group entries.

Table 9-28: Biomonitoring data for WCS 3 – Operators performing brushing/rolling at EEA sites

Individual values	
N	16
AM [µmol Cr/mol creatinine]	0.889
Median [µmol Cr/mol creatinine]	0.240
90th Perc. [µmol Cr/mol creatinine]	2.64
N > 10.0 µmol Cr/mol creatinine	0
Group entries	
N	597
Number of data sets	26
Number of data sets with individual values > 10.0 µmol Cr/mol creatinine	1 [a]
% of data sets with individual values > 10.0 µmol Cr/mol creatinine	3.85%

All exposure values rounded to three significant figures for presentation.

[a] MAX value of 14.4 µmol Cr/mol creatinine is reported for one group entry (data set of 38 values). The number of values exceeding 10.0 µmol Cr/mol creatinine is unknown for this group entry.

In total, 16 individual values are available, with an AM of 0.889 µmol Cr/mol creatinine and a 90th percentile of 2.64 µmol Cr/mol creatinine. No values exceed 10.0 µmol Cr/mol creatinine (UK BMGV).

The majority of values are available as group entries: 597 values from 26 data sets for this WCS. In one of these two data sets, a MAX value exceeding the UK BMGV of 10.0 µmol Cr/mol creatinine was reported (14.4 µmol Cr/mol creatinine). The exact number of values exceeding 10.0 µmol Cr/mol creatinine is unknown for these group entries. During the days before sampling the workers from the group entry with the MAX value of 14.4 µmol Cr/mol creatinine performed brushing, machining, and spraying in a room/booth. These additional tasks with Cr(VI) exposure may have led to the increased exposure in individuals.

Overall, the reported biomonitoring data confirm that the body burden of operators performing brushing/rolling exceeded the UK BMGV only in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.4 Worker contributing scenario 3 – Machinists

Machinists are usually involved in numerous activities related to mechanical treatment of metallic parts. Different types of machining might be necessary: sawing, drilling, bolting, countersinking, riveting, deburring, grinding, fettling, sanding, etc.

All machining activities are conducted in areas, which are separated from the site's other processes and is access controlled (either physically (barrier/signage) or through strict procedures. Machining can take place either in an extraction bench/room/booth, in large work areas, and less frequently in very small work areas. Typical activities with possible direct Cr(VI) exposure performed by these operators are machining on metallic parts previously treated with primers containing StC and/or PCO, and/or PHD.

For the purpose of this assessment, we will distinguish two categories of machining activities leading to different types of exposure:

- "Machining on parts" which refers to a process where a part can be pierced, milled, cut, etc. i.e., machining operations affecting the deeper metallic layers of the part (without Cr(VI)). During these processes, release of shaving/chips and little (or no) dust containing potentially low Cr(VI) concentration may occur.

and

- "Machining on surfaces" which consists in the removal/activation of the part surface only (abrasion, sanding, etc.) i.e. machining operations affecting exclusively the surface layer of the part that may have been previously treated with Cr(VI) primer products. This kind of machining processes generate high emissions of dust particles containing higher Cr(VI) concentration.

Typical tasks with possible Cr(VI) exposure performed by machinists are:

Main tasks

- Task 1: Machining on **surfaces** on an extraction bench/room/booth, including cleaning (PROC 21, 24)
- Task 2: Machining on **surfaces** in large work areas (e.g., workshop, hall, room), including cleaning (PROC 21, 24)
- Task 3: Machining on **surfaces** in very small work areas (confined space, e.g., wing area/tank), including cleaning (PROC 21, 24)
- Task 4: Machining on **parts** on an extraction bench/room/booth, including cleaning (PROC 21, 24)
- Task 5: Machining on **parts** in large work areas (e.g., workshop, hall, room), including cleaning (PROC 21, 24)
- Task 6: Machining on **parts** in very small work areas (confined space, e.g., wing area/tank), including cleaning (PROC 21, 24)

Secondary tasks

- Task 7: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)
- Task 8: Primer application by brushing/rolling (PROC 10)
- Task 9: Handling of solid and/or liquid waste (PROC 8b)
- Task 10: Maintenance and cleaning of equipment and work area (PROC 28)
- Task 11: Media blasting in closed system, including cleaning and waste removal (PROC 21, PROC 24)

As tasks 7 to 11 are main tasks performed by other SEGs, they are described in detail in the respective worker contributing scenarios, WCS 1 'Spray operators for manual spraying in spray room/booth' (task 7; see section 9.2.3.2), WCS 2 'Operators performing brushing/rolling' (task 8; see section 9.2.3.3), WCS 7 'Maintenance and cleaning workers for spray area(s)' (task 9; see section 9.2.3.8), WCS 8 'Maintenance and/or cleaning workers (excluding spray areas)' (task 10; see section 9.2.3.9), and WCS 5 'Workers performing media blasting in closed system' (task 11; see section 9.2.3.6).

At few GB sites , automated machining units (e.g., drilling/milling units) are used. These automated systems enable full control and direction of rig functions from a single remote-control source. At sites where such equipment is used, machinists are typically in charge of the use of the machine. Activities of the operator include the installation of the automated machine, the set-up of the machine, the control of the machining operations, and the insertion and removal of parts. The automated machine typically includes an internal air extraction system. Since very low to no exposure is foreseen during general set-up/removal activities and automated machining operations, it can be expected that exposure during such activities is lower than during the main (and secondary) tasks of machinists described above. Therefore, automated machining is not addressed separately in the present assessment.

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.4.1 Conditions of use

Table 9-29 summarises the conditions of use for the main tasks with direct Cr(VI) exposure carried out by machinists.

Table 9-29: Conditions of use – Worker contributing scenario 3 – Machinists

Product (article) characteristics	
Product type	n.a. (surface-treated parts)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Machining on surfaces on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 480
Frequency of task [days/year]:	<1 - 240

Task 2: Machining on surfaces in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 420
Frequency of task [days/year]:	<1 - 240
Task 3: Machining on surfaces in very small work areas (confined space, e.g., wing area/tank), including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 360
Frequency of task [days/year]:	<1 - 240
Task 4: Machining on parts on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 420
Frequency of task [days/year]:	<1 - 240
Task 5: Machining on parts in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 480
Frequency of task [days/year]:	<1 - 240
Task 6: Machining on parts in very small work areas (e.g., wing area/tank), including cleaning (PROC 21, 24)	
Duration of task [min/shift]:	5 - 360
Frequency of task [days/year]:	<1 - 240
Technical and organisational conditions and measures	
Task 1: Machining on surfaces on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
LEV:	Yes
Type of LEV:	LEV system installed in extraction bench/room/booth
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Task 2: Machining on surfaces in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
LEV:	Yes
Type of LEV:	On-tool extraction system or mobile extraction (including vacuum cleaner)
Type of general ventilation in working hall:	Natural ventilation

Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. If not technically possible to implement a LEV, workers operate under wet conditions.
Task 3: Machining on surfaces in very small work areas (confined space, e.g., wing area/tank), including cleaning (PROC 21, 24)	
LEV:	Yes
Type of LEV:	On-tool extraction system or mobile extraction (including vacuum cleaner)
Type of general ventilation in working hall:	Mechanical ventilation unless use of mechanical ventilation would introduce risks (e.g. local spark risk) or would otherwise not be technically and practically possible.
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. If not technically possible to implement a LEV, workers operate under wet conditions.
Task 4: Machining on parts on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
LEV:	yes
Type of LEV:	LEV system installed in extraction bench/room/booth
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Task 5: Machining on parts in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
LEV:	Yes
Type of LEV:	On-tool extraction system or mobile extraction (including vacuum cleaner)
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.

Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. If not technically possible to implement a LEV, workers operate under wet conditions.
Task 6: Machining on parts in very small work areas (e.g., wing area/tank), including cleaning (PROC 21, 24)	
LEV:	Yes
Type of LEV:	On-tool extraction system or mobile extraction (including vacuum cleaner)
Type of general ventilation in working hall:	Mechanical ventilation unless use of mechanical ventilation would introduce risks (e.g. local spark risk) or would otherwise not be technically and practically possible.
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. If not technically possible to implement a LEV, workers operate under wet conditions.
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
As it is expected that any residual Cr(VI) contained in coated particles released by machining cannot be absorbed through the skin, no specific requirements for gloves with regard to carcinogenic effects result for this scenario. However, the PPE for each machining activity is determined by each site with an overall EH&S risk assessment for potential mechanical injury.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Machining on surfaces on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
RPE:	Yes, at least half mask with P3 filter
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Task 2: Machining on surfaces in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
RPE:	Yes, at least half mask with P3 filter
Protection clothes:	Chemical protective clothing per site-specific risk assessment

Task 3: Machining on surfaces in very small work areas (confined space, e.g., wing area/tank), including cleaning (PROC 21, 24)	
RPE:	Yes, at least half mask with P3 filter
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Task 4: Machining on parts on an extraction bench/room/booth, including cleaning (PROC 21, 24)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms that RPE use is required
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Task 5: Machining on parts in large work areas (e.g. workshop, hall, room), including cleaning (PROC 21, 24)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms that RPE use is required
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Task 6: Machining on parts in very small work areas (e.g., wing area/tank), including cleaning (PROC 21, 24)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms that RPE use is required
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Other conditions affecting workers' exposure	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

9.2.3.4.2 Exposure and risks for workers

Between individual sites, the number of machinists is very variable, depending on several factors such as the size of the site, the organisation of the machining area(s) (presence or not of extraction room(s)/booth(s)/bench(es), machining in large work areas, or machining in very small areas, all possibly organised in different workshops), the distribution and throughput of work. The number of work shifts also differs between sites, ranging from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of machinists typically ranges between one to 69 workers per shift and reach 1440 workers at one large site where machining is a major activity. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average 18 machinists (18 per shift, one shift) are engaged per day per site in this use (at 30% of sites) and 1440 machinists at one site.

Below we describe in detail the relevant tasks with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-29 apply to these tasks.

Task 1 to 3: Machining on **surfaces** on an extraction bench/room/booth, including cleaning - Machining on **surfaces** in large work areas (e.g., workshop, hall, room), including cleaning - Machining on **surfaces** in very small work areas (confined space, e.g., wing area/tank), including cleaning

Machining on surfaces may be required for production, maintenance, and repair activities when parts need to be reworked or resized/fitted to meet dimensional accuracy, special surface characteristics or textures defined in the customer specifications. Common abrasive processes are sanding, grinding, and fettling. Machining on surfaces can be performed manually (e.g., light sanding using sandpaper or abrasive pad) or mechanically using hand-held power tools generally equipped with on-tool extraction (e.g., orbital sander).

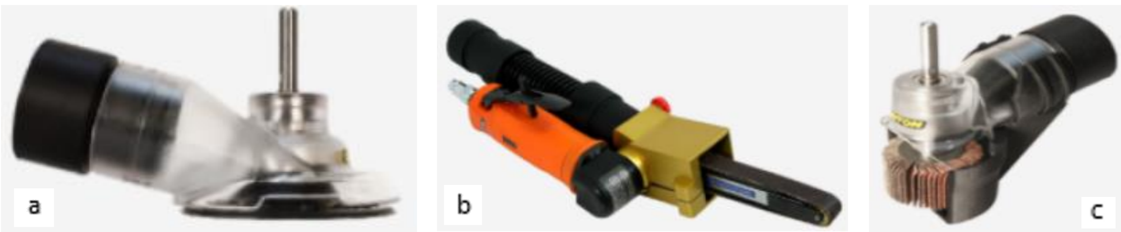

Figure 9-3: Examples of tools used for machining on surfaces (Rotary sander (a), flap wheel sander (b), band sander (c), all equipped with on-tool extraction)

Task 1: Machining on surfaces can be performed in a dedicated extraction room or booth (with an exhaust system where the airflow is usually directed from the ceiling to the floor and/or to the side walls) or an extraction bench specifically designed to capture dust (e.g., grinding table equipped with downdraught extraction systems). Besides the LEV system in place, worker may also use tools equipped with on-tool extraction and/or wetting at the point of release. Examples of LEV systems installed at sites are given in Annex VIII.

Figure 9-4: Extraction bench (a) and fettling booth (b + c) used for machining

Figure 9-5: Manual abrasion performed in an extraction booth

Task 2: At some sites, when machining is required e.g., on the assembly line or in MRO workshops, for example on large parts or, directly on the aircraft, machining of surfaces can take place in large work areas/workshops. Whenever technically possible, machining activities are conducted under the use of a LEV (e.g., on-tool extraction, mobile LEV). If the work area is not equipped with a LEV, machinists operate under wet conditions.

Task 3: At some sites machining on surfaces in confined spaces is required. For instance, during the general equipping of wings, sanding/abrasion for fitting and/or re-work (due to damage or imperfections), and then cleaning and/or removing of dust may be required inside the wing. Inside fuel tanks or inside aircraft fuselage, manual or mechanical machining may also be required. Depending on the activity, the size of the confined space and the tool used, LEV (generally on-tool extraction or small designed LEV) is present if technically possible. If the work area is not equipped with a LEV, wet machining/wet cleaning methods are performed.

Figure 9-6: Machining performed in a confined space (wing tank)

Task 4 to 6: Machining on **parts** on an extraction bench/room/booth, including cleaning - Machining on **parts** in large work areas (e.g., workshop, hall, room), including cleaning - Machining on **parts** in very small work areas (e.g., wing area/tank), including cleaning

Machining on parts is generally required during production activities for the fitting of parts. Machining on parts includes for instance sawing, drilling, bolting, countersinking, riveting, deburring, etc. It is mostly performed using hand-held power tools generally equipped with on-tool extraction (e.g., drilling machine, counter bore cutter, compressed air 'rivet' gun).

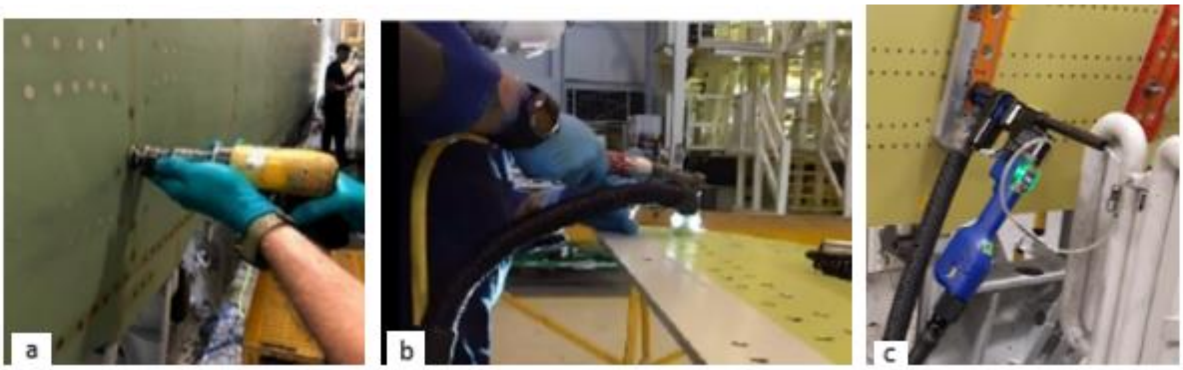

Figure 9-7: Different types of machining activities on parts (Bolting (a), deburring (b), rib drilling (c))

Task 4: Machining on parts can be performed in a dedicated extraction room or booth (with an exhaust system where the airflow is usually directed from the ceiling to the floor and/or to the side walls) or an extraction bench specifically designed to capture metal chips (e.g., fettling booth). Examples of LEV systems installed at sites are given in Annex VIII.

Task 5: At some sites, when machining is required on the assembly line, on large parts or, directly on the aircraft, machining of parts can take place in large work areas/workshops. Whenever technically possible, machining activities are conducted under the use of a LEV (e.g., on-tool extraction, mobile LEV). Besides the LEV system in place, worker may also use tools equipped with on-tool extraction and/or wetting at the point of release.

Task 6: At some sites, machining on parts in confined spaces is required. Typically, a range of activities are conducted during the equipping of wings including drilling, abrading, earth bonding, installation of fuel/hydraulic and electrical systems. The workers may be required to operate inside the wing or tank to perform the machining work. Depending on the activity and the tool used, LEV (generally on-tool extraction or small designed mobile LEV) is present if technically possible. If the work area is not equipped with a LEV, wet machining/wet cleaning methods are performed.

All tasks: Machining on surfaces/parts can be performed under dry or wet conditions depending on the technique used. Use of water or lubricant for wet machining reduces the dispersion of emitted particles. After mechanical treatment, the parts may be rinsed, dried, and checked for quality.

In addition to carrying out the mechanical work, machinists are generally also responsible for cleaning the machines and tools and managing the waste generated at their workplace. These activities are included in these tasks because they are conducted under the same operational conditions and risk management measures as the machining activities. Typical cleaning operations, at the end of the shift or in between, consist of cleaning the working area and tools with wet rags/wipes, vacuum cleaner, and disposing of solid waste generated during the machining process in dedicated hazardous waste containers. All process fluids and hazardous solid waste are collected by maintenance and/or cleaning workers (see section 9.2.3.8).

9.2.3.4.2.1 Inhalation exposure

Measured inhalation exposure concentration

In total, 269 personal monitoring data and 28 stationary data were reported for the inhalation exposure assessment for this SEG. Of these 269 personal monitoring data, 239 are long-term (≥2h)[12] shift-representative and 30 are short-term (<2h) measurements. The 28 stationary measurements can be divided in 24 long-term measurements and 4 short-term measurements.

The 269 personal monitoring data come from three different GB sites. About 48.3% of the data (130 values, including 8 short-term measurements) are <LOQ and 51.7% (139 values, including 22 short-term measurements) are >LOQ.

The 28 stationary data come from two different GB sites. About 64.3% of the stationary measurements (18 values, including 4 short-term measurements) are <LOQ and 35.7% (10 values, including only long-term measurements) are >LOQ.

Table 9-30 gives an overview of the available data for machinists.

Table 9-30: Overview of available inhalation exposure measurements for WCS 3 – Machinists

	Total	>LOQ	<LOQ
Personal			
- Long-term (≥2h)	239	117	122
- Short-term (<2h)	30	22	8
Stationary			
- Long-term (≥2h)	24	10	14
- Short-term (<2h)	4	0	4

The measurements were taken at workers performing one or several main tasks listed above on parts treated with primer products containing StC and/or PCO and/or PHD .

During some measurements, the workers may also be exposed to Cr(VI) from primer products not covered under the present use (e.g., from parts treated with wash primers) or from uses of other chromates (e.g., when performing touch-up with dichromium tris(chromate)). Note that the substance used during the measurement could not always be clearly identified. According to the information given in the measurement reports, during some measurements several substances may have been

[12] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

used. In some measurement reports, no information was given on the substance used. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, due to limited availability of data, no substance-specific analysis can be conducted.

Table 9-31 shows the summary statistics of workplace measurements for machinists. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2020-2023. Further, specific evaluations analyse the role of individual tasks. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-31: Summary statistics of inhalation exposure measurements for WCS 3 – Machinists

Personal – long-term (measurement period 2020 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	239	100	0.165	0.485	0.0230	0.340
Specific evaluations:						
- Machining on **surfaces only** (Tasks 1, 2 and/or 3)	56	23.4	0.321	0.822	0.0300	0.914
- Machining on **parts only** (Tasks 4, 5 and/or 6)	80	33.5	0.0561	0.150	0.0120	0.0896
- Machining on surfaces on an extraction bench/room/booth only (Task 1)	8	3.35	1.63	n.a.	n.a.	n.a. (MAX = 4.60)
- Machining on surfaces in large work areas only (Task 2)	30	12.6	0.0929	0.319	0.0170	0.102
- Machining on surfaces in very small work areas only (Task 3)	18	7.53	0.121	0.186	0.0560	0.300
- Machining on parts in large work areas only (Task 5)	80	33.5	0.0561	0.150	0.0120	0.0896
Personal – short-term (measurement period 2020 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	30	100	14.0	23.7	1.82	43.0
Specific evaluations:						
- Machining on **surfaces only** (Tasks 1, 2 and/or 3)	23	76.7	17.2	26.2	1.00	48.4
- Machining on **parts only** (Tasks 4, 5 and/or 6)	3	11.5	1.46	n.a.	n.a.	n.a. (MAX = 4.30) [a]

- Machining on surfaces on an extraction bench/room/booth only (Task 1)	19	63.3	20.8	27.6	7.90	50.9
- Machining on surfaces in large work areas only (Task 2)	4	13.3	0.0933	n.a.	n.a.	n.a. (MAX = 0.182)
- Machining on parts in large work areas only (Task 5)	3	11.5	1.46	n.a.	n.a.	n.a. (MAX = 4.30) [a]
Stationary – long-term (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	24	100	0.0253	0.0294	0.0158	0.0445
Specific evaluations:						
- Machining on **surfaces only** (Tasks 1, 2 and/or 3)	6	25.0	0.0450	n.a.	n.a.	n.a. (MAX = 0.130)
- Machining on **parts only** (Tasks 4, 5 and/or 6)	6	25.0	0.0118	n.a.	n.a.	n.a. (MAX = 0.0460)
- Machining on surfaces on an extraction bench/room/booth only (Task 1)	4	16.7	0.0325	n.a.	n.a.	n.a. (MAX = 0.0900)
- Machining on surfaces in large work areas only (Task 2)	2	8.33	n.a.	n.a.	n.a.	n.a. (MAX = 0.130) [b]
- Machining on parts in large work areas only (Task 5)	6	25.0	0.0118	n.a.	n.a.	n.a. (MAX = 0.0460)
Stationary – short-term (measurement period 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	4	100	0.0148	n.a.	n.a.	n.a. (MAX = 0.0290)
Specific evaluations:						
- Machining on **surfaces only** (Tasks 1, 2 and/or 3)	3	75.0	0.0100	n.a.	n.a.	n.a. (MAX = 0.0100) [c]
- Machining on **parts only** (Tasks 4, 5 and/or 6)	1	25.0	n.a.	n.a.	n.a.	n.a. (value = 0.0290) [d]
- Machining on surfaces on an extraction bench/room/booth only (Task 1)	3	75.0	0.0100	n.a.	n.a.	n.a. (MAX = 0.0100) [c]
- Machining on parts in large work areas only (Task 5)	1	25.0	n.a.	n.a.	n.a.	n.a. (value = 0.0290) [d]

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual values are <0.0670, <0.0940 and 4.3 µg/m³.

