Disclaimer:

The updated versions of Chemical Safety Reports (CSRs) are, where necessary, submitted to ECHA as part of the authorisation process by the applicant(s) for authorisation.

The update of the CSR by the applicant(s) may be necessary to ensure that any additional information provided by the applicant(s) to ECHA Committees (Committees for Risk Assessment and Socio-economic Analysis) during the evaluation of their application for authorisation on basis of which the authorisation was considered is reflected in the CSR.

By publication of this CSR ECHA does not endorse its content. The European Chemicals Agency does not accept any responsibility for or liability with regard to the contents of the updated CSR. The responsibility and liability for the content of the updated information remains solely with the applicant(s) as the submitter(s) of the document.

CHEMICAL SAFETY REPORT

Legal name of applicant:	*Neoperl GmbH*
Submitted by:	*Neoperl GmbH*
Substance:	*Acid generated from chromium trioxide and their oligomers, EC 231-801-5, 236-881-5*
Use title:	*The use of chromic acid in the functional electroplating of brass-made sanitary articles with the specific purpose of obtaining a final Cr(0) coating that provides a surface with high durability and chemical resistance.*
Use number:	*1*

CONTENTS

TABLES

FIGURES

LIST OF ABBREVIATIONS

ART	Advanced Reach Tool
AfA	Application for Authorisation
BGW	Biologische Grenzwerte
CAS	Chemical Abstract Service
Clocal	Local Concentration
Cr(III)	Trivalent Chromium
Cr(VI)	Hexavalent chromium or Chromium (VI)
Cr	Chromium
CS	Contributing Scenario
CSR	Chemical Safety Report
DGUV	Deutsche Gesetzliche Unfallversicherung
EC	European Commission
ECHA	European Chemicals Agency
ERC	Environmental Release Category
ES	Exposure Scenario
EU	European Union
HvE	Human via Environment
IBC	Intermediate Bulk Container
IFA	Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung
LOD	Limit of Detection
LOQ	Limit of Quantitation
MAK	Maximale Arbeitsplatz-Konzentration
PC	Product Category
PEClocal	Local Predicted Environmental Concentration
PPE	Personal Protective Equipment
PROC	Process Category
RAC	Committee for Risk Assessment
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RMM	Risk management measures
TRGS	Technische Regeln für Gefahrstoffe
TWA	8 hour Time Weighted Average
UBA	Umweltbundesamt
WCS	Worker Contributing Scenario

DECLARATION

We, Neoperl GmbH, request that the information blanked out in the "public version" of the Chemical Safety Report is not disclosed. We hereby declare that, to the best of our knowledge as of today (16th February 2021) the information is not publicly available, and in accordance with the due measures of protection that we have implemented, a member of the public should not be able to obtain access to this information without our consent or that of any third party whose commercial interests are at stake.

Dr. Thomas Schindler
General Manager

16th February 2021, Müllheim, Germany

PREAMBLE

This present AfA represents a bridging application to provide a suitable time frame for the applicant to successfully implement a Cr(VI)-free electroplating process, thereby achieving a full substitution of Cr(VI) from its production.

The AfA of Lanxess et al. (CTAC Consortium - Use 3) covers the current Use of chromic acid. No review period for this AfA has been set at the time of submitting this AfA. The applicant has started the complete substitution of Cr(VI) for their electroplating process. For details, we refer to the Substitution Plan.

The applicant's situation is outlined below:

- the role of the applicant in the supply chain, as a provider of coated brass components for the sanitary equipment industry, constrains their ability to implement substitution without aligning with their customers. Customers have specification requirements and must test and approve any modifications to the components supplied to them. Hence, the substitution programme must be conducted in close cooperation with customers to ensure that substitution is aligned along the supply chain and that all components of the final products meet the required standards of quality.

- the implementation of Cr(VI)-free electroplating processes will take approximately [redacted] to complete. This project started in [redacted] and will extend until [redacted];

- the Substitution Plan clearly shows that the Cr(VI) based electroplating operations are strictly indispensable to ensure the economic affordability of the Cr(VI)-free conversion project;

- the applicant anticipates that the review period for CTAC application will not be sufficient to complete the substitution of Cr(VI) in their operations;

- hence, the applicant submits the present AfA to enable them to continue their business while having the necessary period of time to implement the new Cr(VI)-free production plant.

Authorisation of the existing processes for the bridging period until [redacted] is crucial in order to manage the substitution of Cr(VI). A non-granted authorisation would put the Cr(VI)-free implementation plan at risk.