[b] The individual values are <0.0200 and 0.130 µg/m³.

[c] The individual values are <0.0200 µg/m³ (3x).

[d] The individual value is <0.0580 µg/m³.

Personal measurements – long-term

The AM over the total of long-term personal measurements is 0.165 µg/m^3 and the 90th percentile is 0.340 µg/m^3.

Of the 239 total measurements, 56 (23.4%) cover only machining on surfaces (tasks 1, 2 and/or 3) and 80 (33.5%) cover only machining on parts (tasks 4, 5 and/or 6). The 90th percentile of the long-term personal measurements on machining on surfaces (0.914 µg/m^3) is approximately one order of magnitude higher than the 90th percentile over the long-term personal measurements on machining on parts (0.0896 µg/m^3). This is due to the higher solid weight fraction of Cr(VI) on surfaces compared to parts, and because machining activity on the surface generates usually higher emissions of fine dust particles containing Cr(VI).

Some of the measurements were taken while workers performed only one of the main tasks. Eight measurements (3.35%) cover only machining on surfaces on an extraction bench/room/booth (Task 1), the AM of these long-term personal measurements is 3.69 µg/m^3. Based on this limited set of long-term data, this task appears to be the most exposing tasks for machinists. However these eight measurements come from the same site which might introduce a bias. The results of the other tasks (Tasks 2, 3, and 5) are below the AM and/or the 90th percentile of the total long-term data (no specific measurement is available for Tasks 4 and 6).

Use of RPE was reported for most measurements, but during some of them either RPE is not worn, or the information is not available.

Personal measurements – short term

The 30 personal short-term measurements were taken while the workers performed one or several main tasks assigned to machinists. As workers usually carry out exclusively one task during the measurement (26 measurements out of 30), the number of these measurements covering only one main task are presented below.

- Machining on **surfaces** on an extraction bench/room/booth, including cleaning (Task 1 only): 19
- Machining on **surfaces** in large work areas (e.g., workshop, hall, room), including cleaning (Task 2 only): 4
- Machining on **parts** in large work areas (e.g., workshop, hall, room), including cleaning (Task 5 only): 3

The AM over the total of short-term personal measurements is 14.0 µg/m^3 and the 90th percentile is 43.0 µg/m^3.

A large majority of measurements (76.7%) relates to machining on surfaces only, only three measurements were available for machining on parts only. Still, as it was observed for long-term personal data, Cr(VI) exposure is higher for tasks involving machining on surfaces than machining on parts. The AM over the short-term personal measurements on machining on surfaces (Tasks 1 and 2) and parts (Tasks 5) are respectively 17.2 and 1.46 µg/m^3. This supports that exposure of machinists is mainly driven by data from surface-machining tasks.

Besides, as observed for long-term personal data, short-term personal data is mainly influenced by the results of machining on surfaces on an extraction bench/room/booth (Task 1). The AM and 90th percentile of the 19 measurements are respectively 20.8 and 50.9 µg/m^3 above the AM and 90th percentile of the total short-term personal database (14.0 and 43.0 µg/m^3). The results of the other tasks (Tasks 2 and 5) are below the AM of the total short-term data (no specific measurement is available for Tasks 3, 4 and 6).

All short-term measurements are within the range of 0.0100 to 105 µg/m^3. Of the 30 values, 18 are above the 90th percentile of the total long-term data. The 8h TWA[13] values calculated for all these measurements are within the range of 0.034 to 14.4 µg/m^3. These 8h TWA corrected with the APF for the respective RPE worn during the measurements are all below the 90th percentile of the long-term measurements (0.340 µg/m^3), suggesting that exposure from this individual activity is covered by the shift-average exposure of operators.

Use of RPE was reported for most measurements.

Stationary measurements – long-term

For the total of 24 long-term stationary measurements, the 90th percentile is 0.0445 µg/m^3. Thereof, six values (25.0%) cover only machining on surfaces (tasks 1, 2 and/or 3) and six values (25.0%) cover only machining on parts (tasks 4, 5 and/or 6). The 90th percentile over the long-term stationary measurements on machining on surfaces is approximately by factor four higher than the AM for the machining of parts (90th percentiles are respectively 0.0450 and 0.0118 µg/m^3). As observed above, this can be due to the higher solid weight fraction of Cr(VI) on surfaces compared to parts, and because machining activity on the surface generates usually higher emission of fine dusts particles containing Cr(VI).

Some of the stationary measurements are available for distinctive tasks. But due to the limited number of values, the significance of these statistical determinants is low and does not allow a meaningful comparison of exposure from individual tasks.

Stationary measurements – short-term

The calculated AM over the four short-term stationary measurements is 0.0148 µg/m^3. All four values are below the LOQ.

As shown in Table 9-31, the 90th percentile (0.340 µg/m^3) of the total dataset (including machining on surfaces and parts) is exactly in between the 90th percentiles of long-term personal measurements of machining on surfaces only (0.914 µg/m^3) and on machining on parts only (0.0896 µg/m^3), which confirms the representativeness of the overall dataset.

However, RPE (at least half mask with P3 filter) is worn for all machining activities on surfaces, which would reduce the 90th percentile of personal long-term measurements for exclusively machining on surfaces only to 0.0914 µg/m^3 (considering APF 10), which is comparable with the 90th percentile of personal long-term measurements for machining on parts only exclusively (0.0896 µg/m^3). As RPE is

[13] TWAs are calculated by assuming that the remaining time of the 8h shift, during which the measurement was not performed, is non-exposure time.

not always worn for machining on parts, RPE correction cannot be applied on the full dataset of long-term personal measurements that cover tasks related to both machining on surfaces and parts.

For a conservative exposure assessment we consider it appropriate to use the highest 90th percentile, which is related to machining on surfaces only and correct it for the use of RPE by applying APF 10 (**0.0914 µg/m^3**).

Table 9-32 shows the resulting long-term inhalation exposure concentration for machinists, used for risk assessment, based on 90th percentile of personal sampling values.

At most sites the workers do not spend their whole work shift on Cr(VI) primed parts (e.g., they also perform machining on Cr(VI)-free parts). However, for a conservative assessment, we consider that 100% of their working time is spent on Cr(VI) primed parts. Accordingly, no correction is made in the assessment for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 1.00).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-32: Measured inhalation exposure concentration for WCS 3 – Machinists

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m^3]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m^3]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m^3]
Personal	56	0.914	10	0.0914	1.00	0.210	**0.0192**

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements on machining on parts only (see above).

[b] No RPE is used, see above.

[c] Since the workers spend 100% of their working time on Cr(VI) tasks a time correction factor of 1.00 is used.

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.4.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-33 shows the risk characterisation for carcinogenicity for machinists. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-33: Risk characterisation for carcinogenicity for WCS 3 – Machinists

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.0192	4.00E-03	7.68E-05

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of 4x10-3 for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for machinists is 7.68E-05.
This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **18 machinists** are engaged in this scenario per day per site (at 30% of sites) and 1440 machinists at one site. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.4.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For this WCS biomonitoring data are available from three sites in GB, sampled in the years 2020-2022. The data cover the main tasks of machinists and some measurements additionally cover main tasks performed by spray operators for manual spraying in spray room/booth.

Biomonitoring data were reported by companies either as individual values or as results for groups of workers and are reported here accordingly (see Annex V). The following table shows the summary statistics for the individual values and an overview of the available group entries.

Table 9-34: Biomonitoring data for WCS 4 – Machinists

Individual values	
N	25
AM [µmol Cr/mol creatinine]	1.33
Median [µmol Cr/mol creatinine]	1.00

90th Perc. [µmol Cr/mol creatinine]	2.78
N > 10.0 µmol Cr/mol creatinine	0
Group entries	
N	105
Number of data sets	21
Number of datasets with individual values > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

In total, 25 individual values are available, with an AM of 1.33 µmol Cr/mol creatinine and a 90th percentile of 2.78 µmol Cr/mol creatinine. No value exceeds 10.0 µmol Cr/mol creatinine (UK BMGV).

Another 105 values from 21 data sets are available as group entries for this WCS. No value exceeds 10.0 µmol Cr/mol creatinine (UK BMGV).

Overall, the reported biomonitoring data confirm that the body burden of machinists for machining activities on surfaces and/or parts did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.5 Worker contributing scenario 4 – Sanders in a dedicated hangar

Sanding of large parts or complete aircrafts is performed in dedicated hangars (equipped like dedicated spray hangars) under local exhaust ventilation.

Sanders in a dedicated hangar are usually involved in other processes in a dedicated hangar in addition to sanding activity. They spend most of their time in a dedicated hangar, perform activities that involve direct or no exposure to Cr(VI). Typical activities with possible direct Cr(VI) exposure performed by these operators are:

<u>Main tasks</u>

- Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning (PROC 21, PROC 24)

<u>Secondary task</u>

- Task 2: Decanting/mixing of liquid primer and filling of guns/cups/small containers (PROC 5, PROC 9)
- Task 3: Cleaning of spray gun(s) and equipment (PROC 28)
- Task 4: Primer application by brushing/rolling (PROC 10)
- Task 5: Handling of solid and/or liquid waste (PROC 8b)
- Task 6: Maintenance and cleaning of equipment and work area (PROC 28)

As tasks 2 to 6 are main tasks performed by other SEGs, they are described in detail in the respective worker contributing scenarios ‘Sprayers for manual spraying in spray booth/room’ (tasks 2, and 3; see section 9.2.3.2), ‘Operators performing brushing/rolling’ (task 4; see section 9.2.3.3), ‘Maintenance and cleaning workers for spray area(s)’ (tasks 5; see section 9.2.3.8), and ‘Maintenance and/or cleaning workers (excluding spray areas)’ (task 6; see section 9.2.3.9).

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.5.1 Conditions of use

Table 9-35 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by sanders.

Table 9-35: Conditions of use – Worker contributing scenario 4 – Sanders in a dedicated hangar

Product (article) characteristics	
Product type	n.a. (surface-treated parts)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning (PROC 21, PROC 24)	
Duration of task [min/shift]:	Up to 240 min [a]
Frequency of task [days/year]:	<1-96 [b]
Technical and organisational conditions and measures	
Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning (PROC 21, PROC 24)	
LEV:	Yes
Type of LEV:	Hangar - laminar down-flow or cross-flow (≥3 ACH)
Type of general ventilation in working hall:	n.a.
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure. Depending on the site and its organisation, either on-tool extraction or a vacuum cleaner or wetting/lubrication at the point of release is used during sanding in a hangar to minimise Cr(VI) exposure. Sanding of small areas (e.g., around windows or prior to brushing application) with sandpaper or sanding tools in a hangar with LEV requires no on-tool extraction.

Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
As it is expected that any residual Cr(VI) contained in coated particles released by sanding cannot be absorbed through the skin, no specific requirements for gloves with regard to carcinogenic effects result for this scenario. However, the PPE for each sanding activity is determined by each site with an overall EH&S risk assessment for potential mechanical injury.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during sanding, no further eye protection is needed. Type of eye protection to be used for the specific task is laid down in work instructions for the task.	
Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning (PROC 21, PROC 24)	
RPE:	Yes, ambient air-independent breathing apparatus (fresh air hose, compressed air line, supplied-air respirator or similar, see Annex VI). In case of sanding small areas, at least a half mask with P3 filter (APF 10) is worn.
Protection clothes:	Yes, chemical protective coverall
Other conditions affecting workers' exposure	
Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning (PROC 21, PROC 24)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

[a] At few sites, sanding may be performed up to 480 min/shift, but in a lower frequency (1x/week).

[b] At few sites, the frequency is higher but with a lower duration (e.g., 0.5 h, 3x/week).

9.2.3.5.2 Exposure and risks for workers

Between individual sites, the number of sanders in a dedicated hangar is variable, depending on several factors such as the size of the site, the organisation of the hangar, the distribution and throughput of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8 h but may also be between 7 and 12 h, depending on the organisation of the site and national laws.

In GB, the number of sanders in a hangar typically ranges between one and 56 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that **16 sanders** (16 per shift, one shift) are engaged in this scenario per day per site (at 30% of sites).

Below we describe in detail the relevant task with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-35 apply to this task.

Task 1: Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning

A dedicated hangar wherein sanding is performed has the setup of a spray hangar, which is described in detail in section 9.2.2.3.1. Sanding on aircrafts in a dedicated hangar is necessary (a) to remove (remains of) coatings during overhaul prior to the application of new primer(s), or (b) as surface activation of primer(s) prior to the application of topcoat(s). At some sites prior to sanding, overhauled aircrafts are either chemically stripped or blasted with blasting media (e.g., plastic beads) to remove Cr(VI)-free and Cr(VI)-containing coatings (as described in section 9.2.3.6.2.3). Afterwards they are cleaned by washing with deionised water and/or wiping with solvent-soaked wipes. After sanding of the aircraft, the aircraft is sprayed, either with Cr(VI) primer (if sanding was performed to remove Cr(VI) residues), or with Cr(VI)-free topcoat(s). Most sites perform sanding on aircrafts after application of primer(s) to activate the surface prior to application of topcoat(s).

During the sanding process, sanders are inside the dedicated hangar equipped with exhaust ventilation (down-flow or cross-flow) and move around the aircraft on fixed scaffolds or movable platforms. The workers use sanding tools (e.g., grinders, orbital/rotary sanders) with e.g., on-tool extraction, wetting/lubrication at release point or connected to vacuum cleaner(s). Small areas e.g., prior to brushing/rolling application or around a window are sanded by sanders either using a scotch brite, sandpaper or sanding tools without on-tool extraction. The typical maximum sanding time per shift is interrupted by regular breaks and is therefore not carried out in one go during a shift.

Once the sanding process is complete, the workers clean the aircraft to remove any remaining dust, e.g., by washing with deionised water, wiping with water or solvent soaked wipes, or blowing with compressed air. The wash water is gathered and either treated on-site in a reduction facility before the reduced wastewater is sent to an external STP/WWTP or sent to an external licensed contractor for disposal of the liquid hazardous waste. Solid waste produced during this process consists of contaminated PPE and wipes and equipment used for cleaning. All solid waste is collected by an external waste management company (licensed contractor) for disposal as hazardous waste.

9.2.3.5.2.1 Inhalation exposure

Measured inhalation exposure concentration

For sanders in a hangar no monitoring data from GB sites is available. Therefore, we use monitoring data from EEA sites as a proxy for GB data. As it is expected that the conditions of use in GB are comparable to those in EEA, we consider it appropriate to use these data for the exposure assessment. In the following, the monitoring data from sites in the EEA are presented.

In total, 177 personal monitoring data and 24 stationary data are included in the inhalation exposure assessment for this SEG. Of the 177 personal monitoring data, 79 are long-term (≥2h)[14], shift-representative and 98 are short-term (<2h) measurements. The 24 stationary measurements can be divided in 15 long-term measurements and nine short-term measurements.

The personal monitoring data come from 14 sites in four countries in the EEA (177 measurements; considering also data provided via Art. 66 notification for which an indication of the country and the site was given (15 measurements)). About 3% of the data (five values, all short-term measurements) are <LOQ and 97% (172 values, including 93 short-term measurements) are >LOQ.

[14] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

The 24 stationary data come from five sites in four EEA countries (24 measurements; considering also data provided via Art. 66 notification for which no indication of the country or the site was given (one measurement)). About 17% of the stationary measurements (four values, including one short-term measurements) are <LOQ and 83% (20 values, including eight short-term measurements) are >LOQ.

Table 9-36 gives an overview of the available data for sanders in a dedicated hangar.

Table 9-36: Overview of available inhalation exposure measurements for WCS 4 – Sanders in a dedicated hangar at EEA sites

	Total	>LOQ	<LOQ
Personal			
- Long-term (≥2h)	79	79	0
- Short-term (<2h)	98	93	5
Stationary			
- Long-term (≥2h)	15	12	3
- Short-term (<2h)	9	8	1

The measurements were taken at workers performing the task on surfaces treated with primer products containing StC and/or PCO and/or PHD. During some measurements, the workers also may have had Cr(VI) exposure from primer products not covered under the present use (e.g., from surfaces treated with wash primers) or from uses of other chromates (e.g., when performing chemical conversion coating with dichromium (tris)chromate using a touch-up pen). Note that the chromate present during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements, several chromates may have been used. In some reports, no information was given on the substance present on the surfaces. Due to limited availability of data, no substance-specific analysis can be conducted.

Table 9-37 shows the summary statistics of workplace measurements for sanders in a dedicated hangar. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. Long-term measurements are from the period 2019-2022 and all short-term as well as stationary measurements from 2018-2022. Further, specific evaluations analyse the role of individual tasks. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-37: Summary statistics of inhalation exposure measurements for WCS 4 – Sanders in a dedicated hangar at EEA sites

Personal – long-term (measurement period 2019 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	79	100	39.1	69.4	17.0	91.8
Specific evaluations:						
- Sanding exclusively	22	27.8	81.0	115	10.7	232

Personal – short-term (measurement period 2018 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	98	100	74.6	127	9.00	245
Specific evaluations:						
- Sanding exclusively	73	74.5	97.6	140	26.0	274
Stationary – long-term (measurement period 2018 - 2022)						
Total	15	100	0.766	1.54	0.0500	2.39
Specific evaluations:						
- Sanding exclusively	4	26.7	0.0481	n.a.	n.a.	n.a. (MAX = 0.12)
Stationary – short-term (measurement period 2018 - 2022)						
Total	9	100	0.731	n.a.	n.a.	n.a. (MAX = 1.84)
Specific evaluations:						
- Sanding exclusively	6	66.7	0.882	n.a.	n.a.	n.a. (MAX = 1.84)

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

Personal measurements – long-term

The 90th percentile for the total long-term personal measurements is 91.8 µg/m³. Out of the 79 total measurements, 16 measurements (20.3%) from one site cover various tasks performed by sanders (sanding (task 1) was the main and longest performed task among decanting/mixing (task 2), brush application of primers (task 4), cleaning of equipment (task 3) as well as preparatory work without Cr(VI) exposure (e.g., masking)). From another site, 41 values (51.9%) are reported where sanders performed sanding (task 1) as well as maintenance and cleaning of sanding tools (task 6). Twenty-two (27.8%) of the 79 long-term measurement values were taken while sanders exclusively performed sanding in a dedicated hangar (task 1). The 90th percentile for these measurements (232 µg/m³) is higher by approximately a factor of 3 than the one from the total database (91.8 µg/m³), which shows that the main Cr(VI) exposure of sanders arises from the main task sanding in a dedicated hangar and either the secondary tasks have a minor impact on the overall Cr(VI) exposure of the sanders or that a part of the measurements also cover non-exposure time.

Personal measurements – short-term

The 90th percentile for the total database of short-term personal measurements is 245 µg/m³. In 73 out of the 98 short-term measurements (74.5%), the sanders only performed the main task of sanding in a dedicated hangar. The 90th percentile for these 73 measurements is 274 µg/m³, which is comparable to the total database (245 µg/m³) and long-term measurement values of sanders exclusively performing sanding (232 µg/m³). During 25 short-term personal measurements (25.5%) sanders performed the main task as well as secondary tasks. The majority of 21 measurements (21.4%) were reported by one site and the additional tasks performed by sanders included preparatory work without Cr(VI) exposure, decanting/mixing (task 2), brush application (task 4), and cleaning of equipment (task 3). One measurement (1%) monitored also the maintenance and cleaning of sanding tools. During three measurements (3%) from one site, sanders were also performing machining activities on surfaces or parts besides sanding in a dedicated hangar.

Use of RPE was reported for all long and short-term measurements covering sanding in a dedicated hangar.

Stationary measurements – long-term

For the total of 15 long-term stationary measurements the calculated 90th percentile is 2.39 µg/m³. Of the 15 measurements, four measurements (26.7%) cover solely the main task of sanding in a dedicated hangar. The individual values are as follows 0.120, 0.03 (2x), and 0.0125 µg/m³. Due to the low number of values, the 90th percentile of the measurements solely covering the main task could not be determined. Of the remaining 11 values (73.3%), which monitored the working zone exposure of sanders, three values have a major impact on the statistics, namely 1.22, 3.17, and 5.48 µg/m³. All three values were reported by one site and are representative of typical task performed by sanders as these include sanding in a dedicated hangar, preparatory work, decanting and mixing primers, brush application of primers as well as cleaning of equipment.

Stationary measurements – short-term

In total, nine short-term stationary measurements are available, and the arithmetic mean is 0.731 µg/m³. The 90th percentile was not calculated as only nine values were available, which are not sufficient for a statistical analysis. Six of these measurements (66.7%) were taken while sanders performed only sanding in a dedicated hangar. Due to the low number of measurements the 90th percentile could not be calculated, the individual values are the following: 0.00014, 0.0125, 0.720, 0.900, 1.82, and 1.84 µg/m³. The remaining three short-term measurements are from one site, where sanders in addition to the main task also performed secondary tasks (preparatory work without Cr(VI) exposure, decanting/mixing (task 2), brush application (task 4), and cleaning of equipment (task 3)). The individual values are 0.035, 0.088, and 1.16 µg/m³.

Although the stationary measurement devices were placed near the aircrafts the clearly lower long- and short-term stationary measurements in comparison to personal measurements may indicate that the devices were not placed as close as the sanders working right on the aircraft.

Use of RPE was reported for all measurements covering sanding in a dedicated hangar.

Risk characterisation is based on the complete set of long-term personal measurements. Table 9-38 shows the resulting long-term inhalation exposure concentration for sanders in a dedicated hangar used for risk assessment, based on the 90th percentile of personal sampling values.

RPE is worn by sanders while sanding in a dedicated hangar. Therefore, use of RPE (ambient air-independent breathing apparatus (fresh air hose, compressed air line, supplied-air respirator or similar, see Annex VI)) is considered in the exposure assessment. Accordingly, an APF of 250 is applied to the 90th percentile. In case of sanding small areas (e.g., around windows or prior to brushing/rolling application) by using sandpaper or sanding tools in a dedicated hangar with exhaust ventilation (LEV), operators wear at least a half mask with P3 filter (APF 10). Exposure from this activity is considered covered by the long -term exposure calculated for these workers (see also calculated long-term exposure for machining on surfaces in section 9.2.3.4.2.1).

At most sites, sanding on aircrafts in a dedicated hangar is a task which is typically not performed for a whole shift by sanders. The remaining time of their shift sanders may perform tasks without Cr(VI) exposure like preparatory work (e.g., masking), and tasks involving exposure to Cr(VI) for example, brush application of primer to repair defects prior to sanding, and other tasks in the dedicated hangar (e.g., cleaning of work area). The workers perform sanding in a hanger twice per week. Therefore, we consider that 40% of their working time are spent on Cr(VI) tasks related to sanding in a dedicated hangar.

Accordingly, a correction is made in the assessment for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 0.400).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-38: Measured inhalation exposure concentration for WCS 4 – Sanders in a dedicated hangar

Type of measure-ment	**Number of measure-ments**	**Exposure value [a] [µg/m³]**	**Assigned protection factor (APF) for RPE [b]**	**Exposure value corrected for RPE [µg/m³]**	**Time correction factor for Cr(VI) tasks [c]**	**Market share correction factor [d]**	**Long-term exposur e [e] [µg/m³]**
Personal	79	91.8	250	0.367	0.400	0.210	0.0309

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] RPE is used, see above.

[c] Since the workers spend 40% of their working time on Cr(VI) tasks a time correction factor of 0.400 is used (the task is performed up to twice per week).

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.5.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-39 shows the risk characterisation for carcinogenicity for sanders in a dedicated hangar. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-39: Risk characterisation for carcinogenicity for WCS 4 – Sanders in a dedicated hangar

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.0309	4.00E-03	1.23E-04

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

* RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a) : Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for sanders in a dedicated hangar is 1.23E-04.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **16 sanders** are engaged in this scenario per day per site (at 30% of sites). For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.5.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For sanders in a hangar one GB site provided biomonitoring data sampled in 2022. The data cover the main task of operators performing sanding in a hangar. For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-40: Biomonitoring data for WCS 5 – Sanders in a dedicated hangar at GB sites

Individual values	
N	4 [a]
AM [µmol Cr/mol creatinine]	1.48
Median [µmol Cr/mol creatinine]	n.a.
90th percentile [µmol Cr/mol creatinine]	n.a.

N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] Individual values are 1.10, 1.20, 1.50, and 2.10 µmol Cr/mol creatinine.

The presented biomonitoring data show that the body burden of sanders did not exceed the UK BMGV in a single case.

In addition to the biomonitoring data from GB sites also data for EEA sites are available, which are presented in the following to show on a larger database, under comparable conditions of use, that the body burden of the workers is low.

For this WCS biomonitoring data are available from eight sites in four EEA countries, sampled in the years 2019-2022. The data cover the main tasks of operators performing sanding and some measurements additionally cover main tasks performed by:

- Spray operators for manual spraying in a spray room/booth
- Spray operators for manual spraying in a dedicated spray hangar
- Operators performing brushing/rolling
- Machinists

Biomonitoring data were reported by companies as results for groups of workers and are reported here accordingly (see Annex V). No data were reported as individual values for this WCS. The following table shows an overview of the available group entries.

Table 9-41: Biomonitoring data for WCS 5 – Sanders in a dedicated hangar at EEA sites

Group entries	
N	801
Number of data sets	18
Number of data sets with individual values > 10.0 µmol Cr/mol creatinine	0

[a] MAX values of 4.33-6.25 µmol Cr/mol creatinine are reported for three group entries (data sets of 54-213 values). The number of values exceeding 4.00 µmol Cr/mol creatinine is unknown for this group entry.

Only values as group entries are available, these are 801 values from 18 data sets for this WCS. No value exceeds 10.0 µmol Cr/mol creatinine (UK BMGV).

Overall, the reported biomonitoring data confirm that the body burden of sanders in a dedicated hangar did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.6 Worker contributing scenario 5 – Workers performing media blasting in closed system

Workers performing media blasting in closed system spend part of their time in the work area where the blasting cabinet is installed, on activities that involve blasting of parts treated with primers for rework or refurbishment. Typical activities with possible Cr(VI) exposure performed by these operators are:

Main tasks

- Task 1: Media blasting in closed system, including cleaning and waste removal (PROC 21, PROC 24)

Secondary task

- Task 2: Maintenance and cleaning of equipment and work area (PROC 28)

As task 2 is a main task performed by another SEG, it is described in detail in the worker contributing scenario 'Maintenance and/or cleaning workers (excluding spray areas)' (see section 9.2.3.9).

At some sites, media blasting is a secondary task for machinists (see section 9.2.3.5). However, the main exposure tasks for this SEG are machining activities. Accordingly, these workers are not covered by the present SEG.

In the following sections, the conditions of use for the task with potential direct Cr(VI) exposure is specified and the individual activities are described in more detail.

9.2.3.6.1 Conditions of use

Table 9-42 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by workers performing media blasting in closed system.

Table 9-42: Conditions of use – Worker contributing scenario 5 – Workers performing media blasting in closed system

Product (article) characteristics	
Product type	n.a. (surface-treated parts)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Media blasting in closed system, including cleaning and waste removal (PROC 21, PROC 24)	
Duration of task [min/shift]:	Up to 270
Frequency of task [days/year]:	<1-240
Technical and organisational conditions and measures	
Task 1: Media blasting in closed system, including cleaning and waste removal (PROC 21, PROC 24)	
Containment:	Closed system (media blasting) *
LEV:	No (cleaning and waste removal)
Type of LEV:	n.a.
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure

Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
As it is expected that any residual Cr(VI) contained in coated particles released by media blasting cannot be absorbed through the skin, no specific requirements for gloves with regard to carcinogenic effects result for this scenario. However, the PPE for each blasting activity is determined by each site with an overall EH&S risk assessment for potential mechanical injury.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Media blasting in closed system, including cleaning and waste removal (PROC 21, PROC 24)	
RPE:	No
Protection clothes:	Chemical protective clothing per site-specific risk assessment
Other conditions affecting workers' exposure	
Task 1: Media blasting in in closed system, including cleaning and waste removal (PROC 21, PROC 24)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

* At a few sites media blasting may be performed in a semi-closed system equipped with LEV, in that case the workers wear respiratory protection (at least half mask with P3 filter) during the activity.

9.2.3.6.2 Exposure and risks for workers

Between individual sites, the number of workers performing media blasting in closed system may be variable, depending on several factors such as the size of the site, the distribution and throughput of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of media blasters performing media blasting in closed system typically ranges between one to 15 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average, **six workers performing media blasting in a closed system** (three per shift, two shifts) are engaged per day per site per day in this scenario (at 30% of sites).

Below we describe in detail the relevant tasks with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-42 apply to these tasks.

<u>Task 1: Media blasting in closed system, including cleaning and waste removal</u>

Media blasting in closed system is typically performed on small to medium sized parts (e.g., components of landing gear, vane …), in order to remove the surface layer for rework (e.g., nonconformity), for quality testing or before refurbishment (strip off paint including Cr(VI) primers). Typically, plastic beads, plastic granules, or nut shells are used as blasting medium.

Media blasting is performed in a glovebox or blasting cabinet (closed system), the worker stands outside, in front of the equipment and operates by placing his hands in dedicated gloves to allow him to manipulate the part, and the blasting gun. Part of the box is usually transparent to allow the operator to see what is being manipulated. No or low exposure is expected during the media blasting process itself.

Figure 9-8: Media blasting in closed cabinet

At the beginning of the process, the worker opens the blasting machine, introduces the part and closes the system. Then, they put their hands into the gloves to maintain the part with one hand and to move the blasting gun with the other one.

Some sites are equipped with automatic blast cabinets allowing workers to operate the blasting process remotely, from a computer.

At the end of the blasting process or for exchanging parts, the worker opens the machine. During this operation, they may be exposed to dust deposits present inside the cabinet, on the blasted part, as well as on remaining beads or granules.

At a few sites, the workers carry out media blasting in a semi-closed system. This is a system that is not completely closed, as it has narrow openings at the front sealed by brush strips, through which the worker inserts the arms to manoeuvre the blasting gun and the component. The system is equipped with LEV and the worker wears respiratory protection during this activity (at least a half-mask with P3 filter).

Workers may also be responsible of the cleaning of the workplace (e.g., vacuum cleaning) and of the machine, including dust evacuation and new media filling. Usually, the used blasting media is extracted, and partly recycled into the blasting cabinet. Primer residues and spent media are automatically collected under the machine, in bags, or containers connected to the machine. They are managed as solid hazardous waste by WCS 7 – Maintenance and/or cleaning workers for spray area(s), see section 9.2.3.8.

9.2.3.6.2.1 Inhalation exposure

Measured inhalation exposure concentration

For workers performing media blasting in closed system only one personal monitoring data and two stationary monitoring data are available from GB sites. These three monitoring data are all long-term measurements (>2h), reported by two GB sites. The personal long-term measurement is <LOQ, and for the stationary long-term measurements one is < LOQ, and one is > LOQ.

Due to the very limited amount of GB data, we included below also measurements data for workers performing media blasting in closed system from EEA sites operating under comparable conditions of use.

From EEA sites, 20 personal monitoring data and 13 stationary data are available for this SEG. Of these 20 personal monitoring data, 12 are long-term (≥2h)[15], shift-representative and eight are short-term (<2h) measurements. The 13 stationary measurements can be divided in 11 long-term measurements and two short-term measurements.

The personal monitoring data come from six sites in five countries in the EEA. 70% of the data (14 values, including five short-term measurements) are <LOQ and 30% (six values, including three short-term measurements) are >LOQ.

The 13 stationary data come from four sites in three EEA countries (considering also data provided via Art. 66 notification for which no indication of the country or the site was given). About 61.5% of the stationary measurements (eight values, including one short-term measurements) are <LOQ and 38.5% (five values, including one short-term measurements) are >LOQ.

Table 9-43 gives an overview of the available data for workers performing media blasting in closed system .

Table 9-43: Overview of available inhalation exposure measurements for WCS 5 – Workers performing media blasting in closed system at GB and EEA sites

	Total	**>LOQ**	**<LOQ**
Personal at GB sites			
- Long-term (≥2h)	1	0	1
- Short-term (<2h)	0	0	0
Personal at EEA sites			
- Long-term (≥2h)	12	3	9

[15] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

	Total	>LOQ	<LOQ
- Short-term (<2h)	8	3	5
Stationary at GB sites			
- Long-term (≥2h)	2	1	1
- Short-term (<2h)	0	0	0
Stationary at EEA sites			
- Long-term (≥2h)	11	4	7
- Short-term (<2h)	2	1	1

The measurements were taken at workers performing media blasting in closed system on parts treated with primer products containing StC and/or PCO and/or PHD.

During some measurements, the workers may also be exposed to Cr(VI) from primer products not covered under the present use (e.g., from parts treated with wash primers) or from uses of other chromates (e.g., when performing touch-up with dichromium tris(chromate)). Note that the substance used during the measurement could not always be clearly identified. According to the information given in the measurement reports, during some measurements several substances may have been used. In some measurement reports, no information was given on the substance used. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, due to limited availability of data, no substance-specific analysis can be conducted.

Further, it has to be noted that exposure of workers performing media blasting in closed system was not considered in previous applications.

Table 9-44 shows the summary statistics of workplace measurements for workers performing media blasting in closed system at both EEA and GB sites. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2017-2022. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-44: Summary statistics of inhalation exposure measurements for WCS 5 – Workers performing media blasting in closed system at GB and EEA sites in total

Personal – long-term (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	13	100	0.115	0.130	0.0449	0.307
Personal – short-term (measurement period 2021-2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	8	100	0.611	n.a.	n.a.	n.a. (MAX = 2.00)

Stationary – long-term (measurement period 2017 - 2022)						
	N	% of total	AM [µg/m³]	SD [µg/m³]	Median [µg/m³]	90th Perc. [µg/m³]
Total	13	100	0.0652	0.0516	0.0500	0.134
Stationary – short-term (measurement period 2022)						
	N	% of total	AM [µg/m³]	SD [µg/m³]	Median [µg/m³]	90th Perc. [µg/m³]
Total	2	100	n.a.	n.a.	n.a.	n.a. (MAX = 0.140)

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

Personal measurements – long-term

The 90th percentile for the total long-term personal measurements is 0.307 µg/m³. Monitoring was conducted when workers performed media blasting in closed system only. The measurement reported by the GB site was <0.0200 µg/m³, and the worker wore RPE. Some measurements report potential exposure from chromates and uses not covered under the present use (e.g., parts previously treated by conversion coating, anodising, or slurry coating with chromium trioxide) but no perceptible impact on these exposure results can be noted.

Some measurements reported the use of RPE, but for most of them RPE is not worn or reported.

Personal measurements – short term

The AM for the total dataset of short-term personal measurements is 0.611 µg/m³. All measurements cover media blasting in closed system only, except for two measurements for which transfer/disposing of blasting material, cleaning of the area, and opening/closing the filter system were also reported. The results of these two measurements are <0.200 and 0.240 µg/m³ showing that no increase of exposure is expected from these specific activities.

Seven of the eight short-term measurements are within a range of 0.100 to 0.650 µg/m³. One measurement differs from the other results by its higher value: 2.00 µg/m³ (with 15 min of sampling duration). This measurement was taken during sandblasting with no other activity reported. The 8h TWA[16] value calculated from this measurement is 0.0625, considering 465 min non-exposure time[17]. It was clearly stated that RPE was worn during the measurement (half-mask with P3 filter). This 8h TWA corrected for RPE (considering APF 10; 0.00625 µg/m³) is well below the 90th percentile of the long-term measurements, suggesting that exposure from this individual activity using a RPE is covered by the shift-average exposure of operators.

Use of RPE was reported for most of the measurements covering media blasting in closed system.

[16] TWAs are calculated by assuming that the remaining time of the 8h shift, during which the measurement was not performed, is non-exposure time.
[17] 2.00 µg/m3 x (15 min/480 min) = 0.0625 µg/m³

Stationary measurements

For the total of 13 long-term stationary measurements, the calculated 90th percentile is 0.134 µg/m³. The two measurements reported by two different GB sites are <0.20 and 0.180 µg/m³.

Two stationary short-term measurements are available, the results were below the LOQ (<0.130 µg/m³; 117 min) for the first measurement and 0.140 µg/m³ (30 min) for the second one. For all these measurements, the sampler was positioned next to the media blasting machine during processing.

Risk characterisation is based on the total dataset of long-term personal measurements from GB and EEA sites. Table 9-45 shows the resulting long-term inhalation exposure concentration for workers performing media blasting in closed system used for risk assessment, based on the 90th percentile of personal sampling values.

RPE may be worn by the operators during specific activities as documented for some measurements. However, as it is not systematically worn, no RPE is considered in the exposure assessment, which constitutes a further conservative element of the assessment.

The assessment assumes that workers performing media blasting in closed system spend a maximum of 60% of their time on parts previously treated with primers containing Cr(VI) (task performed up to 270 min, 240 days/year). Accordingly, a correction is made for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 0.600).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-45: Measured inhalation exposure concentration for WCS 5 – Workers performing media blasting in closed system

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m³]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m³]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m³]
Personal	13	0.307	1	0.307	0.600	0.210	0.0387

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] No RPE is used, see above.

[c] Since the workers spend 60% of their working time on Cr(VI) tasks a time correction factor of 0.600 is used (task performed up to 270 min, 240 days/year).

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.6.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-46 shows the risk characterisation for carcinogenicity for workers performing media blasting in closed system. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-46: Risk characterisation for carcinogenicity for WCS 5 – Workers performing media blasting in closed system

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.0387	4.00E-03	1.55E-04

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for workers performing media blasting in closed system is **1.55E-04**.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- no correction for wearing RPE was applied although workers may wear RPE for some activities,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **six workers performing media blasting in a closed system** are engaged per day per site (at 30% of sites). For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.6.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For workers performing media blasting in closed system, three GB site provided biomonitoring data sampled in 2017, 2018 and 2021. The data cover the main task of workers performing media blasting in closed system. For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-47: Biomonitoring data for WCS 5 – Workers performing media blasting in closed system at GB sites

Individual values	
N	8
AM [µmol Cr/mol creatinine]	1.98
Median [µmol Cr/mol creatinine]	n.a.
90th percentile [µmol Cr/mol creatinine]	n.a.
N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

The presented biomonitoring data show that the body burden of incidentally exposed workers did not exceed the UK BMGV in a single case.

In addition to the biomonitoring data from GB sites also data for one EEA site is available, which is presented in the following to show on a larger database, under comparable conditions of use, that the body burden of the workers is low.

One site in EEA provided biomonitoring data, sampled in 2020. The data cover only the main task of workers performing media blasting in closed system.

Biomonitoring data were reported by the company as results for groups of workers and are reported here accordingly (see Annex V). The following table shows an overview of the available group entry.

Table 9-48: Biomonitoring data for WCS 5 – Workers performing media blasting in closed system at EEA sites

Group entries	
N	6
Number of data sets	1
Number of datasets with individual values > 4.00 µmol Cr/mol creatinine	0

For this WCS, no individual biomonitoring values were reported. The values are only available as a group entry: six values from one data set. The MAX value of this data set (0.513 µmol Cr/mol creatinine) is well below the limit value of 10.0 µmol Cr/mol creatinine (UK BMGV). All other values of this data set are below the LOQ (<0.400 µmol Cr/mol creatinine).

Overall, very limited data is available but the reported biomonitoring data confirm that the body burden of workers performing media blasting in closed system did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.7 Worker contributing scenario 6 – Workers performing media blasting in a room/hall

Workers performing media blasting in a room/hall spend most of their time in the working hall where media blasting is performed, on activities that involve direct exposure to Cr(VI). Typical activities with possible direct Cr(VI) exposure performed by these operators are:

Main task

- Task 1: Media blasting in a room/hall (PROC 21, PROC 24)

Secondary task

- Task 2: Handling of solid and/or liquid waste (PROC 8b)

As task 2 is a main task performed by another SEG, it is described in detail in the respective worker contributing scenario 'Maintenance and cleaning workers for spray area(s)'; (see section 9.2.3.8).

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.7.1 Conditions of use

Table 9-49 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by workers performing media blasting in a room/hall.

Table 9-49: Conditions of use – Worker contributing scenario 6 – Workers performing media blasting in a room/hall

Product (article) characteristics	
Product type	n.a. (surface-treated parts)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Media blasting in a room/hall (PROC 21, PROC 24)	
Duration of task [min/shift]:	Up to 480
Frequency of task [days/year]:	Up to 240
Technical and organisational conditions and measures	
Task 1: Media blasting in a room/hall (PROC 21, PROC 24)	
LEV:	Yes
Type of LEV:	Blasting hall - laminar down-flow or cross-flow (≥ 3 ACH) For blasting of medium-sized parts also wall extraction in the designated blasting area *
Type of general ventilation in working hall:	n.a.
Air changes per hour (ACH) of general ventilation:	n.a.

Other RMMs in place:	Mobile LEV for medium-sized parts Restriction of access by means of signage or physical segregation or through strict procedure. During media-blasting, only persons involved in the blasting process are allowed in the working hall.
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
As it is expected that any residual Cr(VI) contained in coated particles released by media blasting cannot be absorbed through the skin, no specific requirements for gloves with regard to carcinogenic effects result for this scenario. However, the PPE for each blasting activity is determined by each site with an overall EH&S risk assessment for potential mechanical injury.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Media blasting in a room/hall (PROC 21, PROC 24)	
RPE:	Yes, ambient air-independent breathing apparatus (fresh air hose, compressed air line, supplied-air respirator or similar, see Annex VI).
Protection clothes:	Yes, chemical protective coverall
Other conditions affecting workers' exposure	
Task 1: Media blasting in a room/hall (PROC 21, PROC 24)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

* At few sites media blasting is performed in a room/hall not equipped with LEV, but a closed-circuit media blasting system with on-tool extraction is used. In this device, the blasting media is recovered and recycled immediately after being blasted onto the part.

9.2.3.7.2 Exposure and risks for workers

Between individual sites, the number of workers performing media blasting in a room/hall may be variable, depending on several factors such as the size of the site, the distribution and throughput of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

The number of media blasters in a room/hall typically ranges between one and seven workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average **six workers performing media blasting in a room/hall** (three per shift, two shifts) are engaged in this scenario per day per site (at 10% of sites).

Below we describe in detail the relevant tasks with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-49 apply to these tasks.

Task 1: Media blasting in a room/hall

Media blasting in a room/hall is typically performed on medium-sized to large parts (i.e., parts which do not fit into a media-blasting cabinet; e.g., components of aircrafts) or whole aircrafts in order to remove the surface layer of a part or aircraft (including the layer with Cr(VI) primers). Typically, plastic beads are used as blasting medium.