Part A

1 SUMMARY OF RISK MANAGEMENT MEASURES

Neoperl GmbH receives chromium (VI) through the supply chain in liquid form (chromic (VI) acid).

The substance exhibits a number of physical and acute health and environmental hazards (Ox. Sol. 1, H271, Met. corr. 1, H290, Acute Tox. 3, H301, Acute Tox. 2, H310, Acute Tox. 2, H330, Skin Corr. 1A, H314, Skin Sens. 1, H317, Resp. Sens. 1, H334, STOT SE 3, H335, Aquatic Acute 1, H400).

The substance exhibits a number of chronic hazards (harmonised classification according to Annex VI of the CLP Regulation: Muta. 1B, H340, Carc. 1A, H350, Repr. 2, H361f, STOT RE 1, H372, Aquatic Chronic 1, H410).

This chemical safety report only contains sections 1, 9 and 10. The use of chromium (VI) for chrome plating of sanitary appliances as part of an inline electroplating system has been assessed in part B of this chemical safety report. A summary of risk management measures to control worker and environmental exposure is provided below in the "Succinct Summary".

Table A-1: Succinct Table: Neoperl, Chromium (VI) Use 1

ECS and WCS	Task (ERC/ PROC)	Annual amount per site (tonnes/year)	Technical RMMs, including: *Containment, *Ventilation (general, LEV…) *Customized technical installation, etc.	Organisational RMMs, including: *Duration and Frequency of exposure *OSH management system *Supervision *Monitoring arrangements *Training, etc.	PPE (characteristics)	Other conditions	Effectiveness of waste water and waste air treatment (for ERC)	Release factors: water, air and soil (for ERC)	Detailed information in CSR (section)
ECS1	ERC5	[redacted] [10 - 15] tonnes aqueous chromium (VI) trioxide solution (chromic acid)/year, equivalent to [redacted] [1 – 3] tonnes Cr(VI)	Waste treatment: Any solid, sludge, or liquid waste containing Cr(VI) is sent to an external waste management company (licenced contractor) for disposal as hazardous waste. Cr(VI) in wastewater is reduced to Cr(III) on-site. Exhaust air from Cr(VI)-containing processes is passed through wet scrubbers or filters according to best available technique before being released to atmosphere. Containment: Strict containment of chromic acid during any (re-) filling of the chrome baths via closed, fixed piping. IBC only opened to insert / remove drum pump. During the electroplating process, the chrome baths are covered. Ventilation: General ventilation with 22.000 m^3/h nominal capacity via the central air conditioning system. Chrome baths have bath rim exhausts connected to the exhaust system. The conveyer system for the racks is encapsulated with local exhaust vented to the central air treatment unit (carriage suction). Chrome baths have local exhaust ventilation with 8.000 m^3/h. Other RMM: Chromium trioxide only purchased	Duration: 245 days / year Management System: Certified quality management system according to ISO 14001:2015, certified occupational health and safety management system according to ISO 45001:2018 and certified for environment management system ISO 50001:2018. Supervision & training: The applicant's work safety specialists conduct safety training with all workers at least once a year based on the standard operating procedures and the risk assessment results. Handling of Cr(VI) is especially emphasized to ensure safe handling. The training is documented. The effectiveness of the training is verified by regular workplace inspections. Monitoring: Air emissions are regularly measured. Cr(VI) concentration in wastewater measured before release to STP. Cr(VI) concentration at the workplace is monitored regularly. Chrome biomonitoring mandatory for plating operators.	-	Chromic acid with concentration of 500 g Cr(VI) trioxide / l.	Continuous local exhaust ventilation is routed through an exhaust wet scrubber system; legal requirements for air and wastewater emissions are met.	Water: 0.0068% = 0.1765 kg/a. Air: 0.0093% = 0.2415 kg/a. Soil: 0%.	9.1.2 and 9.2.1