The working hall where media-blasting is performed is equipped with roof to floor extraction. Shafts are embedded in the floor where the off-blasted surface material and blasting medium are collected and through which the exhaust air is extracted. Also, designated areas of the hall (e.g., in a corner) may be equipped with additional roof to wall extraction to allow more efficient exhaust air extraction. In these designated areas preferably medium-sized parts are media blasted, e.g., on a table. Also, a mobile LEV system may be used where required to enhance air extraction.

For media-blasting of a whole aircraft typically scaffoldings are installed in the hall to allow workers to access all parts of the aircraft. For blasting a whole aircraft typically three to four workers perform media blasting simultaneously. They stand on the floor or on the scaffold and blast the aircraft using blasting guns. After the aircraft is blasted, the workers typically move it to a washing area (close to the blasting hall), where they wash the airplane with water (using a hose) to remove the blasting particles and dust from the surface. The generated wastewater is collected and treated as described in section 9.2.3.1.

When medium-sized parts are blasted, the worker places the part in the designated area close to the wall extraction (if required, on a table), and perform blasting using a blasting gun while standing on the floor.

Typically, workers do not perform blasting during their entire shift, but take breaks at regular intervals (e.g., 10-minutes breaks every 50 minutes).

After the blasting process, the workers blow the dust and off-blasted surface material into the shafts in the floor. The material is collected in a collection container. Every 1-1.5 weeks, this collection container is emptied and disposed as hazardous solid waste.

At few sites media blasting is performed in a room/hall not equipped with LEV, but a closed-circuit media blasting system with on-tool extraction is used. In this device, the blasting media is recovered and recycled immediately after being blasted onto the part. The opening of the device looks like a wider vacuum cleaner opening, which is surrounded by a brush seam. During blasting the worker permanently presses the brush seam against the component. The brush seam prevents the released particles from entering the environment. The immediate extraction inside the brush seam draws the released particles back into the device. The blasting gun is located inside the brush-seamed opening. Sites using this closed-circuit device do not have LEV installed in the blasting room/hall but the closed-circuit recovery system is expected to have at least the same efficiency.

Figure 9-9: Worker performing media blasting in a room/hall (a + b)

9.2.3.7.2.1 Inhalation exposure

Measured inhalation exposure concentration

For media blasters in a room/hall no monitoring data from GB sites is available. Therefore, we use monitoring data from EEA sites as a proxy for GB data. As it is expected that the conditions of use in GB are comparable to those in EEA, we consider it appropriate to use these data for the exposure assessment. In the following, the monitoring data from sites in the EEA are presented.

Only two personal monitoring data and no stationary measurements are available for inhalation exposure assessment for this SEG. The two data are long-term (≥2h)[18] measurements (385 and 392 min) from 2020. They come from one site in the EEA. Both measurements are >LOQ. The measurements were taken at workers performing the task on surfaces treated with primer products containing StC and PCO and on surfaces not treated with Cr(VI).

Personal measurements – long-term

The exposure values for the two long-term personal measurements are 22.8 and 32.9 µg/m³. During max. 120 min of the measurement (~ 30% of the time) the workers performed media blasting on Cr(VI)

[18] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

surfaces, the remaining time Cr(VI)-free surfaces were blasted. The workers wore RPE (air supply respirator and hood with neck/shoulder cover) during the measurements.

Personal measurements – short-term

One short-term value is available for a worker performing media blasting on parts coated with Cr(VI) primer. The exposure value is 83 µg/m^3 and the measurement duration is 55 min. The worker wore RPE (air supply respirator and hood) during the measurement.

The number of data covering this SEG is low since media blasting in a room/hall is carried out at very few sites compared to other tasks supported by the ADCR consortium. For exposure and risk assessment of these workers we therefore use the data from 'WCS 4 – Sanders in a dedicated hangar' as a proxy (as it is performed in a similar environment – large hall, hangar – and exposure is via particulate matter in both cases). We consider the use of exposure data from 'Sanders in a dedicated hangar' conservative for the present SEG due to the following reasons:

- The dust particles produced by sanding are expected to be smaller than the particles produced by media blasting, thereby facilitating the inhalation of the particles by the worker.
- We use the 90th percentile of long-term personal measurements for 'Sanding of large surfaces containing Cr(VI) in a dedicated hangar, including cleaning', covering exclusively the sanding activity as shift-representative for media blasters in a room/hall.

Table 9-50 shows the summary statistics of workplace measurements for 'WCS 4 – Sanders in a dedicated hangar' For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. Long-term measurements are from the period 2019-2022 and all short-term measurements from the period 2018-2022. Further, specific evaluations analyse the role of individual tasks. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-50: Summary statistics of inhalation exposure measurements for WCS 4 – Sanders in a dedicated hangar, used as a deputy for inhalation exposure assessment of WCS 6 – Workers performing media blasting in a room/hall at EEA sites

Personal – long-term (measurement period 2019 – 2022) – Sanders in a dedicated hangar						
	N	**% of total**	**AM [µg/m^3]**	**SD [µg/m^3]**	**Median [µg/m^3]**	**90th Perc. [µg/m^3]**
Total	79	100	39.1	69.4	17.0	91.8
Specific evaluations:						
- Sanding exclusively	22	27.8	81.0	115	10.7	232
Personal – short-term (measurement period 2018 – 2022) – Sanders in a dedicated hangar						
	N	**% of total**	**AM [µg/m^3]**	**SD [µg/m^3]**	**Median [µg/m^3]**	**90th Perc. [µg/m^3]**
Total	98	100	74.6	127	9.00	245

Specific evaluations:						
- Sanding exclusively	73	74.5	97.6	140	26.0	274

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

Personal measurements – long-term

The 90th percentile for the total long-term personal measurements is 91.8 µg/m³. Twenty-two (27.8%) of the 79 long-term measurement values were taken while sanders exclusively performed sanding in a dedicated hangar (task 1). The 90th percentile for these measurements (232 µg/m³) is higher by approximately a factor of 3 than the one from the total database (91.8 µg/m³), which shows that the main Cr(VI) exposure of sanders arises from the main task sanding in a dedicated hangar and either the secondary tasks have a minor impact on the overall Cr(VI) exposure of the sanders or that a part of the measurements also cover non-exposure time. Use of RPE was reported for all measurements covering sanding in a dedicated hangar. For additional information on these measurements see description in section 9.2.3.5.2.1).

Personal measurements – short-term

The 90th percentile for the total database of short-term personal measurements is 245 µg/m³. In 73 out of the 98 short-term measurements (74.5%), the sanders only performed the main task of sanding in a dedicated hangar. The 90th percentile for these 73 measurements is 274 µg/m³, which is comparable to the total database (245 µg/m³) and long-term measurement values of sanders exclusively performing sanding (232 µg/m³). Use of RPE was reported for all measurements covering sanding in a dedicated hangar. For additional information on these measurements see description in section 9.2.3.5.2.1).

For a conservative exposure assessment, we use the long-term exposure level from the 90th percentile of the total long-term data for exclusively sanding (232 µg/m³). We consider these data as representative for long-term exposure of media blasters (as the workers perform media blasting for 480 min/day, 5 days/week). The 90th percentile long-term value is comparable to the 90th percentile of the total short-term measurements for sanders in a dedicated hangar (245 µg/m³) and to the 90th percentile of the total short-term measurements covering exclusively sanding (274 µg/m³). This value is by factor ten higher than the two values from personal long-term measurements of media blasters in a room/hall (22.8 and 32.9 µg/m³). Considering that during the two measurements for media blasting only approximately 30% of the time Cr(VI) surfaces were blasted, exposure can be expected to be higher by factor 3 in case media blasting is performed for a whole shift (approximately 100 µg/m³). This is in line with the exposure value for the personal short-term measurement available (83.0 µg/m³), which is approximately by factor 3 lower than the 90th percentile exposure level of the total long-term data for exclusively sanding (232 µg/m³). Accordingly, these values suggest that use of the 90th percentile of the long-term measurements for sanding in a dedicated hangar as a deputy for exposure of media blasters overestimates the real exposure.

Risk characterisation is based on the 90th percentile of the complete set of long-term personal measurements covering exclusively sanding (22 values). Table 9-51 shows the resulting long-term inhalation exposure concentration for media blasters in a room/hall used for risk assessment.

Media blasting in a room/hall is typically performed daily for a large part of the shift. Therefore, we consider that 100% of their working time are spent on Cr(VI) tasks related to media blasting in a room/hall Accordingly, no correction is made in the assessment for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 1.00). This is a conservative assumption as it can be expected that not all blasted surfaces contain Cr(VI) and/or not in all cases the blasting is carried out all shift all days.

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-51: Measured inhalation exposure concentration for WCS 6 – Workers performing media blasting in a room/hall

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m^3]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m^3]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m^3]
Personal	22	232	250	0.927	1.00	0.210	0.195

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] RPE is used, see above.

[c] Since the workers spend 100% of their working time on Cr(VI) tasks a time correction factor of 1.00 is used.

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.7.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-52 shows the risk characterisation for carcinogenicity for sanders in a dedicated hangar. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-52: Risk characterisation for carcinogenicity for WCS 6 – Workers performing media blasting in a room/hall

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.195	4.00E-03	7.79E-04

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a) : Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for media blasters in a room/hall is 7.79E-04.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the long-term measurements
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **six media blasters in a room/hall** are engaged in this scenario per day per site (at 10% of sites). For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.7.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

No biomonitoring data are available for this WCS. This can be explained by the fact that media blasting is only carried out at very few sites. Further, the activity was not described as a separate scenario in the existing applications. Therefore, it is not a requirement of the existing authorisations to perform biomonitoring on these workers and to report them to ECHA.

9.2.3.8 Worker contributing scenario 7 – Maintenance and/or cleaning workers for spray area(s)

Maintenance and/or cleaning workers for spray areas are usually involved in numerous activities related to the maintenance of the spray booths/rooms where spray applications of primers products take place. These activities are for example: maintenance of extraction systems by filters change, grids cleaning or cleaning of the spray area using a floor vacuum cleaner or by removal of walls films/foils protection. In addition, maintenance and/or cleaning workers for spray areas are also in charge of the management of solid and/or liquid waste.

Typical activities with possible Cr(VI) exposure performed by maintenance and/or cleaning workers for spray area(s), where primers containing StC and/or PCO, and/or PHD have been used, are:

Main tasks

- Task 1: Maintenance and cleaning of spray area(s), including filter change (PROC 28)
- Task 2: Handling of solid and/or liquid waste (PROC 8b)

Secondary task

- Task 3: Maintenance and cleaning of equipment and work area (PROC 28)

As task 3 is a typical main task performed by the SEG 'maintenance and/or cleaning workers (excluding spray areas)', it is described in detail in the corresponding worker contributing scenarios, WCS 8 'Maintenance and/or cleaning workers (excluding spray areas)' (task 1; see section 9.2.3.9).

In the following sections, the conditions of use for each task with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.8.1 Conditions of use

Table 9-53 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by Maintenance and/or cleaning workers for spray area(s).

Table 9-53: Conditions of use – Worker contributing scenario 7 – Maintenance and/or cleaning workers for spray area(s)

Product (article) characteristics	
1: Primer products containing StC (water-based or solvent-based)	
Maximum concentration of StC [%] (w/w):	19
Concentration of Cr(VI) from StC [%] (w/w):	4.85
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Maintenance and cleaning of spray area(s), including filter change (PROC 28)	
Duration of task [min/shift]:	Up to 360
Frequency of task [days/year]:	<1-48*
Task 2: Handling of solid waste and/or liquid waste (PROC 8b)	
Duration of task [min/shift]:	Up to 60
Frequency of task [days/year]:	<1 - 240
Technical and organisational conditions and measures	
Task 1: Maintenance and cleaning of spray area(s), including filter change (PROC 28)	
LEV:	Yes, where technically and practically possible
Type of LEV:	Spray room/hangar - laminar down-flow or cross-flow

Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Task 2: Handling of solid waste and/or liquid waste (PROC 8b)	
LEV:	No
Type of LEV:	n.a.
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
Chemical resistant gloves according to EN 374 as per relevant risk assessment must be worn during all tasks.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Maintenance and cleaning of spray area(s), including filter change (PROC 28)	
RPE:	Yes, at least half mask with P3 filter (including combined gas-particle filter)
Protection clothes:	Yes, chemical protective coverall
Task 2: Handling of solid waste and/or liquid waste (PROC 8b)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms that RPE use is required
Protection clothes:	Yes, chemical protective coverall
Other conditions affecting workers' exposure	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

* At few sites, maintenance and cleaning of equipment and work area may be performed up to 480 min/shift, but with a lower frequency (< 1x/week to 1x/month) or with a lower duration (max. 90 min/shift) at a higher frequency (up to everyday).

9.2.3.8.2 Exposure and risks for workers

Between individual sites, the number of maintenance and/or cleaning workers for spray area(s) is very variable, depending on several factors such as the size of the site (one individual spray area vs. several spray area(s), possibly organised in different departments), the organisation of the maintenance program and the distribution and throughput of work. Maintenance and/or cleaning activities for spray area(s) can be conducted either by spray operators or by internal maintenance and cleaning operators, but they are also often subcontracted to external service providers.

The number of work shifts differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of maintenance and/or cleaning workers for spray area(s) typically ranges between one and seven workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that as a conservative average of **three workers performing maintenance and/or cleaning workers for spray area(s)** (three per shift, one shift) per day are engaged in this scenario per site.

Maintenance can be preventative to maintain the performance of the equipment (e.g., LEV system) or curative in case of deterioration or deficiency. Maintenance and cleaning operations may occur daily (such as LEV functionality checks, vacuum cleaning, or handling of waste), or less frequently but on a periodic basis as defined by the site under a dedicated maintenance program (e.g., filters change). Maintenance and/or cleaning workers follow standard operating procedures to minimize release of dust (e.g., during handling of solid waste) and implement effective cleaning practices in order to prevent Cr(VI) surface contamination.

At most sites, maintenance and/or cleaning workers do not spend their whole work shift on activities related to Cr(VI) primers (e.g., maintenance and cleaning activities performed in areas where only Cr(VI)-free primers or paints are sprayed).

Below we describe in detail the relevant tasks with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-53 apply to these tasks.

<u>Task 1: Maintenance and cleaning of spray area(s), including filter change</u>

Maintenance and/or cleaning activities at the paint area are performed by internal and/or external maintenance and/or cleaning workers, who may be exposed to primer products in liquid form or mainly as paste or dried solids.

Workers are responsible of various tasks related to spray areas as cleaning and maintenance of the installed LEV systems and equipment (e.g., filters change, check or repair of mechanical or automated systems such as pumps, spray robot, …). Examples of LEV systems installed at sites and details on their maintenance are given in Annex VIII.

During maintenance or cleaning of the spray areas, no spraying activities take place and access is restricted. Filters in the spray areas are regularly checked and replaced by maintenance workers. Filters pressure sensors are typically in place to either indicate malfunction or breakdown of the extraction system to the worker (e.g., by light or audible signal) or to stop the spraying process in this case.

Filter change is carried out without the LEV running due to technical reasons. Depending on the installed LEV system, maintenance workers change inlet and exhaust filters. Maintenance workers check, maintain, and if necessary, change the filter mats and/or cartridges in the rear, floor and/or ceiling of the spraying booth/room or hangar LEV systems.

In spray rooms equipped with water curtain, water is periodically renewed. In spraying areas equipped with a dry extraction system, the walls of the spray booth/room are covered with foils, films, or are painted, whereby no cleaning of the walls is necessary. Maintenance workers perform foils/films replacement or walls repaint. They clean the floor, grids, and pits using a vacuum cleaner or a cleaning machine. If a floor liner is in place, they remove it and replace it. Maintenance workers may also clean surfaces of equipment and tools by wet wiping. Cr(VI)-contaminated water and all other generated waste (e.g., soiled foils/liners/paper/wipes) are stored in dedicated hazardous waste containers and disposed of by an external waste management company (licensed contractor), see task 2. At sites where it is technically not possible to run the LEV system during spray area cleaning, the LEV system runs throughout the night prior to spray area cleaning.

Figure 9-10: Booth extraction control panel

Task 2: Handling of solid and/or liquid waste

Hazardous solid and/or liquid waste generated by the spraying or brush activities, primer solution preparation and cleaning operations (empty soiled paint cups/container/pressed drums, soiled brushes, contaminated wipes, rags, and disposable PPE, foils or films from spray booth walls, filter cartridges, non-used or residues of primer solution, or (wash machines) cleaning solution, ...) is disposed of in dedicated solid or liquid hazardous waste container, typically by the worker who generates the waste (secondary task identified in relevant SEG). In cases where there is a considerable amount of liquid in the waste, the worker may add a special sorbent to the waste to absorb the moisture. During the handling of soiled filters, vacuum cleaner bags containing contaminated dust or other process waste, the operator proceeds in accordance with appropriate standard operating procedures to reduce as low as possible the release of dust in the air during these operations. At some sites, solid waste is wrapped and sealed using plastic sheeting/bags. Maintenance and/or cleaning workers collect the waste in a closable waste container located near the work area (i.e., spray booth, preparation room or machining area). At most sites the solid waste container holds a waste bag in which the waste is collected. Waste containers are closed when they are not in use. Where it is technically feasible, waste containers are connected to a LEV system.

When waste containers are full, the maintenance and/or cleaning worker for spray area(s) tightly seals the waste bag and takes it out of the waste container, or directly takes the waste container, and then transport it to the waste dedicated storage area. The waste is then kept there until it is collected by an external waste management company (licensed contractor) for final disposal as hazardous waste.

Depending on the site organisation, management of waste as described above may be carried out by Maintenance and/or cleaning workers (excluding spray areas) (see section 9.2.3.9).

9.2.3.8.2.1 Inhalation exposure

Measured inhalation exposure concentration

For GB, 22 personal monitoring data and three stationary data were reported for the inhalation exposure assessment of maintenance and/or cleaning workers for spray area(s). Of these 22 personal monitoring data, five are long-term (≥2h)[19], shift-representative and 17 are short-term (<2h) measurements. The three stationary measurements are all long-term measurements.

The personal monitoring data come from eight sites in GB. About 36.4% of the data (eight values, including five short-term measurements) are <LOQ and 63.6% (14 values, including 12 short-term measurements) are >LOQ.

The three long-term stationary data come from two sites in GB. Two of them (66.7%) are <LOQ and one (33.3%) is < LOQ.

Due to the limited amount of GB data (only five long-term personal data), we included below also measurements data for maintenance and/or cleaning workers for spray area(s) from EEA sites operating under comparable conditions of use.

From EEA sites, 81 personal monitoring data and 14 stationary data are available for this SEG. Of these 81 personal monitoring data, 22 are long-term (≥2h)[20], shift-representative and 59 are short-term (<2h) measurements. The 14 stationary measurements can be divided in four long-term measurements and ten short-term measurements.

The personal monitoring data come from 21 sites in seven countries in the EEA (considering also data provided via Art. 66 notification for which no indication of the country or the site was given). About 38.3% of the data (31 values, including 19 short-term measurements) are <LOQ and 61.7% (50 values, including 40 short-term measurements) are >LOQ.

The stationary data come from five sites in four EEA countries (considering also data provided via Art. 66 notification for which no indication of the country or the site was given). Half of the stationary

[19] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

[20] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

measurements (seven values, including three short-term measurements) are <LOQ and half (seven values, all short-term measurements) are >LOQ. It can be noted that all long-term are < LOQ.

Table 9-54 gives an overview of the available data for maintenance and cleaning workers for spray area(s).

Table 9-54: Overview of available inhalation exposure measurements for WCS 7 – Maintenance and/or cleaning workers for spray area(s) at GB and EEA sites

	Total	>LOQ	<LOQ
Personal at GB sites			
- Long-term (≥2h)	5	2	3
- Short-term (<2h)	17	12	5
Personal at EEA sites			
- Long-term (≥2h)	22	10	12
- Short-term (<2h)	59	40	19
Stationary at GB sites			
- Long-term (≥2h)	3	2	1
- Short-term (<2h)	0	-	-
Stationary at EEA sites			
- Long-term (≥2h)	4	0	4
- Short-term (<2h)	10	7	3

The measurements were taken at workers performing maintenance activities on areas where primer products containing StC and/or PCO and/or PHD were used.

During some measurements, the workers also may have had Cr(VI) exposure from primer products not covered under the present use (e.g., from surfaces/waste contaminated with wash primers) or from uses of other chromates (e.g., slurry coating). Note that the chromate present during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements, several chromates may have been present. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, due to limited availability of data, no substance-specific analysis can be conducted.

Where it is explicitly described in the data documentation that the maintenance activity was performed at the paint area (e.g., cleaning the spray booths, maintenance of the installed LEV systems), the data is assigned to this WCS. Otherwise, data has been affected to WCS 8 'Maintenance and/or cleaning workers (excluding spray areas)'.

Table 9-55 shows the summary statistics of workplace measurements for maintenance and cleaning workers for spray area(s). For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2017-2023. Annex IV of this report provides a

summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-55: Summary statistics of inhalation exposure measurements for WCS 7 – Maintenance and/or cleaning workers for spray area(s) at GB and EEA sites

Personal – long-term at GB sites (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	5	100	0.808	n.a.	n.a.	n.a. (MAX = 2.00)
Specific evaluations:						
- Filter change exclusively	1	20.0	n.a.	n.a.	n.a.	n.a. (0.540)
Personal – short-term at GB sites (measurement period 2017 and 2020 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	17	100	43.5	64.3	14.0	127.0
Specific evaluations:						
- Filter change exclusively	8	47.0	67.2	n.a.	n.a.	n.a. (MAX = 231)
Stationary – long-term at GB sites (measurement period 2021)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	3	100	5.74	n.a.	n.a.	n.a. (MAX = 15.0) [a]
Personal – long-term at EEA sites (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	22	100	0.332	0.534	0.0317	1.02
Specific evaluations:						
- Filter change exclusively	16	72.7	0.400	0.604	0.0575	1.17
Personal – short-term at EEA sites (measurement period 2017 - 2023)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	59	100	15.1	40.8	0.485	33.1
Specific evaluations:						
- Filter change exclusively	30	50.8	26.7	54.6	0.953	99.5

Stationary – long-term at EEA sites (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	4	100	0.000104	n.a.	n.a.	n.a. (MAX = 0.000157)

Stationary – short-term at EEA sites (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	10	100	2.71	5.35	0.281	11.1

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual values are <0.420, 2.00 and 15.0 µg/m³.

Personal measurements – long-term

At GB sites, the AM for the five long-term personal measurements is 0.808 µg/m³. All measurements are within a range of 0.500 to 2.00 µg/m³. Only one measurement covers the main task of filter change only, which correspond to the measurement showing the highest result of 2.00 µg/m³. It should be noted that during all five measurements, RPE was always worn.

At EEA sites, the 90th percentile for the total long-term personal measurements is 1.02 µg/m³. Out of the 22 total measurements, 16 measurements (72.7%) cover exclusively filter change of the spray facility, remaining data cover either cleaning of the paint area and/or waste management. The 90th percentile calculated over long-term personal measurements related to filter change only is 1.17 µg/m³. It should be noted that for this filter change activity, RPE was always worn.

In comparison the AM of total personal long-term measurements at GB sites (0.808 µg/m³) is in the same range of the AM and the 90th percentile of total personal long-term measurements at EEA sites (respectively 0.332 and 1.02 µg/m³).

Use of RPE was reported for most of the measurements covering maintenance and/or cleaning activities at spray area(s).

Personal measurements – short term

At GB sites, the 90th percentile of the 17 short-term personal measurements is 127 µg/m³. Fourteen of the 17 measurements are within a range of 0.289 to 70.0 µg/m³. Three measurements differ from the other results by their higher values: 120, 137 and 231 µg/m³ (with respectively 4, 5 and 42 min of sampling duration). These three measurements were taken at three different sites and are related to filter change and cleaning of paint cabin. The 8h TWA[21] values calculated from these three measurements are respectively 1.00, 1.43 and 20.2 µg/m³ respectively, considering remaining time as

[21] TWAs are calculated by assuming that the remaining time of the 8h shift, during which the measurement was not performed, is non-exposure time.

non-exposure time[22]. It was clearly stated that RPE was worn during these three measurements (with at least air-fed RPE). These three 8h TWA corrected for RPE (considering APF 40): 0.0250, 0.0360 and 0.505 µg/m³ respectively, are well below the AM of the GB long-term measurements (0.808 µg/m³) and the 90th percentile of the EEA long-term measurements (1.02 µg/m³), suggesting that exposure from these three individual activities using a RPE are covered by the shift-average exposure of operators. Out of these 17 short-term personal measurements, eight (47.0%) cover exclusively filter change activity. The AM of these measurements is 67.2 µg/m³, slightly higher than the AM of the total GB short-term data (43.5 µg/m³).

At EEA sites, the 59 personal short-term measurements were taken while the workers performed one or both main tasks of maintenance and/or cleaning workers for spray area(s). The 90th percentile for the total database of short-term personal measurements is 33.1 µg/m³. Out of these 59 measurements, 30 (50.8%) cover exclusively filter change activity. The 90th percentile of these measurements is 99.5 µg/m³, three times higher than the 90th percentile of the total short-term data. The remaining 29 measurements cover either other maintenance tasks, cleaning of the paint booth and/or waste management. The 90th percentile of these 29 measurements is 6.52 µg/m³ more than five times lower than the 90th percentile of the total short-term data. Again, based on these results worker exposure seems to be mainly driven by filter change activity. It should be noted that for this filter change activity, RPE was reported to be worn during all measurements.

The 90th percentile of the GB short-term data is higher by a factor 3.8 than the 90th percentile of the EEA short-term data. This is mainly due to the three high values highlighted above. Without these three values, the AM and the 90th percentile would be respectively 17.9 and 56.3 µg/m³, comparable to the EEA results. No explanation was found to clarify why these values were high.

Use of RPE was reported for most of the measurements covering maintenance and/or cleaning activities at spray area(s).

Stationary measurements – long-term

Only three long-term stationary measurements are available from GB sites. Individual values are <0.420, 2.00 and 15.0 µg/m³. The measurement leading to the first result was taken during waste management whereas the two other measurements showing higher results were taken during filter change.

At EEA sites, all four long-term stationary measurements are below the LOQ and the calculated AM is 0.000104 µg/m³. All measurements cover waste management only (Task 2). As observed above, these data suggest that waste management leads to low exposure compared to other tasks performed by this SEG (i.e., cleaning of spray areas and filter change).

Stationary measurements – short-term

In total, ten short-term stationary measurements from EEA sites are available, with a 90th percentile of 11.1 µg/m³. Monitoring was conducted when workers performed filter change, cleaning of the paint cabin and/or waste management. Three measurements cover waste management only (Task 2), with an AM of 0.052 µg/m³ showing that waste handling leads to low exposure. RPE was worn during some measurements, for some others this information was not documented.

[22] 120.0 µg/ m³ x (4 min/480 min) = 1.00 µg/m³ // 137.4 µg/ m³ x (5 min/480 min) = 1.43 µg/m³ // 231 µg/ m³ x (42 min/480 min) = 20.2 µg/m³

Due to the small database from GB sites and the comparable exposure values between GB and EEA monitoring data, the complete set of long-term personal measurements of maintenance and/or cleaning workers for spray area(s) from GB and EEA sites combined was used for the risk characterisation (90th percentile: 1.14 µg/m³, see table below).

Table 9-56: Summary statistics of personal long-term inhalation exposure measurements for WCS 8 – Maintenance and/or cleaning workers for spray area(s) at GB and EEA sites

Personal – long-term at GB sites and EEA sites in total (measurement period 2019 - 2022)					
	N	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	27	0.420	0.578	0.0900	1.14

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

Table 9-56 shows the resulting long-term inhalation exposure concentration for maintenance and/or cleaning workers for spray area(s) used for risk assessment, based on the 90th percentile of personal long-term sampling values from GB and EEA sites combined.

RPE is systematically worn for maintenance and cleaning of spray area(s) activities (Task 1) but usually not for Task 2 (Handling of solid and/or liquid waste). Since the 90th percentile of long-term measurements is dominated by maintenance activities (filter change mostly; observed also for personal short-term measurements), for which RPE is always worn, we consider it appropriate to correct the 90th percentile exposure value for use of RPE and apply an APF of to the exposure value.

The assessment conservatively assumes that maintenance and/or cleaning workers for spray area(s) spend a maximum of 20% of their time on tasks related to maintenance and cleaning of spray area(s) and waste management involving Cr(VI) (tasks performed up to 420 min, once a week). Accordingly, a correction is made for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 0.20).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-57: Measured inhalation exposure concentration for WCS 7 – Maintenance and/or cleaning workers for spray area(s)

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m³]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m³]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m³]
Personal	27	1.14	10	0.114	0.200	0.210	0.00478

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] RPE is used, see above.

[c] Since the workers spend 20% of their working time on Cr(VI) tasks a time correction factor of 0.200 is used (tasks performed up to 420 min, once a week).

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.8.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-58 shows the risk characterisation for carcinogenicity for maintenance and/or cleaning workers for spray area(s). The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-58: Risk characterisation for carcinogenicity for WCS 7 – Maintenance and/or cleaning workers for spray area(s)

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.00478	4.00E-03	1.91E-05

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of 4×10^{-3} for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for maintenance and/or cleaning workers for spray area(s) is 1.91E-05.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **three maintenance and/or cleaning workers for spray area(s)** are engaged per day per site. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.8.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For maintenance and/or cleaning workers for spray areas two GB sites provided biomonitoring data sampled from 2017 to 2021. The data cover the main tasks of maintenance and/or cleaning workers however the data documentation does not allow the distinction between "Maintenance and/or cleaning workers for spray area(s)" and "Maintenance and/or cleaning workers (excluding spray areas)". Thus, all biomonitoring data related to maintenance activity is grouped together and affected to both WCS.

For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-59: Biomonitoring data for WCS 7 – Maintenance and/or cleaning workers for spray area(s) at GB sites

Individual values	
N	5
AM [µmol Cr/mol creatinine]	1.72
Median [µmol Cr/mol creatinine]	n.a.
90th percentile [µmol Cr/mol creatinine]	n.a.
N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

The presented biomonitoring data show that the body burden of maintenance and/or cleaning workers at GB sites did not exceed the UK BMGV in a single case.

In addition to the biomonitoring data from GB sites also data for EEA sites are available, which are presented in the following table to show on a larger database, under comparable conditions of use, that the body burden of the workers is low.

For this WCS biomonitoring data are available from two sites in two EEA countries, sampled in the years 2021-2022. The data cover only the main tasks of maintenance and/or cleaning workers, again all biomonitoring data related to maintenance activity is grouped and affected to "Maintenance and/or cleaning workers for spray area(s)" and "Maintenance and/or cleaning workers (excluding spray areas)" WCS. Biomonitoring data were reported by the companies as results for groups of workers and are reported here accordingly (see Annex V). The following table shows an overview of the available group entries.

Table 9-60: Biomonitoring data for WCS 7 – Maintenance and/or cleaning workers for spray area(s) at EEA sites

Group entries	
N	29
Number of data sets	3
Number of datasets with individual values > 10.00 µmol Cr/mol creatinine	0

For this WCS, no individual biomonitoring values were reported. The values are only available as group entries: 29 values from three data sets for this WCS. The MAX values of these three data sets (0.218, 2.24 and 2.56 µmol Cr/mol creatinine) are well below the limit value of 10.0 µmol Cr/mol creatinine (UK BMGV).

Overall, the reported biomonitoring data confirm that the body burden of maintenance and/or cleaning workers for spray area(s) did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.9 Worker contributing scenario 8 – Maintenance and/or cleaning workers (excluding spray areas)

Maintenance and/or cleaning workers (excluding spray areas) are usually involved in numerous maintenance and cleaning activities of workplace areas where machining activities, media blasting, or other operations not related to spray activities take place. These operations take place in machining areas, hangars, etc… but not in spray areas. Indeed, maintenance and cleaning activities for spray areas are covered in WCS 7 (see section 9.2.3.8).

Typical activities performed by maintenance and/or cleaning workers (excluding spray areas), with possible Cr(VI) exposure, are:

Main task

- Task 1: Maintenance and cleaning of equipment and work area (PROC 28)

Secondary task

- Task 2: Handling of solid and/or liquid waste (PROC 8b)

As Task 2 is a typical main task performed by the SEG 'Maintenance and/or cleaning workers for spray area(s)', it is described in detail in the corresponding worker contributing scenarios, WCS 7 (Task 2; see section 9.2.3.7.2.3).

In the following section, the conditions of use of Task 1 with potential direct Cr(VI) exposure are specified and the individual activities are described in more detail.

9.2.3.9.1 Conditions of use

Table 9-61 summarises the conditions of use for Task 1 with direct Cr(VI) exposure carried out by maintenance and/or cleaning workers (excluding spray areas).

Table 9-61: Conditions of use – Worker contributing scenario 8 – Maintenance and/or cleaning workers (excluding spray areas)

Product (article) characteristics	
Product type	n.a. (surface-treated parts residues)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Maintenance and cleaning of equipment and work area (PROC 28)	
Duration of task [min/shift]:	up to 360
Frequency of task [days/year]:	< 1-96*
Technical and organisational conditions and measures	
Task 1: Maintenance and cleaning of equipment and work area (PROC 28)	
LEV:	No
Type of LEV:	n.a.
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	Restriction of access by means of signage or physical segregation or through strict procedure
Conditions and measures related to personal protection, hygiene, and health evaluation	
Gloves	
Chemical resistant gloves according to EN 374 as per relevant risk assessment must be worn during all tasks.	
Eye protection	
Eye protection as per relevant risk assessment must be worn during all tasks. If an air-fed hood, helmet, or full-mask is worn during spray application, no further eye protection is needed. Type of eye protection to be used for specific tasks is laid down in work instructions for the tasks.	
Task 1: Maintenance and cleaning of equipment and work area (PROC 28)	
RPE:	RPE is worn if industrial hygiene exposure assessment confirms that RPE use is required
Protection clothes:	Chemical protective clothing per site-specific risk assessment

Other conditions affecting workers' exposure	
Task 1: Maintenance and cleaning of equipment and work area (PROC 28)	
Place of use:	Indoors
Temperature:	Room temperature
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

* At few sites, maintenance and cleaning of equipment and work area may be performed up to 480 min/shift, but with a lower frequency (< 1x/week to 1x/month) or with a lower duration (max. 120 min/shift) at a higher frequency (up to everyday).

9.2.3.9.2 Exposure and risks for workers

Between individual sites, the number of maintenance and/or cleaning workers (excluding spray areas) is very variable, depending on several factors such as the size of the site (one individual machining room/booth or dedicated sanding hangar vs. several workplace areas, possibly organised in different departments), the organisation of the maintenance program and the distribution and throughput of work. Depending on the activity, maintenance and/or cleaning operations can be conducted either by internal maintenance and cleaning operators or by other operators (e.g., machinists, sanders). But it should be noted that these tasks are also often subcontracted to external service providers.

Maintenance can be preventative to maintain the performance of the equipment and tools (e.g., LEV system, machining tools, wet scrubbers) or curative in case of deterioration or deficiency. Maintenance and cleaning operations may occur daily (e.g., LEV functionality checks, floor vacuum cleaning in the machining areas), or less frequently but on a periodic basis as defined by the site under a dedicated maintenance program. Maintenance and/or cleaning workers follow standard operating procedures to minimize release of dust (e.g., during handling of dust bags) and implement effective cleaning practices in order to prevent Cr(VI) surface contamination.

The number of work shifts differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may also be between 7 and 12h, depending on the organisation of the site and national laws.

In GB, the number of maintenance and/or cleaning workers (excluding spray areas) typically ranges between one to 30 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average **nine workers performing maintenance and/or cleaning workers in non-spray area** (nine workers, one shift) are engaged per day per site in this use.

Below we describe in detail the relevant task with direct Cr(VI) exposure and the working conditions. The use conditions specified in Table 9-61 apply to this task.

<u>Task 1: Maintenance and cleaning of equipment and work area</u>

Maintenance and/or cleaning activities can take place in various workplace areas such as machining areas (see section 9.2.3.4), dedicated sanding hangars (see section 9.2.3.5), or large working hall where media blasting is performed (see section 9.2.3.7). These locations are either equipped with LEV (e.g., extraction bench/room/booth, hangar, …) or without LEV. During maintenance or cleaning of these working areas, no machining activities take place and access is restricted.

Prior to any maintenance activity on dusty area, maintenance workers usually clean the area with a vacuum cleaner or a wet wipe on surfaces before they start working or repairing. Maintenance workers regularly check filtration systems of extraction bench/room/booth or hangar and replace filters when necessary. Filters change is carried out without the LEV running due to technical reasons. Depending on the installed LEV system, maintenance workers change inlet and exhaust filters. Maintenance workers check, maintain, and if necessary, change the filter in the rear, floor and/or ceiling of the machining booth/room, dedicated sanding hangar or extraction bench LEV systems.

Machining tools are maintained and repaired on a regular basis. For this purpose, the tools are partially disassembled, cleaned, and minor repairs are carried out. When Automated drilling units (ADU) are returned from use, they are inspected/adjusted and calibrated by drilling standard non painted coupons inside an extraction bench. ADUs may have some residual chromate dust contamination following use in production, especially in areas which may not be accessed during normal cleaning. During calibration, minor maintenance/adjustment of the equipment is also performed when necessary. Tools can either be cleaned under an extraction hood, on an extraction bench, in a glove box (e.g., orbital/rotary sanders with pressured air at some sites) or in a dedicated room.

Maintenance and cleaning workers clean the floor of the work area with a vacuum cleaner, a mop, an automatic floor scrubbing machine, or a high-pressure cleaner (e.g., in dedicated sanding hangars). Workers are also in charge of the disconnection, closure, and renewal of dust bags of vacuum cleaners, central air extraction system (CES), extraction grinding tables, … They also perform the cleaning of dust collectors (e.g., at riveting machines or sanding booth).

Cr(VI)-contaminated dust and all other generated solid waste (e.g., PPE, LEV filters, wipes) and wastewater are collected in dedicated hazardous waste containers and disposed of as hazardous waste by an external waste management company (licensed contractor).

9.2.3.9.2.1 Inhalation exposure

Measured inhalation exposure concentration

In total, 34 long-term personal monitoring data were reported for the inhalation exposure assessment for this SEG. No short-term or stationary data is available. These long-term personal monitoring data come from two sites in GB. About 61.8% of the data (21 values) are <LOQ and 38.2% (13 values) are >LOQ.

Table 9-62 gives an overview of the available data for maintenance and/or cleaning workers (excluding spray areas).

Table 9-62: Overview of available inhalation exposure measurements for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas) at GB sites

	Total	>LOQ	<LOQ
Personal			
- Long-term (≥2h)	34	13	21
- Short-term (<2h)	0	0	0
Stationary			
- Long-term (≥2h)	0	0	0

- Short-term (<2h)	0	0	0

(1) Figures include only EEA data as no GB data is available

The measurements were taken at workers performing maintenance activities in non-spray areas where treated parts and primer products containing StC and/or PCO and/or PHD were used.

During some measurements, the workers also may have had Cr(VI) exposure from primer products not covered under the present use (e.g., from surfaces/waste contaminated with wash primers) or from uses of other chromates (e.g., when performing chemical conversion coating on small surfaces with dichromium (tris)chromate using a touch-up pen). Note that the chromate present during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements, several chromates may have been present. In some reports, no information was given on the substance. However, due to limited availability of data, no substance-specific analysis can be conducted.

The monitoring data considered in this WCS does not include measured results from activities performed in paint areas (when the data documentation specifies e.g., cleaning the spray booths, maintenance of the installed LEV systems) which have been affected to WCS 7 Maintenance and/or cleaning workers for spray area(s).

Table 9-63 shows the summary statistics of workplace measurements for maintenance and/or cleaning workers (excluding spray areas). For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2018-2022. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-63: Overview of available inhalation exposure measurements for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas) at GB sites

Personal – long-term (measurement period 2018 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	34	100	0.120	0.256	0.0190	0.211

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

<u>Personal measurements – long-term</u>

The 90th percentile for the total long-term personal measurements is 0.211 µg/m³. All long-term measurements are within a range of 0.0110 to 1.00 µg/m³. Out of 34 total measurements, 32 measurements (94.1%) cover calibration of machining tools. The two remaining data cover general maintenance activities and cleaning activities.

None of these measurements reported RPE, either RPE is not worn, or this information is not reported.

Risk characterisation is based on the complete set of long-term personal measurements from GB.Table 9-64 shows the resulting long-term inhalation exposure concentration for workers performing media blasting in closed system used for risk assessment, based on the 90th percentile of personal sampling values.

RPE is worn during activities for which industrial hygiene exposure assessment requires it. No RPE is considered in the exposure assessment, which constitutes a further conservative element of the assessment.

The assessment conservatively assumes that maintenance and/or cleaning workers (excluding spray areas) spend a maximum of 30% of their time on tasks related to maintenance and cleaning of equipment and workplaces involving Cr(VI) (task performed up to 360 min, twice a week). Accordingly, a correction is made for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 0.300).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time on using such primer types. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-64: Measured inhalation exposure concentration for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas)

Type of measure-ment	Number of measure-ments	Exposure value [a] [µg/m³]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [µg/m³]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [µg/m³]
Personal	34	0.211	1	0.211	0.300	0.210	0.0133

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] No RPE is used, see above.

[c] Since the workers spend 30% of their working time on Cr(VI) tasks a time correction factor of 0.210 is used (task performed up to 360 min, twice a week).

[d] The share of primer types covered under the present use is 0.0300 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.9.2.2 Risk characterisation

Risk for carcinogenicity

Table 9-65 shows the risk characterisation for carcinogenicity for maintenance and/or cleaning workers (excluding spray areas). The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-65: Risk characterisation for carcinogenicity for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas)

Route of exposure and type of effects	Long-term exposure [µg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/µg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.0133	4.00E-03	5.32E-05

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 µg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for maintenance and/or cleaning workers (excluding spray areas) is 5.32E-05.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- no correction for wearing RPE was applied although workers may wear RPE under certain conditions for some activities,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **nine maintenance and/or cleaning workers (excluding spray areas)** are engaged per day per site in this use. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.9.2.3 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For this WCS two GB sites provided biomonitoring data sampled from 2017 to 2021. The data cover the main tasks of maintenance and/or cleaning workers however the data documentation does not allow the distinction between "Maintenance and/or cleaning workers for spray area(s)" and "Maintenance and/or cleaning workers (excluding spray areas)". Thus, all biomonitoring data related to maintenance activity is grouped together and affected to both WCS.

For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-66: Biomonitoring data for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas) at GB sites

Individual values	
N	5
AM [µmol Cr/mol creatinine]	1.72
Median [µmol Cr/mol creatinine]	n.a.
90th percentile [µmol Cr/mol creatinine]	n.a.
N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

The presented biomonitoring data show that the body burden of maintenance and/or cleaning workers at GB sites did not exceed the UK BMGV in a single case.

In addition to the biomonitoring data from GB sites also data for EEA sites are available, which are presented in the following table to show on a larger database, under comparable conditions of use, that the body burden of the workers is low.