ECS and WCS	Task (ERC / PROC)	Annual amount per site (tonnes/year)	Technical RMMs, including: *Containment, *Ventilation (general, LEV…) *Customized technical installation, etc.	Organisational RMMs, including: *Duration and Frequency of exposure *OSH management system *Supervision *Monitoring arrangements *Training, etc.	PPE (characteristics)	Other conditions	Effectiveness of waste water and waste air treatment (for ERC)	Release factors: water, air and soil (for ERC)	Detailed information in CSR (section)
			and used in aqueous solution. Chromic acid dosing almost completely automatically. Chrome baths have a stirrer instead of an air injector to avoid forming chrome aerosols. Wetting agent is used on chrome baths to avoid the release of chromic acid aerosols. Multiple-stage cascade rinsing implemented.						
WCS1	PROC1	-	Chromic acid is kept in separate, lockable areas to which only shift supervisors and plating operators have access.	- Duration of activity: <0.5 hour - Frequency: 2 - 4 times / year - 2 worker / shift There is no potential for exposure.	Protective clothing and safety shoes are mandatory.	Regular workplace monitoring.	-	-	9.2.2
WCS2	PROC13	-	Cr(VI) is contained within the treatment process. General ventilation with 22,000 m^3/h nominal capacity via the central air conditioning system. All chrome baths have bath rim exhausts. Conveyor system is encapsulated with local exhaust vented to the central air treatment unit (carriage suction). Local exhaust ventilation with 8,000 m^3/h. All chromium baths have a stirrer instead of an air injector to avoid forming chrome aerosols. Additionally, a wetting agent is used on all chrome baths to prevent the release of chromic acid aerosols.	WCS2 carried out by plating line operator. - 3 shifts / week - Duration: 5 to 10 minutes / shift (3 shifts per week) - Frequency: daily (5 days/week) - 2 worker /shift. Workers are skilled and receive regular training regarding chemical risk management and how to properly wear PPE. Applicant's work safety specialists conduct safety training at least once a year based on standard operating procedures and the risk assessment. The effectiveness of the training is verified by regular workplace inspections.	Protective clothing, safety shoes, and chemical safety gloves are mandatory.	Regular workplace monitoring. Mandatory medical examination.	-	-	9.2.3
WCS3	PROC4	-	General ventilation with 2 – 3 air changes / hour via the central air intake system. Plating line operators also involved	- 4 to 6 worker / shift - Duration of activity: 8h / shift (2- 3 shifts) - Frequency: 6 days / week	No Cr(VI)-specific PPE. Gloves for handling of	Regular workplace monitoring. Voluntary	-	-	9.2.4

ECS and WCS	Task (ERC / PROC)	Annual amount per site (tonnes/year)	**Technical RMMs, including:** *Containment, *Ventilation (general, LEV…) *Customized technical installation, etc.	**Organisational RMMs, including:** *Duration and Frequency of exposure *OSH management system *Supervision *Monitoring arrangements *Training, etc.	PPE (characteristics)	Other conditions	Effectiveness of waste water and waste air treatment (for ERC)	Release factors: water, air and soil (for ERC)	Detailed information in CSR (section)
			in this task; they are the only workers at this workplace who enter the plating line (catwalk).	The applicant has management systems in place ensuring high standards of industrial hygiene and housekeeping. Applicant's work safety specialists conduct safety training at least once a year based on standard operating procedures and the risk assessment. The effectiveness of the training is verified by regular workplace inspections.	finished parts.	medical examination.			
WCS4	PROC8b	-	General ventilation with 2 – 3 air changes / hour via the central air conditioning system. Strict containment of chromic acid during any (re-) filling of Cr(VI)-containing baths via closed, fixed piping. IBC only opened to insert/remove drum pump.	WCS4 is carried out by one plating operator. - 2 worker / shift - Duration of activity: 1 -2 minutes - Frequency: 6-9 times / year Workers are skilled and receive regular training regarding chemical risk management and how to properly wear PPE. Applicant's work safety specialists conduct safety training at least once a year based on standard operating procedures and the risk assessment. The effectiveness of the training is verified by regular workplace inspections.	Protective clothing, safety shoes, and chemical safety gloves are mandatory. Respiratory protection with (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D with 99,95 % efficiency.	Mandatory medical examination.	-	-	9.2.5
WCS5	PROC8b	-	General ventilation with 2 - 3 air changes / hour via the central air conditioning system. Wastewater treated to reduce Cr(VI) to Cr(III) (fully enclosed process). Other process waste is stored in closed containers, which are collected by licensed waste management companies	WCS5 is carried out by the plating line operator. - 1 worker / shift - Duration of activity: 0.5 hours - Frequency: 2 – 3 / day (5 days / week)	Protective clothing, safety shoes are mandatory.	Regular workplace monitoring. Mandatory medical examination.	-	-	9.2.6