For this WCS biomonitoring data are available from two sites in two EEA countries, sampled in the years 2021-2022. The data cover only the main tasks of maintenance and/or cleaning workers, again all biomonitoring data related to maintenance activity is grouped and affected to "Maintenance and/or cleaning workers for spray area(s)" and "Maintenance and/or cleaning workers (excluding spray areas)" WCS. Biomonitoring data were reported by the companies as results for groups of workers and are reported here accordingly (see Annex V). The following table shows an overview of the available group entries.

Table 9-67: Biomonitoring data for WCS 8 – Maintenance and/or cleaning workers (excluding spray areas) at EEA sites

Group entries	
N	29
Number of data sets	3
Number of datasets with individual values > 4.00 µmol Cr/mol creatinine	0

For this WCS, no individual biomonitoring values were reported. The values are only available as group entries: 29 values from three data sets for this WCS. The MAX values of these three data sets (0.218, 2.24 and 2.56 µmol Cr/mol creatinine) are well below the limit value of 10.0 µmol Cr/mol creatinine (UK BMGV).

Overall, the reported biomonitoring data confirm that the body burden of maintenance and/or cleaning workers (excluding spray areas) did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

9.2.3.10 Worker contributing scenario 9 – Incidentally exposed workers

Incidentally exposed workers are defined as workers who spend a relevant part (10% or more) of their working time in the work area where activities involving primer products are located, but do not carry out tasks with direct Cr(VI) exposure potential themselves. These workers may incidentally be exposed from such activities due to inhalation background exposure in the work area. Their operations are required to be performed in this work area, as they are essential activities related to either the present use or to other primers uses (use of protective and/or wash primers containing StC, PCO or PHD), carried out in the same workplace. The activities performed by incidentally exposed workers are summarized for the present assessment as the following task:

Main task

- Task 1: Activities with indirect Cr(VI) exposure (PROC 0)

9.2.3.10.1 Conditions of use

Table 9-68 summarises the conditions of use for the tasks with direct Cr(VI) exposure carried out by Incidentally exposed workers.

Table 9-68: Conditions of use – Worker contributing scenario 9 – Incidentally exposed workers

Product (article) characteristics	
Product type	
Primer products containing StC	4.85% max (indirect exposure)
Surface-treated parts	n.a. (indirect exposure)
Amount and concentration used (or contained in articles), frequency and duration of use/exposure	
Task 1: Activities with indirect Cr(VI) exposure (PROC 0)	
Duration of task [min/shift]:	Up to 240
Frequency of task [days/year]:	Up to 240
Technical and organisational conditions and measures	
Task 1: Activities with indirect Cr(VI) exposure (PROC 0)	
LEV:	n.a. (indirect exposure)
Type of LEV:	n.a. (indirect exposure)
Type of general ventilation in working hall:	Natural ventilation
Air changes per hour (ACH) of general ventilation:	n.a.
Other RMMs in place:	No

Conditions and measures related to personal protection, hygiene, and health evaluation	
Task 1: Activities with indirect Cr(VI) exposure (PROC 0)	
Standard PPE (not intended for protection against chromates), as described in work instructions for the tasks	
Other conditions affecting workers' exposure	
Task 1: Activities with indirect Cr(VI) exposure (PROC 0)	
Place of use:	Indoors
Temperature:	Room temperature
Primary emission source proximity:	The primary emission source is usually in the far field (>1 m)
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply	
None	

9.2.3.10.2 Exposure and risks for workers

The number of incidentally exposed workers can be highly variable, depending on the size of the site, the organisation of the activities (e.g., numerous activities in one hall vs. less activities in different areas) and the organisation of work. The number of work shifts also differs between sites, ranging typically from one to three shifts per day. The shift duration is usually 8h but may be also up to 12h, depending on the organisation of the site and national law.

In GB, the number of incidentally exposed workers typically ranges between one to 200 workers per shift. Based on the arithmetic mean calculated from information received from DUs, in the following we assume that on average, **14 incidentally exposed workers** (seven per shift, two shifts) are engaged per day per site in this scenario.

It has to be noted that in compliance with Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (EU, 2013), wherever a carcinogen or mutagen is used, the sites keep the number of workers exposed or potentially to be exposed as low as possible and only essential activities are carried out in the vicinity of activities with a potential of Cr(VI) exposure.

Below we listed the potential activities that can be performed by incidentally exposed workers and the working conditions under which indirect Cr(VI) exposure may occur. The use conditions specified in Table 9-68 apply to this task.

<u>Task 1: Activities without direct Cr(VI) exposure</u>

The tasks of incidentally exposed workers can be very diverse, but at many sites, workers who are not working directly with Cr(VI) sources may regularly carry out activities near other workers, including but not limited to the following:

- supervision of processes
- quality assessment of parts
- un-/masking of parts
- primed parts drying/self-curing and transportation out of the paint area

- transportation of primers in closed containers

Depending on the organisation of the site, some of the above-mentioned activities may also be performed by other operators (e.g., masking or transportation of the part out of the paint area can be taken in charge by sprayer).

9.2.3.10.2.1 Inhalation exposure

Measured inhalation exposure concentration

For incidentally exposed workers, in total seven personal monitoring data and 18 stationary monitoring data are available for eight GB sites. The personal monitoring data are long-term measurements (≥2h)[23], shift-representative, with three measurements <LOQ, and four >LOQ. Of the 18 stationary monitoring values, 15 are long-term measurements and three short-term measurements (<2h). About 77.8% of the stationary measurements (14 values, including two short-term measurements) are <LOQ and 22.2% (four values, including one short-term measurements) are >LOQ.

Due to the rather limited amount of GB data, we report below also measurements data for incidentally exposed workers from EEA sites operating under comparable conditions of use.

From EEA sites, 32 personal monitoring data and 70 stationary data are available for this SEG. Of these 32 personal monitoring data, 14 are long-term (≥2h)[24], shift-representative and 18 are short-term (<2h) measurements. The stationary measurements can be divided in 45 long-term measurements and 25 short-term measurements.

The personal monitoring data come from 12 sites in six countries in the EEA. About 53.1% of the data (17 values, including ten short-term measurements) are <LOQ and 46.9% (15 values, including eight short-term measurements) are >LOQ.

The 70 stationary data come from 17 sites in four EEA countries (considering also data provided via Art. 66 notification for which no indication of the country or the site was given). About 61.4% of the stationary measurements (43 values, including 19 short-term measurements) are <LOQ and 38.6% (27 values, including six short-term measurements) are >LOQ.

Table 9-69 gives an overview of the available data for incidentally exposed workers.

[23] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

[24] All long-term measurements (≥2h) are considered as shift-representative measurements and used as such as 8h TWA exposure values; no recalculation has been performed. Measurements <2h were not used to calculate 8h TWA exposure values.

Table 9-69: Overview of available inhalation exposure measurements for WCS 9 – Incidentally exposed workers at GB and EEA sites

	Total	>LOQ	<LOQ
Personal at GB sites			
- Long-term (≥2h)	7	4	3
- Short-term (<2h)	0	-	-
Personal at EEA sites			
- Long-term (≥2h)	14	7	7
- Short-term (<2h)	18	8	10
Stationary at GB sites			
- Long-term (≥2h)	15	3	12
- Short-term (<2h)	3	1	2
Stationary at EEA sites			
- Long-term (≥2h)	45	21	24
- Short-term (<2h)	25	6	19

The measurements were taken at workers who may incidentally be exposed from activities involving the use of primer products containing StC and/or PCO and/or PHD due to inhalation background exposure (e.g., masking activities, supervision).

During some measurements, the workers also may have had been incidentally exposed to Cr(VI) primer products not covered under the present use (e.g., from surfaces/waste contaminated with wash primers) or from uses of other chromates (e.g., chemical conversion coating with dichromium (tris)chromate using a touch-up pen). Note that the chromate present during the measurement could not always be clearly assigned. According to the information given in the monitoring reports, during some measurements, several chromates may have been present. In some reports, no information was given on the substance. It has to be noted that the majority of the provided monitoring data are related to primers containing StC, whereas fewer monitoring data are available for PCO or PHD. However, due to limited availability of data, no substance-specific analysis can be conducted.

Further, it has to be noted that exposure of incidentally exposed workers was not considered in previous applications.

Table 9-70 shows the summary statistics of workplace measurements for incidentally exposed workers. For values <LOQ, we considered half of the LOQ (LOQ/2) for statistical evaluation. All measurements are from the period 2017-2022. Annex IV of this report provides a summary on the analytical methods for inhalation exposure monitoring and information on their LOQs. The individual measurements can be provided upon request.

Table 9-70: Summary statistics of inhalation exposure measurements for WCS 9 – Incidentally exposed workers at GB and EEA sites

Personal – long-term at GB sites (measurement period 2021 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	7	100	0.0276	n.a.	n.a.	n.a. (MAX = 0.0580)
Personal – short-term at GB sites						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	0	-	-	-	-	-
Stationary – long-term at GB sites (measurement period 2017 and 2021-2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	15	100	0.692	0.785	0.500	1.44
Stationary – short-term at GB sites (measurement period 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	3	100	0.330	n.a	n.a	n.a. (MAX = 0.970)a
Personal – long-term at EEA sites (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	14	100	0.0812	0.125	0.0480	0.185
Personal – short-term at EEA sites (measurement period 2020 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	18	100	0.267	0.586	0.0850	0.436
Stationary – long-term at EEA sites (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	45	100	0.251	0.614	0.0500	0.725
Stationary – short-term at EEA sites (measurement period 2018 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	25	100	0.0595	0.0422	0.0425	0.106

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

[a] The individual values are <0.020 (2x), and 0.970 µg/m³.

Personal measurements – long-term

At GB sites, the AM for the seven long-term personal measurements is 0.0276 µg/m³. All long-term measurements are within a range of 0.0105 to 0.0580 µg/m³. Nearly all the data (six measurements) cover supervisory activity carried out by process managers, the other data is related to diverse activities (e.g., masking/demasking, transfer of parts to ovens, etc.).

At EEA sites, the AM for the 14 long-term personal measurements is 0.0812 µg/m³ and the 90th percentile is 0.185 µg/m³. 28.6% of the data (four measurements) cover supervisory activity carried out by process managers, the other data is related to diverse activities (e.g., masking/demasking) next to spray booths, ovens, or machining areas.

The AMs of long-term values for incidentally exposed workers from EEA sites and GB sites are in the same order of magnitude.

Personal measurements – short term

There is no short-term personal measurement available for GB sites.

The 90th percentile for the 18 short-term personal measurements available for EEA sites is 0.436 µg/m³. The measurements were performed at workers standing next to drying components, to ovens, or to machining areas. Seventeen of the 18 short-term measurements are within a range of 0.00500 to 0.800 µg/m³. One higher value (2.50 µg/m³, 30 min of sampling duration) was measured during drying/heat-curing of a part. No detail is available regarding the distance from the worker to the part. The 8h TWA[25] values calculated from this measurement (0.156 µg/m³, considering 450 min non-exposure time[26]) is below the 90th percentile of the long-term measurements, suggesting that exposure is covered by the shift-average exposure of operators.

Stationary measurements – long-term

Fifteen stationary long-term measurements from six GB sites are available. The measurements were taken in halls e.g., outside the spray booth, outside of paint shop, or next to drying parts. For these stationary long-term measurements the AM is 0.692 µg/m³ and the 90th percentile is 1.436 µg/m³, which is higher by one or two orders of magnitude than the AM of total personal long-term measurements from GB sites (0.0276 µg/m³). The main reason for the higher exposure from stationary monitoring are two high values of 3.00 and 2.06 µg/m³ (all other stationary measurements are below the LOQ (from 0.071 to 1 µg/m³)). The reason why the first value (3.00 µg/m³) is high is due to fugitive loss identified from the paint booth (location of the sample was immediately outside the entrance) but other static samples performed afterwards showed concentration below the LOD. Regarding the value of 2.06 µg/m³, the site reported that the worker operated at the masking table in the paint area and it

[25] TWAs are calculated by assuming that the remaining time of the 8h shift, during which the measurement was not performed, is non-exposure time.

[26] 2.50 µg/m³ x (30 min/480 min) = 0.156 µg/m³

was monitored during application of slurry coating with chromium trioxide, primers, and chemical conversion coating.

For the 45 stationary long-term measurements at EEA sites, the calculated 90th percentile is 0.725 µg/m³. The measurements were taken in halls e.g., outside the spray booth, outside an enclosed milling center, or next to drying parts.

Stationary measurements – short-term

Only three short-term stationary measurement are available for GB sites. The AM is 0.330 µg/m^3, based on two values below LOQ (0.0200 µg/m^3) and one value of 0.970 µg/m^3.

For EEA sites, the 90th percentile for the 18 short-term stationary measurements is 0.106 µg/m^3 and the AM is 0.059 µg/m^3. All short-term measurements are within the range of 0.00025 to 0.197 µg/m^3. The measurements were taken in halls e.g., outside the spray booth, outside an enclosed milling center, or next to drying parts.

Due to the limited database from GB sites and the comparable exposure values between GB and EEA monitoring data, the complete set of long-term personal measurements for incidentally exposed workers from GB and EEA sites combined was used for the risk characterisation (90th percentile: 0.150 µg/m^3; see table below).

Table 9-71: Summary statistics of personal long-term exposure measurements for WCS 10 – Incidentally exposed workers at GB and EEA sites

Personal – long-term at GB and EEA sites (measurement period 2017 - 2022)						
	N	**% of total**	**AM [µg/m³]**	**SD [µg/m³]**	**Median [µg/m³]**	**90th Perc. [µg/m³]**
Total	21	100	0.063	0.105	0.0360	0.150

All exposure values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

Table 9-71 shows the resulting long-term inhalation exposure concentration for incidentally exposed workers used for risk assessment, based on the 90th percentile of personal sampling values from GB and EEA sites combined.

RPE is usually not worn by incidentally exposed workers. Therefore, no RPE is considered in the exposure assessment, which constitutes a further conservative element of the assessment.

At most sites, incidentally exposed workers do not spend their whole work shift in areas where activities related to Cr(VI) primers are performed. In this assessment, it will be conservatively assumed that incidentally exposed workers are exposed to Cr(VI) for 50% of their shifts (up to 240 min, everyday). Accordingly, a correction is made for the working time spent on tasks related to this use (time correction factor for Cr(VI) tasks = 0.500).

As stated above, some measurements cover (partial) exposure from uses not related to the present use, but it is not possible to differentiate the measurement data according to uses. However, we consider that workers have partial exposure from use of protective and/or wash primers containing StC, PCO and/or PHD, since they spend part of their working time in environments where such primer types are used. Therefore, we apply an additional factor to the 90th percentile to account for that. This factor is based on the market shares of the primer types covered under the different uses and is 0.210 for the present use (as described in section 9.1.2.6.2).

Table 9-72: Measured inhalation exposure concentration for WCS 9 – Incidentally exposed workers

Type of measure-ment	Number of measure-ments	Exposure value [a] [μg/m³]	Assigned protection factor (APF) for RPE [b]	Exposure value corrected for RPE [μg/m³]	Time correction factor for Cr(VI) tasks [c]	Market share correction factor [d]	Long-term exposure [e] [μg/m³]
Personal	21	0.150	1	0.150	0.500	0.210	0.0158

All exposure values rounded to three significant figures for presentation, but unrounded values were used for calculation of exposure.

[a] Based on 90th percentile of measurements.

[b] No RPE is used, see above.

[c] Since the workers spend 50% of their working time in areas where activities related to Cr(VI) are performed, a time correction factor of 0.500 is used (activities performed up to 240 min, everyday).

[d] The share of primer types covered under the present use is 0.210 compared to all primer types on the market relevant for ADCR.

[e] The factors for time correction and market share were applied (see text above).

9.2.3.10.2.1 Risk characterisation

Risk for carcinogenicity

Table 9-73 shows the risk characterisation for carcinogenicity for incidentally exposed workers. The risk for carcinogenicity is based on measured Cr(VI) inhalation exposure data for these workers and the RAC dose-response relationship for the excess lifetime cancer risk for lung cancer (ECHA, 2013a).

Table 9-73: Risk characterisation for carcinogenicity for WCS 9 – Incidentally exposed workers

Route of exposure and type of effects	Long-term exposure [μg/m³]	Risk characterisation: Excess lifetime lung cancer risk [a] [1/μg/m³]	Excess lifetime cancer risk (ELCR) [b]
Inhalation: Systemic Long Term	0.0158	4.00E-03	6.30E-05

All values rounded to three significant figures for presentation, but unrounded values used for calculation of exposure.

[a] RAC dose-response relationship based on excess lifetime lung cancer risk (ECHA, 2013a): Exposure to 1 μg/m³ Cr(VI) relates to an excess risk of $4x10^{-3}$ for workers, based on 40 years of exposure; 8h/day; 5 days/week.

[b] Excess lifetime lung cancer risk.

Conclusion on risk characterisation

Carcinogenicity

The excess life-time cancer risk for incidentally exposed workers is 6.30E-05.

This risk estimate can be considered as conservative, because:

- it is based on a conservative exposure-risk relationship (ERR),
- it uses the 90th percentile of the reported long-term measurements,
- no correction for wearing RPE was applied,
- these measurements were not corrected for their duration but assumed to be shift representative values.

On average, we assume that **14 incidentally exposed workers** are engaged per day per site in this use. For sites where the work is distributed among a higher number of workers, a higher number of people would have to be considered, but their long-term average individual exposure concentration would be lower.

9.2.3.10.2.2 Biomonitoring

A detailed description of how the biomonitoring data was compiled and additional information on the available database is provided in Annex V of this CSR.

For incidentally exposed workers, three GB site provided biomonitoring data sampled from 2017 to 2021. The data mainly cover indirect Cr(VI) exposure of masking operators and quality inspectors. For this WCS, all available data were reported as individual values and no data for groups of workers are available. The following table shows an overview of the available individual values.

Table 9-74: Biomonitoring data for WCS 9 – Incidentally exposed workers at GB sites

Individual values	
N	15
AM [µmol Cr/mol creatinine]	1.99
Median [µmol Cr/mol creatinine]	0.801
90th percentile [µmol Cr/mol creatinine]	4.00
N > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

The presented biomonitoring data show that the body burden of incidentally exposed workers did not exceed the UK BMGV in a single case.

In addition to the biomonitoring data from GB sites also data for EEA sites are available, which are presented in the following table to show on a larger database, under comparable conditions of use, that the body burden of the workers is low.

For this WCS biomonitoring data are available from one site in EEA, sampled in 2020. The data cover indirect Cr(VI) exposure of managers and quality inspectors. Biomonitoring data were reported by the company either as an individual value or as results for groups of workers and are reported here accordingly (see Annex V). The following table shows the result for the individual value and an overview of the available group entries.

Table 9-75: Biomonitoring data for WCS 9 – Incidentally exposed workers at EEA sites

Individual values	
N	1
AM [µmol Cr/mol creatinine]	n.a. (value = 0.100)
Median [µmol Cr/mol creatinine]	n.a.
90th Perc. [µmol Cr/mol creatinine]	n.a.
N > 10.00 µmol Cr/mol creatinine	0
Group entries	
N	14
Number of data sets	2
Number of datasets with individual values > 10.0 µmol Cr/mol creatinine	0

All exposure values rounded to three significant figures for presentation.

n.a. = not assessed; the statistical parameter was only determined if at least three (for AM) or ten (for SD, Median and 90th percentile) values were available.

Only one individual value is available for this WCS (0.100 µmol Cr/mol creatinine) well below the limit value of 10.0 µmol Cr/mol creatinine (UK BMGV).

The other values are available as group entries: 14 values from two data sets. The MAX values of these two data sets (0.673 and 1.15 µmol Cr/mol creatinine) are both below the limit value of 10.0 µmol Cr/mol creatinine (UK BMGV).

Overall, the reported biomonitoring data confirm that the body burden of incidentally exposed workers did not exceed the UK BMGV in a single case.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

10 RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

10.1 Human health (related to combined, shift-long exposure)

10.1.1 Workers

Efforts were undertaken to clearly identify and describe groups of workers exposed to chromates. These SEGs (similar exposure groups) typically perform more than one task. Exposure data provided cover the various activities performed during the work routine of these workers and are used to describe long-term exposure. Therefore, the combined exposure from performing several tasks is already covered in the exposure assessment.

In rare cases, unusual combinations of exposure tasks might occur for some workers at individual sites. For example, a worker may perform sanding in a dedicated hangar and spraying in a spray room. However, the upper ranges of CoU (e.g., frequency, duration) used for the assessment for the individual WCS are selected sufficiently conservative to also cover exposure from 'unusual' additional tasks during the work shift. Accordingly, in such cases the duration and/or frequency of the performed tasks reported by the companies is lower than the duration/frequency as described in the CoU for the respective WCS. For example, sanding in a dedicated hangar may be performed once per month for 480 min (CoU for Sanders in a dedicated hangar: 2x/week for 240 min each) and, in addition, spraying in a spray room may be performed occasionally (e.g., 30 min per day; CoU for Spray operators for manual spraying in a spray room/booth daily for up to 480 min).

The situation where workers are exposed due to activities related to other uses with Cr(VI) are discussed in the respective worker contributing scenarios.

10.1.2 Consumers

No consumer uses are addressed in this CSR.

10.2 Environment (combined for all emission sources)

10.2.1 All uses (regional scale) – regional assessment

In accordance with RAC's conclusions (see e.g., the RAC/SEAC "Opinion on an Application for Authorisation for Use of Sodium dichromate for surface treatment of metals such as aluminium, steel, zinc, magnesium, titanium, alloys, composites and sealings of anodic films"[27]), no regional assessment has been carried out as it can be assumed that Cr(VI) from any source will be reduced to Cr(III) in most environmental situations and therefore the effects of Cr(VI) as such are likely to be limited to the area around the source, as described in the EU Risk Assessment Report for chromates (ECB, 2005). Therefore, combined exposures from various sources on the regional scale do not need to be considered.

[27] RAC/SEAC, consolidated version, 2016; https://echa.europa.eu/documents/10162/658d42f4-93ac-b472-c721-ad5f0c22823c

On the local scale all relevant exposures from the emission source to air and wastewater are assessed (see section 9.2.3.1).

10.2.2 Local exposure due to all wide dispersive uses

There are no wide dispersive uses covered in this CSR.

10.2.3 Local exposure due to combined uses at a site

The assessment of exposure of humans via the environment was performed using site-specific emission data for all substances used for this use, considering the relative amounts of Cr(VI) applied for the present use. Accordingly, at sites using also primer types not covered under the present use (e.g., wash primers) the total release at the site is higher.

The total air releases per site are between 4.02E-05 and 13.6 kg Cr(VI) per year (compared to 4.75E-06 and 3.05 kg Cr(VI) to air for use of bonding primers only, considering each a site-specific share of air emission of 0.118 and 0.223 for the site with the lowest and the highest air emission respectively).

The total wastewater releases per site are between 0 and 0.00510 kg Cr(VI) per year (compared to 0 to 0.00106 kg Cr(VI) to wastewater for use bonding primers only, considering a site-specific share of wastewater emission of 0.207 for the site with the highest wastewater emission). The total releases per site are summarised in Table 9-12 and are shown in detail in Annex III (Table Annex III-1) of this CSR.

11 Annexes

11.1 Annex I – Comparative assessment of physico-chemical input parameters for EUSES modelling

In the following tables the physico-chemical properties of the two other chromates for which monitoring data are used for this use, PCO and PHD, as well as of barium chromate[28], a substance not covered under ADCR but being present in several primer products covered by the present use, are shown. The physico-chemical properties of StC are given in section 9.1.2.5.

We carried out a comparative EUSES assessment, where an identical example exposure scenario was calculated with the different substance-specific physico-chemical properties of StC, PHD, PCO and barium chromate (although not required for this use of the single substance StC).

Physico-chemical properties of the other chromates covered by the ADCR consortium

Table Annex I-1: Physico-chemical properties of potassium hydroxyoctaoxodizincate-dichromate (PHD), required for EUSES modelling

Property	Description of key information	Value selected for EUSES modelling	Comment
CAS	11103-86-9		
Molecular weight	418.9 g/mol	418.9 g/mol	Refers to PHD; in the Annex XV dossier for PHD (ECHA, 2011)
Melting/freezing point	n/a; decomposes above 500°C	500°C	Refers to PHD; in the Annex XV dossier for PHD (ECHA, 2011)
Boiling point	n/a; decomposes above 500°C	500°C	Refers to PHD; in the Annex XV dossier for PHD (ECHA, 2011)
Vapour pressure	n/a: inorganic ionic compound	0.00001 Pa	n/a; dummy value entered
Log Kow	n/a: inorganic ionic compound	0	n/a; dummy value entered
Water solubility	0.5-1.5 g/L at 20°C	1.5 g/L at 20°C	Refers to PHD; in the Annex XV dossier for PHD (ECHA, 2011)

[28] Barium chromate is not subject to authorisation but is present in some primer products in combination with at least one ADCR chromate and thus contributes to Cr(VI) exposure.

Table Annex I-2: Physico-chemical properties of pentazinc chromate octahydroxide (PCO), required for EUSES modelling

Property	Description of key information	Value selected for EUSES modelling	Comment
CAS	49663-84-5		
Molecular weight	579 g/mol	579 g/mol	Refers to PCO; value used in the Annex XV dossier for PCO (ECHA, 2013c)
Melting/freezing point	n/a; decomposes above 300°C	300°C	Refers to PCO; value used in the Annex XV dossier for PCO (ECHA, 2013c)
Boiling point	n/a; decomposes above 300°C	300°C	Refers to PCO; value used in the Annex XV dossier for PCO (ECHA, 2013c)
Vapour pressure	n/a: inorganic ionic compound	0.00001 Pa	n/a; dummy value entered
Log Kow	n/a: inorganic ionic compound	0	n/a; dummy value entered
Water solubility	< 0.02 g/L at 20°C	0.02 g/L at 20°C	Refers to PCO; value used in the Annex XV dossier for PCO (ECHA, 2013c)

Table Annex I-3: Physico-chemical properties of barium chromate (BaCr), required for EUSES modelling

Property	Description of key information	Value selected for EUSES modelling	Comment
CAS	10294-40-3		
Molecular weight	253 g/mol	253 g/mol	Refers to BaCr; value used in Registration Dossier of BaCr[29]
Melting/freezing point	n/a; decomposes at 1400°C	500°C (highest value possible for EUSES)	Refers to BaCr; value used in Registration Dossier of BaCr[18]
Boiling point	n/a; decomposes at 1400°C	500°C (highest value possible for EUSES)	Refers to BaCr; value used in Registration Dossier of BaCr[18]
Vapour pressure	n/a: inorganic ionic compound	0.00001 Pa	n/a; dummy value entered
Log Kow	n/a: inorganic ionic compound	0	n/a; dummy value entered

[29] Registration Dossier of barium chromate, as published on ECHA´s dissemination website; https://echa.europa.eu/de/registration-dossier/-/registered-dossier/25071; assessed in November 2022

Property	Description of key information	Value selected for EUSES modelling	Comment
Water solubility	0.0026 g/L at 20°C	0.0026 g/L at 20°C	Refers to BaCr; value used in Registration Dossier of BaCr[18]

Comparative EUSES assessment with an example scenario

The table below shows the outcome of the comparative EUSES assessment. We carried out the comparative assessment using mean partition coefficients. The scenario considers that a company uses 3000 kg Cr(VI) per year and releases of 0.9 kg/year to water and 0.8 kg/year to air. Wastewater is treated in a biological STP, with an adjusted Cr(VI) distribution in the STP of 50% to water and 50% to sludge (as described in section 9.1.2.5.2). Application of STP sludge to agricultural soil and grassland is considered.

As can be seen from the table, the modelling results are largely identical, except for the daily dose through intake of drinking water, which is marginally lower for BaCr, having the lowest water solubility out of the four chromates.

Table Annex I-4: Outcome of the comparative EUSES assessment of the impact of the physico-chemical properties of the four different chromates on the Cr(VI) concentrations in drinking water, fish, and air

Chromate	Daily dose through intake of drinking water [mg/kg/day]	Daily dose through intake of fish [mg/kg/day]	Daily dose through intake of air [mg/kg/day]	Sum of daily dose through intake of drinking water, fish, and air [mg/kg/day]
StC	2.56E-05	9.97E-08	1.74E-07	2.59E-05
PHD	2.56E-05	9.97E-08	1.74E-07	2.59E-05
PCO	2.56E-05	9.97E-08	1.74E-07	2.59E-05
BaCr	2.55E-05	9.97E-08	1.74E-07	2.58E-05

11.2 Annex II – EUSES sensitivity analysis of impact of partition coefficients

We assessed the impact of the selected partition coefficients (mean value of partition coefficients determined for acidic and alkaline conditions) in a sensitivity analysis with EUSES. We carried out the same exemplary exposure scenario as described in Annex I, using (a) the lowest coefficients, determined for alkaline conditions, (b) the calculated mean values, or (c) the highest coefficients, determined for acidic conditions. The outcome of the assessment is shown in the table below. Use of the lowest partition coefficients lead to the highest oral exposure, while use of the highest partition coefficient leads to the lowest oral exposure.

Table Annex II-1: Outcome of the comparative EUSES assessment of the impact of the partition coefficients on the concentrations in the considered Cr(VI) uptake media drinking water, fish, and air

Set of partition coefficients used	Annual average local PEC in air (total) [mg/m³]	Local PEC in groundwater under agricultural soil [mg/L]	Local concentration in drinking water [mg/L]	Local PEC in surface water during emission episode (dissolved) [mg/L]	Daily dose through intake of drinking water [mg/kg/day]	Daily dose through intake of fish [mg/kg/day]	Daily dose through intake of air [mg/kg/day]	Sum of dose from drinking water and fish and air
Alkaline	6.10E-07	4.46E-03	4.46E-03	6.15E-05	1.27E-04	1.01E-07	1.74E-07	1.27E-04
Mean	6.10E-07	8.97E-04	8.97E-04	6.07E-05	2.56E-05	9.97E-08	1.74E-07	2.59E-05
Acidic	6.10E-07	4.91E-04	4.91E-04	5.99E-05	1.40E-05	9.84E-08	1.74E-07	1.43E-05

11.3 Annex III – EUSES input data and release fractions derived from environmental monitoring data of individual sites

The table below shows total amounts of Cr(VI) used per site, total releases per site and the shares of the present use on the overall emissions per site.
The Cr(VI) amounts used by the sites range from <1 to 85 kg/year for GB sites and from <1 to 1372 kg/y for GB and EEA sites. Note that these are total Cr(VI) amounts used, which also include use of other primer types (wash primers or primer products other than wash or bonding primers), which are not covered under the present use.

Table Annex III-1: EUSES input data and release fractions derived from environmental monitoring data of individual sites

Site	Amount of Cr(VI) used [kg/year]	Fraction of tonnage released to air	Release to air [kg/year]	Fraction of tonnage released to water	Release to water [kg/year]	Share of air emission relevant for this use	Share of water emission relevant for this use
1 - GB	2.86	4.93E-02	0.141	No emission	0	0.223	0.223
2 - GB	22.6	5.65E-04	0.0127	No emission	0	0.222	0.222
4 - GB	0.411	9.80E-05	0.0000402	No emission	0	0.118	0.118
5 - GB	[a]	[a]	0.0120	No emission	0	0.209	0.209
7 - GB	84.9	1.35E-04	0.0115	No emission	0	0.223	0.223
8 - EEA	1372	[a]	0.306	No emission	0	0.165	0.165
9 - EEA	2.92	1.18E-04	0.000346	No emission	0	0.223	0.223
10 - EEA	650	5.50E-04	0.357	No emission	0	0.034	0.034
11 - EEA	47.4	1.63E-03	0.0775	No emission	0	0.223	0.223
12 - EEA	36.8	1.31E-03	0.0482	No emission	0	0.001	0.00139
13 - EEA	10.0	[a]	0.0226	No emission	0	0.223	0.223
14 - EEA	0.765	1.79E-02	0.0137	No emission	0	0.223	0.223
15 - EEA	28.6	[a]	0.110	[a, b]	3.24E-03	0.178	0.178
16 - EEA	18.3	[a]	0.840	No emission	0	0.223	0.223
17 - EEA	18.3	[a]	0.420	No emission	0	0.223	0.223
18 - EEA	36.5	[a]	0.626	No emission	0	0.223	0.223
19 - EEA	38.3	3.40E-02	1.30	No emission	0	0.223	0.223
20 - EEA	200	1.30E-03	0.260	No emission	0	0.223	0.223
21 - EEA	[a]	[a]	1.03 [c]	No emission	0	0.096	0.096

Site	Amount of Cr(VI) used [kg/year]	Fraction of tonnage released to air	Release to air [kg/year]	Fraction of tonnage released to water	Release to water [kg/year]	Share of air emission relevant for this use	Share of water emission relevant for this use
22 - EEA	167	5.13E-02	8.55	No emission	0	0.189	0.189
23 - EEA	3.47	[a]	0.101	No emission	0	0.117	0.117
24 - EEA	112	1.51E-02	1.68	No emission	0	0.223	0.223
25 - EEA	88.4	1.26E-03	0.112	No emission	0	0.014	0.014
26 - EEA	[a]	[a]	0.124	[a, b]	5.10E-03	0.207	0.207
27 - EEA	153	1.06E-02	1.62	No emission	0	0.223	0.223
28 - EEA	240	4.05E-05	0.00972	No emission	0	0.112	0.112
29 - EEA	2.52	2.75E-03	0.00692	No emission	0	0.113	0.113
30 - EEA	146	1.34E-02	1.95	No emission	0	0.056	0.056
31 - EEA	[a]	[a]	0.0209	No emission	0	0.096	0.096
32 - EEA	1.31	9.19E-03	0.0120	No emission	0	0.223	0.223
33 - EEA	28.2	8.39E-03	0.236	No emission	0	0.223	0.223
34 - EEA	[a]	[a]	1.19	No emission	0	0.212	0.212
35 - EEA	[a]	[a]	13.6	No emission	0	0.223	0.223
36 - EEA	[a]	[a]	0.0138	No emission	0	0.223	0.223
37 - EEA	[a]	[a]	1.64	No emission	0	0.074	0.074
38 - EEA	[a]	[a]	6.34	No emission	0	0.112	0.112
39 - EEA	[a]	[a]	8.69	No emission	0	0.112	0.112
40 - EEA	[a]	[a]	0.00295	No emission	0	0.223	0.223
41 - EEA	289	3.00E-03	0.868	No emission	0	0.104	0.104
42 - EEA	25.0	2.00E-04	0.00500	No emission	0	0.223	0.223
43 - EEA	13.2	4.20E-02	0.553	No emission	0	0.218	0.218
44 - EEA	2.55	3.64E-02	0.0931	No emission	0	0.223	0.223
45 - EEA	0.36	6.19E-03	0.00224	No emission	0	0.223	0.223
GB sites							
MIN	0.411	9.80E-05	4.02E-05	0	0.00	0.118	0.118
MAX	**85**	**4.93E-02**	**1.41E-01**	**0**	**0.00**	**0.223**	**0.223**
90th percentile	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Site	Amount of Cr(VI) used [kg/year]	Fraction of tonnage released to air	Release to air [kg/year]	Fraction of tonnage released to water	Release to water [kg/year]	Share of air emission relevant for this use	Share of water emission relevant for this use
Median	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
AM	27.7	1.25E-02	3.55E-02	0	0.00	0.199	0.199
Total (GB + EEA sites)							
MIN	0.362	4.05E-05	4.02E-05	0	0.00	0.00139	0.00139
MAX	1372	4.93E-02	13.6	n.a.[d]	0.00510	0.223	0.223
90th percentile	**236**	**3.57E-02**	**1.90**	**n.a.[d]**	**0.00** [e]	0.223	0.223
Median	28.4	2.88E-03	0.124	n.a.[d]	0.000	0.222	0.222
AM	120	1.06E-02	1.23	n.a.[d]	0.000194	0.173	0.173

n.a. = not available. 90th percentiles and medians were only calculated if data for at least ten sites were available.

[a] The fraction of tonnage released to air or wastewater is an artificial value as we have assumed placeholder tonnages, resulting in artificial release fractions and/or the emission data from the site also cover sanding, machining or media blasting (in which case the calculated release fractions are also artificial). We have not included these in the statistics because they are not meaningful.

[b] No site-specific information is available for the STP discharge rate and thus the EUSES default of 2000 m^3/day was used. No site-specific information is available for the flow rate of the receiving water and thus the EUSES default of 18 000 m^3/day was used, resulting in a dilution factor of ten in the receiving water. Application of STP sludge to agricultural soil/grassland is considered since no information to the contrary is available.

[c] Only total chromium was measured.

[d] The release fractions for the two sites with water emissions are artificial.

[e] Since only 2/43 sites have emissions to wastewater and the other sites have zero release to wastewater the AM is 0.000194, while the median and the 90th percentile are 0 kg/year.

In the following table the exposure concentrations for humans via the environment (on a local scale) are shown. Note that the exposure concentrations are based on the overall releases of the sites, of which only a certain share is generated from the use of bonding primers containing StC.

Table Annex III-2: Exposure concentrations for humans via the environment – on local scale (based on total emissions from site)

	Inhalation	Oral (drinking water and fish)		
Site	**Local Cr(VI) PEC in air [µg/m³]**	**Drinking water * [µg Cr(VI)/kg x d]**	**Fish * [µg Cr(VI)/kg x d]**	**Oral exposure (water and fish) [µg Cr(VI)/kg x d]**
1 - GB	1.01E-04	4.96E-07	6.78E-10	4.97E-07
2 - GB	9.73E-06	4.78E-08	6.56E-11	4.79E-08

	Inhalation	Oral (drinking water and fish)		
Site	Local Cr(VI) PEC in air [µg/m³]	Drinking water * [µg Cr(VI)/kg x d]	Fish * [µg Cr(VI)/kg x d]	Oral exposure (water and fish) [µg Cr(VI)/kg x d]
4 - GB	3.07E-08	1.51E-10	2.06E-13	1.51E-10
5 - GB	2.55E-04	1.25E-06	1.72E-09	1.26E-06
7 - GB	8.73E-06	4.30E-08	5.88E-11	4.31E-08
8 - EEA	2.33E-04	1.15E-06	1.57E-09	1.15E-06
9 - EEA	2.62E-07	1.29E-09	1.77E-12	1.29E-09
10 - EEA	2.72E-04	1.34E-06	1.84E-09	1.34E-06
11 - EEA	5.88E-05	2.90E-07	3.96E-10	2.90E-07
12 - EEA	3.67E-05	1.81E-07	2.48E-10	1.81E-07
13 - EEA	1.72E-05	8.48E-08	1.16E-10	8.49E-08
14 - EEA	1.04E-05	5.14E-08	7.04E-11	5.15E-08
15 - EEA	8.41E-05	1.88E-05	7.22E-08	1.89E-05
16 - EEA	6.41E-04	3.16E-06	4.32E-09	3.16E-06
17 - EEA	3.21E-04	1.58E-06	2.16E-09	1.58E-06
18 - EEA	4.78E-04	2.36E-06	3.22E-09	2.36E-06
19 - EEA	9.92E-04	4.88E-06	6.70E-09	4.89E-06
20 - EEA	1.98E-04	9.74E-07	1.34E-09	9.75E-07
21 - EEA	7.86E-04	3.86E-06	5.30E-09	3.87E-06
22 - EEA	6.53E-03	3.22E-05	4.40E-08	3.22E-05
23 - EEA	7.69E-05	3.78E-07	5.18E-10	3.79E-07
24 - EEA	5.04E-03	2.48E-05	3.40E-08	2.48E-05
25 - EEA	8.48E-05	4.18E-07	5.72E-10	4.19E-07
26 - EEA	9.43E-05	2.94E-05	1.14E-07	2.95E-05
27 - EEA	1.23E-03	6.08E-06	8.32E-09	6.09E-06
28 - EEA	7.40E-06	3.64E-08	5.00E-11	3.65E-08
29 - EEA	5.28E-06	2.60E-08	3.56E-11	2.60E-08
30 - EEA	1.49E-03	7.34E-06	1.01E-08	7.35E-06
31 - EEA	1.59E-05	7.82E-08	1.07E-10	7.83E-08
32 - EEA	9.17E-06	4.52E-08	6.18E-11	4.53E-08
33 - EEA	1.80E-04	8.86E-07	1.21E-09	8.87E-07

	Inhalation	**Oral (drinking water and fish)**		
Site	**Local Cr(VI) PEC in air [µg/m³]**	**Drinking water * [µg Cr(VI)/kg x d]**	**Fish * [µg Cr(VI)/kg x d]**	**Oral exposure (water and fish) [µg Cr(VI)/kg x d]**
34 - EEA	9.04E-04	4.46E-06	6.10E-09	4.47E-06
35 - EEA	1.04E-02	5.12E-05	7.00E-08	5.13E-05
36 - EEA	1.05E-05	5.18E-08	7.08E-11	5.19E-08
37 - EEA	1.25E-03	6.14E-06	8.40E-09	6.15E-06
38 - EEA	4.84E-03	2.38E-05	3.26E-08	2.38E-05
39 - EEA	6.62E-03	3.26E-05	4.46E-08	3.26E-05
40 - EEA	2.25E-06	1.11E-08	1.52E-11	1.11E-08
41 - EEA	6.61E-04	3.26E-06	4.46E-09	3.26E-06
42 - EEA	3.81E-06	1.87E-08	2.56E-11	1.88E-08
43 - EEA	4.22E-04	2.08E-06	2.84E-09	2.08E-06
44 - EEA	7.07E-05	3.48E-07	4.76E-10	3.48E-07
45 - EEA	1.71E-06	8.40E-09	1.15E-11	8.41E-09
GB sites				
MIN	3.07E-08	1.51E-10	2.06E-13	1.51E-10
MAX	**2.55E-04**	**1.25E-06**	**1.72E-09**	**1.26E-06**
90^{th} percentile	n.a.	n.a.	n.a.	n.a.
Median	n.a.	n.a.	n.a.	n.a.
AM	7.49E-05	3.68E-07	5.04E-10	3.69E-07
Total (GB + EEA)				
MIN	3.07E-08	1.51E-10	2.06E-13	1.51E-10
MAX	1.04E-02	5.12E-05	1.14E-07	5.13E-05
90^{th} percentile	**4.17E-03**	**2.46E-05**	**4.20E-08**	**2.46E-05**
Median	1.01E-04	9.74E-07	1.34E-09	9.75E-07
AM	1.03E-03	6.19E-06	1.13E-08	6.20E-06

n.a. = not available. 90^{th} percentiles and median were only calculated if data for at least ten sites were available.

* See explanations on oral uptake via drinking water and fish in CSR section 9.1.2.5.2

Remarks on measured exposure:

For GB, the MAX of the local exposure concentrations based on the **overall releases of the GB sites** are 2.55E-04 µg/m^3 for the PEC in air and 1.25E-06 µg Cr(VI)/kg per day for oral exposure via drinking water and fish.

For the total database, the 90th percentiles of the local exposure concentrations based on the **overall releases of the sites** are 4.17E-03 µg/m^3 for the PEC in air and 2.46E-05 µg Cr(VI)/kg per day for oral exposure via drinking water and fish.

Note that for the exposure via drinking water and fish a reduction factor of 5 was applied, as described in section 9.1.2.5.2 of the CSR.