ECS and WCS	Task (ERC / PROC)	Annual amount per site (tonnes/year)	Technical RMMs, including: *Containment, *Ventilation (general, LEV…) *Customized technical installation, etc.	Organisational RMMs, including: *Duration and Frequency of exposure *OSH management system *Supervision *Monitoring arrangements *Training, etc.	PPE (characteristics)	Other conditions	Effectiveness of waste water and waste air treatment (for ERC)	Release factors: water, air and soil (for ERC)	Detailed information in CSR (section)
WCS6	PROC8b	-	Cr(VI) is contained within the treatment process. General ventilation with 22,000 m^3/h nominal capacity via the central air conditioning system. All chrome baths have bath rim exhausts. Conveyor system is encapsulated with local exhaust vented to the central air treatment unit (carriage suction). Local exhaust ventilation with 8,000 m^3/h. All chromium baths have a stirrer instead of an air injector to avoid forming chrome aerosols. Additionally, a wetting agent is used on all chrome baths to prevent the release of chromic acid aerosols.	WCS6 is carried out by the plating line operator. - 1 worker / shift - Duration of activity: 0.5 hours - Frequency: 1 - 2 / month Workers are skilled and receive regular training regarding chemical risk management and how to properly wear PPE. Applicant's work safety specialists conduct safety training at least once a year based on standard operating procedures and the risk assessment. The effectiveness of the training is verified by regular workplace inspections. There is no plating activity during sampling.	Protective clothing, safety shoes, and chemical safety gloves are mandatory. Respiratory protection with (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D with 99,95 % efficiency.	Regular workplace monitoring. Mandatory medical examination.	-	-	9.2.7
WCS7	PROC15	-	-	-	-	-	-	-	9.2.8
WCS8	PROC28	-	Cr(VI) is contained within the treatment process. General ventilation with 22,000 m^3/h nominal capacity via the central air conditioning system. All chrome baths have bath rim exhausts. Conveyor system is encapsulated with local exhaust vented to the central air treatment unit (carriage suction). Local exhaust ventilation with 8,000 m^3/h. All chromium baths have a stirrer instead of an air injector to avoid forming chrome aerosols.	WCS8 is carried out by the plating line operator. - 2 worker / shift - Duration of activity: 10 minutes - Frequency: 1 / week Workers are skilled and receive regular training regarding chemical risk management and how to properly wear PPE. Applicant's work safety specialists conduct safety training at least once a year based on standard operating procedures and the risk assessment. The effectiveness of the training is verified by regular workplace inspections.	Protective clothing (long sleeves), safety shoes, and chemical safety gloves are mandatory. Respiratory protection with (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D with 99,95 % efficiency	Mandatory medical examination.			9.2.9

ECS and WCS	Task (ERC / PROC)	Annual amount per site (tonnes/year)	Technical RMMs, including: *Containment, *Ventilation (general, LEV…) *Customized technical installation, etc.	Organisational RMMs, including: *Duration and Frequency of exposure *OSH management system *Supervision *Monitoring arrangements *Training, etc.	PPE (characteristics)	Other conditions	Effectiveness of waste water and waste air treatment (for ERC)	Release factors: water, air and soil (for ERC)	Detailed information in CSR (section)
			Additionally, a wetting agent is used on all chrome baths to prevent the release of chromic acid aerosols.						
WCS9	PROC28	-	General ventilation with 22,000 m^3/h nominal capacity via the central air conditioning system. During WCS9, the plating process is disabled and the baths are completely drained.	WCS9 is carried by the plating line operator. - 3 internal plus 3 external worker - Duration of activity: 8 hours (internal worker), 8 hours (external worker) - Frequency: 2 times/year (internal and external worker)	Protective clothing (long sleeves), safety shoes, and chemical safety gloves are mandatory. Respiratory protection with (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D with 99,95 % efficiency	Mandatory medical examination.	-	-	9.2.10

2 DECLARATION THAT RISK MANAGEMENT MEASURES ARE IMPLEMENTED

The applicant implements the risk management measures that are discussed in Section 9 of Part B of this document.

3 DECLARATION THAT RISK MANAGEMENT MEASURES ARE COMMUNICATED

The risk management measures mentioned in section 9 of part B are communicated to all involved Neoperl employees and any affected third party.

Part B

The present application for authorisation (AfA) is submitted for chromic acid; the aqueous solution of chromium trioxide.

Table B-1: Substance identity

EC number	231-801-5
CAS number	7738-94-5
CAS name	Chromic acid
IUPAC name	Dihydroxy(dioxo)chromium
Molecular formula	CrH_2O4
Molecular weight	118.01 g/mol

Composition of the substance

The applicant uses an aqueous solution of chromium trioxide (chromic acid, H_2CrO_4) with a concentration of 50% by weight.

9 EXPOSURE ASSESSMENT (AND RELATED RISK CHARACTERISATION)

9.1 Introduction

According to Article 62 (4)(d) of the REACH regulation, an application for authorisation (AfA) shall include, unless already submitted as part of the registration, a chemical safety report in accordance with Annex I covering the risks to human health and/or the environment from the use of the substance(s) arising from the intrinsic properties specified in Annex XIV, which is for chromium trioxide carcinogenic (Cat. 1A) and mutagenic (Cat. 1B). Therefore, this CSR focuses on the carcinogenicity and mutagenicity endpoints, whereby the mutagenicity endpoint is covered by the carcinogenicity because the mutagenicity is considered to be only a contributory factor in the carcinogenic process.