11.4 Annex IV – Monitoring: sampling and analytical methods

Method for inhalation exposure measurements for workers

Workers monitoring campaigns are performed by accredited subcontractors who are responsible for carrying out a suitable monitoring programme using appropriate samplers based on the type of particles to be analysed. In the case of Cr(VI), an equipment designed to sample aerosol respirable fraction is used. The general principle to obtain airborne samples is by attaching battery powered pumps to individuals or in case of static measurement, in static locations. Defined air volumes are drawn through specific sample media within a sample head positioned in the individual's breathing zone or for background measurements fixed in static locations, at approximately head height, away from obstructions. The monitoring is undertaken under normal working and operating conditions where operators carry out typical work activities with direct or indirect exposure to Cr(VI) during the course of the working shift. The type and numbers of operators to be monitored (or the number and locations in case of static samples), the number of samples to be collected and the frequency of the monitoring campaign is determined by the site based on the industrial hygiene exposure assessment.

The limit of detection (LOD) and the limit of quantification (LOQ) mainly depend on the volume of air sampled and the sensitivity of the sampling equipment used and the analytical method. Therefore, a longer sampling time is preferred to achieve deposition of the substance sufficient to achieve a low LOD/LOQ. Ideally, sampling should be performed throughout the entire shift, covering the period of the Cr(VI) exposure tasks being performed.

Usually, all this information (task description of the workers, number of samples, tasks performed during the measurement, etc.) are provided in the monitoring report elaborated by the accredited subcontractor.

For inhalation exposure measurements, diverse analytical methods were used. Frequently reported sampling and analytical methods to measure Cr(VI) in air samples are MDHS14/4[30], NIOSH 7600, PN-87/Z-04126/02, PN-87/Z-04126/03 (UV-VIS spectrophotometry), ISO 16740:2005, NIOSH 7605, OSHA method 215 (ion chromatography/UV-VIS or HPLC/ICP-MS-DRC), and IFA 6665: 2014-10 (ion chromatography or UV/VIS spectroscopy).

According to the diversity of analytical methods used, the reported LOQs are heterogeneous, ranging from 0.0001 µg/m^3 to 3 µg/m^3.

Biological analysis for workers

Occupational biomonitoring of chromium consists in urinary measurements. Urine samples are collected either before and at the end of the shift or only post shift, in bottles labelled to clearly identify the workers and time of sampling. Samples are then rapidly sent to the competent laboratory for analysis within 48 hours of collection or frozen if not possible.

The most frequently used analytical method to measure chromium in urine is an inductively coupled plasma-universal cell technology-mass spectrometer (ICP-UCT-MS), performed on post-shift samples. A less frequent method reported by companies is atomic absorption spectrophotometry (AAS).

The reported LOQs are heterogeneous, ranging from 0.1 µg Cr/L (0.16 µmol Cr/mol creatinine) to 2 µg Cr/L (3.21 µmol Cr/mol creatinine).

[30] General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols, Health and Safety Executive.

Methods for environmental emission monitoring

Stack emission monitoring campaigns are conducted by accredited subcontractors. Sampling is performed directly into the duct, at a suitable location inside the stacks, from outside the building. A preliminary velocity survey is typically conducted to ensure that measurements at the sampling point meets the flow stability criteria requirements and has therefore been chosen appropriately. The sampling system comprises of an in-line stack monitoring probe containing an appropriate filter, connected via tubing to a portable precision pump set at the recommended flowrate. The probe is inserted into the duct to extract from the airstream at the centre point of the duct. The location, duration of sampling, and flow rate are recorded and usually detailed in the monitoring report. After the sampling, the filter is removed from the probe and placed into an appropriate filter holder cassette in which the sample is maintained stable until further processing. Analysis of the filters for Cr(VI) constituents in the dust is carried out by an external accredited laboratory.

For environmental emission measurements, diverse analytical methods were used. For the monitoring of Cr(VI) in air samples, the most frequently reported analytical methods are EN 14385:2004, XPX 43-136, NIOSH 7600:1994, NIOSH 7703, EN 13284-1, DIN EN 15259 (01/2008), EN 18412, EN 23210, CARB 425 1997, EPA Method 3060A:1996, PB-03 7th Edition 09.03.2018.

According to the diversity of analytical methods used, the reported LOQs are heterogeneous, ranging from 0.2 µg/m^3 to 12.8 µg/m^3.

Wastewater containing Cr(VI) are sampled after on-site treatment or before being discharged to an external municipal wastewater/sewage treatment plant either by the site or by an external subcontractor. Analysis is performed according to a standard methodology by an accredited laboratory who is responsible for calibrating the equipment and validating the method (according to existing procedures, e.g. EN ISO 10523).

For Cr(VI) monitoring in wastewater releases, only few sites reported emissions to wastewater. The described analytical methods are DIN 38405-24:1987-05, CNR IRSA Q 64 VOLUME 3 METODO 16, CNR IRSA 3150 C Man 29 2003, UNI ENI ISO 19458:2006 and EN 18412.

The reported LOQs range from 0.004 mg/L to 0.01 mg/L.

Information on methods and LOQs for individual measurements for inhalation exposure monitoring, biomonitoring and environmental emission monitoring are documented in separate spreadsheets and can be provided on request.

11.5 Annex V – Biomonitoring

Biomonitoring data for workers exposed to primers are available for numerous sites in GB. We included in our assessment all values provided directly by the sites. No data received via Art. 66 notifications to ECHA are included in the assessment due to time constraints and since follow-up questions often are not possible with the data received via Art. 66 due to anonymity of the site submitting the data. Therefore, taking into account also all the Art. 66 notifications, substantially more biomonitoring data are available to the ADCR consortium for several tasks (e.g., spraying, machining) than are reported in the CSR. However, the recorded values already provide a meaningful and representative picture for the WCS for which it is mandatory to perform biomonitoring campaigns (i.e., Sprayers, Machinists, Sanders).

Numerous data were submitted by the sites not as individual values but as group entries. The group entries were usually reported by indicating the number of values per SEG, together with MIN and MAX (sometimes also AM, median, 90th percentile), or an indication of how many values were <LOQ. In some cases, no number of measurement values was given for group entries. For these entries we assumed n = 2. For group entries we recorded the MIN (where available) and the MAX value. For values <LOQ we considered LOQ/2 and for values <LOD we considered value = LOD in case no LOQ was provided.

Biomonitoring data are available for all WCSs covered by this CSR. In total, 164 individual biomonitoring values and 184 values from 27 data sets with group entries are available for workers exposed to primers. The values assigned to the individual WCS are described in sections 0 to 9.2.3.9.2.3. Note that for some data it was reported that several tasks were performed by the workers in the days prior to sampling (e.g., spraying in a room/booth and spraying in a hangar), based on which we assigned these values to all WCS for which we describe these tasks as main tasks. Accordingly, several values are reported for more than one WCS (and the sum of the values reported for the individual WCSs is higher than the total number of values).

Generally, it is not possible to differentiate for the biomonitoring data to which primer types the worker was exposed during the days before sampling. For this reason, the values cannot be assigned individually to the different uses. However, based on the market shares, it can be assumed that over 20% of the exposure comes from the present use.

In the following table we report biomonitoring data that could not be assigned to any WCS described in the CSR as no information was provided on the activities performed by the workers prior to sampling.

Table Annex V: Biomonitoring data for unknown SEG

Individual values	
N	31
AM [µmol Cr/mol creatinine]	2.38
Median [µmol Cr/mol creatinine]	1.09
90th Perc. [µmol Cr/mol creatinine]	5.60
N > 10.0 µmol Cr/mol creatinine	2
% of data with > 10.0 µmol Cr/mol creatinine	6.45

Group entries	
N	26
Number of data sets	3
Number of datasets with individual values > 10.0 µmol Cr/mol creatinine	0

In total, 31 individual values are available, with an AM of 2.38 µmol Cr/mol creatinine and a 90th percentile of 5.60 µmol Cr/mol creatinine. Two values are above the UK BMGV of 10.0 µmol Cr/mol creatinine (as described in CSR section 9.1.2.6.2). The values are 10.2 and 11.1 µmol Cr/mol creatinine, exceeding the UK BMGV only slightly. No explanation is available for these elevated concentrations.

Twenty-six values are available as group entries from three data sets. All values are below the UK BMGV.

The presented biomonitoring data show that the overall body burden of workers belonging to the unknown SEG is low, with only two exceedances of the UK BMGV.

The biomonitoring data are not considered quantitatively for the present exposure and risk assessment due to the reasons described in section 9.1.2.6.2.

11.6 Annex VI – Respiratory protection – Assigned protection factors (APF)

The European Standard EN 529 – "Respiratory protective devices. Recommendations for selection, use, care and maintenance" provides guidance on the selection and use of RPE. It also lists "Assigned protection factors" as recommended in various European countries. Further, factors used in France are given in INRS guidance ED6106 and APFs used in UK are laid down in HSG 53. As can be seen in the table below, APFs vary numerically between countries and no generally accepted factors exist As it is not always possible to differentiate between companies using combined gas-particle or pure particle filters P3, the same APF (20) is used for half masks resp. full masks with combined gas particle filter Gas X P3 and with particle filter P3. For all ambient-air independent devices an APF of 250 is used.

We noted that large differences exist in the APFs ambient air-independent breathing apparatuses in the UK and in EEA countries. HSG 53 gives APFs ranging from 40 to 2000, whereas much larger APFs are used in several EEA countries (see Annex V). Examples:

- fresh air hose breathing apparatus (EN 138): UK: APF 40, Germany: APF 1000, Sweden: APF 500
- constant flow airline breathing apparatus with full mask (EN 14594): UK: APF 40, France: APF 250.

We asked HSE for assistance in choosing adequate APFs and were referred to the British Standards Institutions (BSI). BSI explained that these APFs were discussed many years ago and cited recent publications (Connell and Lynch, 2023). These authors describe some potential reasons for the differences, among them different types of data used (data from compliant and non-compliant programs were used according to Connell and Lynch (2023) in the UK) and the use of a safety factor. Considering these uncertainties and for the sake of a harmonised assessment of risks in the UK and the EEA based on the same type of data (an APF of 250 is used in respective ADCR EU applications for chromates in primer products, this being the lowest APF reported in an EEA country) in this report for various types of ambient air-independent breathing apparatuses (e.g. fresh air hose breathing apparatus, constant flow airline breathing apparatus with full mask or hoods/helmet demand valve compressed air breathing apparatus), an APF of 250 is used for calculating exposure concentrations.

Table Annex V-1: Assigned protection factors used for assessment

Type	Specific EU norm	Example	APFs as used in some countries according to EN 529						APF used in this report
			Fin	D	I	S	UK	FR[1]	
Filtering half mask FFP3 (non-reusable)	EN 149		20	30	30	20	20	10	**10**
Half mask with particle filter P3	EN 140 (mask) EN 143 (filter)		-	30	30	-	20	10	**10**

Type	**Specific EU norm**	**Example**	**APFs as used in some countries according to EN 529**						**APF used in this report**
			Fin	D	I	S	UK	FR[1]	
Half mask with combined gas-particle filter Gas X P3	EN 405		-	30	-	-	10	-	**10**
Full mask (all types) with particle filter P3	EN 136 (mask) EN 143 (filter)		500	400	400	500	40	30	**20**
Full mask (all types) with combined gas-particle filter Gas X P3	EN 136 (mask) EN 143 (filter)		-	400	-	-	20	-	**20**
Powered filtering device incorporating a hood or a helmet (PAPR, powered & supplied air respiratory protection) TH3	EN 12941		200	100	200	200	40	40	**40**
Powered filtering device incorporating a full mask TM3	EN 12942		1000	500	400	1000	40	60 (120 L/min) 100 (160 L/min)	**40**
Fresh air hose breathing apparatus - full mask or hood or helmet	EN 138		500	1000	400	500	40	-	**250**
Supplied-air respirator (SAR) Continuous flow compressed airline	EN 14594		-	-	-	-	40 [2]	250	**250**

Type	Specific EU norm	Example	APFs as used in some countries according to EN 529						APF used in this report
			Fin	D	I	S	UK	FR[1]	
breathing apparatus 4A/4B									
Compressed air line breathing apparatus with demand valve - Apparatus with a full face mask	EN 14593-1		1000	1000	400	1000	2000 [2]	-	**250**

[1] Source: INRS guidance ED6106
[2] Source: HSG 53

11.7 Annex VII – Factors for calculating use-specific shares

Typically, at the sites not only primer products covered by the present use but also other primer types (e.g., bonding primers) are used. In order to be able to account for workers' exposure and environmental emissions that only come from the present use, we have derived factors based on market shares of the primer types.

In the below table the amounts of chromates used per primer type in GB are shown, as they were derived in the SEA document (see SEA document for the present use).

Table Annex VII-1: Amount of chromate used in different primer types

	StC [t/year]	PCO [t/year]	PHD [t/year]
Wash primers	0.00	2.35	0.0245
Bonding primers	14.7	0.00	0.00
Primers other than wash or bonding primers	51.2	4.01	2.38
Total	66.0	6.36	2.40

From these amounts we calculated the amount of Cr(VI) per chromate used in different primer types and the sum of Cr(VI) amounts from all chromates used in different primer types, as shown in the below table. The sum of Cr(VI) used over all primer types is 18.0 tonnes per year, which we have set equal to 1.0. Relative to that amount we then calculated the fraction of Cr(VI) used per primer type, which is 0.0120 for wash primers (rounded to 0.0100), 0.209 for bonding primers (rounded to 0.210) and 0.779 for primers other than wash or bonding primers (rounded to 0.780). These relative amounts are used in worker contributing scenarios to calculate the share of worker's exposure assigned to a specific primer type.

Table Annex VII-2: Amount of Cr(VI) used per chromate in different primer types

	StC [t Cr(VI)/ year]	PCO [t Cr(VI)/ year]	PHD [t Cr(VI)/ year]	Sum Cr(VI) from all chromates [t Cr(VI)/ year]	Fraction of Cr(VI) per primer type	Rounded
Wash primers	0.00	0.211	0.00608	0.217	0.0120	**0.0100**
Bonding primers	3.76	0.00	0.00	3.76	0.209	**0.210**
Primers other than wash or bonding primers	13.1	0.360	0.590	14.0	0.779	**0.780**
Total	16.8	0.571	0.596	18.0	1.00	**1.00**

However, for one WCS these shares do not apply. Since for spray operators for manual spraying in a spray hanger (WCS 2; section 9.2.3.3) no bonding primers are used, we have adjusted the relative amounts for this WCS by distributing the annual Cr(VI) quantity for bonding primers (3.76 t Cr(VI)/year) equally between wash primers and other primers. This adjustment leads to rounded fractions of 0.120 for wash primers (2.10 t Cr(VI)/year) and 0.880 for primers other than wash or bonding primers (15.9 t Cr(VI)/year).

From the amounts of Cr(VI) provided in the above table we also calculated the relative amount of Cr(VI) used per chromate in different primer types by dividing the Cr(VI) amount used per chromate per primer type by the respective total amount of Cr(VI) per chromate. The resulting relative amounts of Cr(VI) used per chromate per primer type are shown in the below table.

Table Annex VII-3: Fraction of Cr(VI) used per chromate in different primer types

	StC	PCO	PHD
Wash primers	0.00	0.369	0.0102
Bonding primers	0.223	0.00	0.00
Primers other than wash or bonding primers	0.777	0.631	0.990
Total	1.00	1.00	1.00

These fractions are used in the environmental contributing scenario to calculate the share of environmental emission assigned per substance to a specific primer type.

For wash primers a fraction of 0.369 for Cr(VI) from PCO and a fraction of 0.0102 for Cr(VI) from PHD are considered.

For bonding primers a fraction of 0.223 for Cr(VI) from StC is considered.

For primers other than wash or bonding primers a fraction of 0.777 for Cr(VI) from StC, a fraction of 0.631 for Cr(VI) from PCO and a fraction of 0.990 for Cr(VI) from PHD are considered.

11.8 Annex VIII – Illustrations and additional information on spray facilities, LEV systems and air abatement

Open spray booth

Figure VIII-1: Open spray booth where exhaust air from three booths is emitted via one stack

Spray room

Figure VIII-2: Spray room with an installed water curtain as air abatement

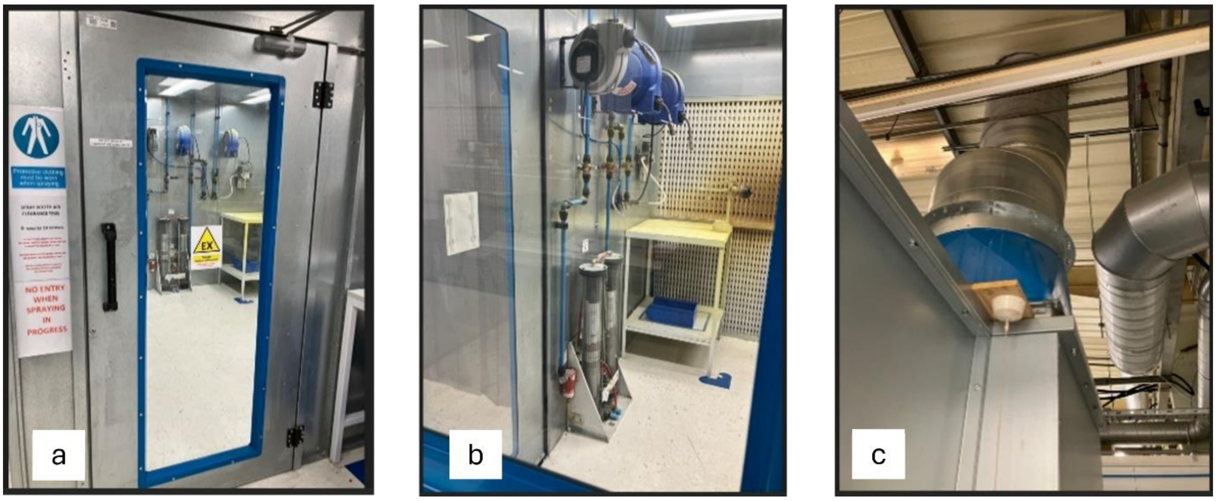

Figure VIII-3: Spray room (a) with side wall extraction (b) with exhaust air extraction via a designated stack (c)

Spray hangar

Figure VIII-4: Small spray hangar with installed side wall extraction (laminar cross flow)

Other working stations equipped with LEV

Further units and LEV systems used in paint areas include spray gun cleaning units (see Figure VIII-5), fume hoods (see Figure VIII-6) or paint mixing booths (similar to a small spray booth or room).

Figure VIII-5: Spray gun cleaning unit

Figure VIII-6: Fume hood

Machining facilities and on-tool extraction

Figure VIII-7: Industrial vacuum cleaner used for machining/sanding activities

Machining activities can also be carried out at workbenches with downdraft extraction (referred to as “extracted bench” in the CSR), as shown in Figure VIII-8. Dedicated extraction rooms or booths are also used to carry out the machining tasks. These rooms/booths are constructed in a similar way to spraying booths/rooms. In all the options presented, air abatement is achieved by filters (e.g., HEPA filters in vacuum cleaners).

Figure VIII-8: Workbench with downdraft dust extraction

Maintenance and performance criteria of LEV systems and filters

Maintenance of LEV systems and air abatements technologies include regular filter changes, which is performed by internal operators or by external contractors. Depending on the organisation at the site (e.g., types of filters installed, operation time of the LEV system, used chromate products) the filters are changed either if the filter gauge advises, the negative pressure of the spray facility or LEV system advises or, after a certain time of operation (e.g., quarterly, every 6 months or 1000 hours). The indicator-based filter replacement procedures are in place to reduce the exposure of operators involved in filter replacement. Maintenance work on the booth/room/hangar, LEV system or abatement technology (e.g., inlets, outlets, ducts, pressure control system, fans) are carried out once per week, in addition to irregular maintenance and repair requirements (e.g., failure or defects). For spray rooms with an installed water curtain, maintenance is scheduled up to twice a year and wastewater collection from these systems is scheduled for up to four times per year.

At least annual inspections and thorough testing of the LEV system/air abatement technology are carried out by an external accredited service provider. Some sites also reported that these inspections are carried out twice a year. Emission testing of the LEV and stack discharge is also performed at least annually, and some sites reported that the stack discharge complies to HSG 258.

Before starting spraying, spray operators check the LEV system for proper functioning. Several sites reported that a magnehelic system or control system for pressure is used in the spray booth/room or hangar, which also ensures the proper function and performance of the LEV and reduce the operator's exposure to overspray.

Regarding the performance criteria, several sites reported that the installed filters (e.g., cardboard filters, corrugated paper cassette filters, polyester filters, filters manufactured from thermally bonded fibres) across various types of spray facilities have an efficiency rate of 99% for all particles, including Cr(VI).

One example is presented here: A specific spray room uses dry back filters with sequential filters installed. The first filter has an efficiency of up to 98.1% and the second filter (20 mm thick, 100% polyester) with an arrestance of 93% according to DIN 24185/BS6540. After the first filter, 1.9% may escape, which is mainly captured by the second filter and only a small portion of particles of 0.133% may be unbound, resulting in an efficiency of 99.87%.

In addition, the face velocity, capture velocity and/or volumetric flow of the LEV systems are regularly monitored (and if needed appropriate measures are undertaken).

Some sites have also reported that during the annual LEV examination or emission testing, a smoke test is performed and/or the clearance time of the spray facility/LEV system of the unit (e.g., media blasting in a closed system) is determined. The clearance time is either displayed at the entrance to the spray facility/unit or the spray facilities are equipped with a mist clearance indicator, which has a red LED light array that provides a warning not to enter when hazardous products are being used during the spraying process and for 1-2 minutes after spraying has stopped.

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