The carcinogenicity of chromium trioxide is driven by the Cr(VI) ion. The leading health effect is lung cancer by the inhalation route. Gastrointestinal cancer is also identified by the oral route. The Risk Assessment Committee (RAC) published that based on the available data chromium (VI) is considered as non-threshold carcinogen [1].

The applicant is a downstream user for chromium trioxide and the substance is only used by workers as industrial use at the applicant´s facility in Müllheim, Germany. For workers, the relevant exposure route is inhalation and exposure via oral route is generally not considered. The risk for gastrointestinal cancer is lower than for lung cancer [1]. Thus, the "protective measures" to minimize the risk for lung cancer also cover the risk for gastrointestinal cancer. There are no data to indicate that dermal exposure to chromium trioxide presents a cancer risk to humans [1].

There is no Cr(VI) present in the final product, and thus also not in any of the final end products of the downstream users. Consequently, downstream exposure and consumer exposure is not applicable.

The aim of the CSR is to demonstrate minimization of risk, reducing exposure for the use applied for and high awareness of workplace hygiene in compliance with stringent regulatory requirement of the use of the chromium (VI) compound at the applicant´s facility in Müllheim, Germany. The applicant performed the risk assessment in accordance to the Reference Dose Response Relationship as proposed by RAC [1].

An evaluation of the environmental risk is not required within the framework of this authorisation application. Strict emission control measures to avoid emissions into the environment are in place. The only relevant direct exposure path is for workers via the air and through inhalation. An indirect exposure path for humans via the environment might occur via food and water. The hazard information for the risk assessment for Humans via the Environment is based on the Reference Dose Response Relationship provided by ECHA in the RAC opinion document [1] and described in section 9.2.1.3.

9.1.1 Overview on USE 1

This exposure assessment addresses the use of chemical compounds containing hexavalent chromium (Cr(VI)) at the Neoperl site in Germany. It comprises one use:

- USE 1 - The use of chromic acid in the functional electroplating of brass-made sanitary articles with the specific purpose of obtaining a final Cr (0) coating that provides a surface with high durability and chemical resistance.

Neoperl GmbH (hereafter referred to as ´the applicant´) uses chromium trioxide solution (chromic (VI) acid). In this CSR, chromium trioxide solution is abbreviated as ‘Cr(VI)’ which refers to the hexavalent chromium in the medium. Chromic acid dosing is done almost completely automatically and under rigorous containment (see Section 9.2.2 to 9.2.11).

USE 1:

The applicant uses Cr(VI) for the application of a functional chrome layer with decorative character by electroplating on brass substrates at its plant in Müllheim, Germany. Sanitary objects such as faucet aerators, diverters and shower hoses are coated with sublayers of nickel before the chromium finish is applied.

Figure 9-1: Chrome plated parts

Technical function of plating:

- The bright chrome surface layer as deposited on the brass exhibits a characteristic grain structure and thickness of 0.2 to 1µm. Chromium has been chosen because of its resistance against corrosion, wear, and chemicals. The longevity and the colour consistency are one of the main reasons that the bright appearance of the chrome is the standard of the global industry for sanitary installations for which the brass parts are used.
- The chrome plating as applied has multiple properties, such as corrosion protection, chemical resistance, good wear and abrasion properties, mirror-like surface and it provides a high level of adhesion to the underlying base plated surfaces.

9.1.1.1 Chrome Plating Process General Description

The chrome plating process on the applicant's site is integrated into an electroplating process, which involves two manual steps (1 and 9), and in the automated lines combines eight subsequent treatment steps including nickel plating and rinsing baths. Cr(VI) is used in the process steps 5 and 6.

1) Loading of racks (manual/automated)
2) Automated move of the racks into the automated inline plating system
3) Surface cleaning and degreasing of the brass parts (alkaline dip, ultrasonic cleaning, anodic cleaning)
4) Deposition of sublayers (electroplating of nickel on brass)

5) **Chrome-activation (after Ni-plating)**
6) **Deposition of a thin shiny chromium layer on substrate by electroplating;**
7) Cascaded water rinsing to remove excess electrolyte in several subsequent steps;
8) Drying and automated moving to the unloading station
9) Unloading of racks (manual / automated) and quality control of chrome-plated parts

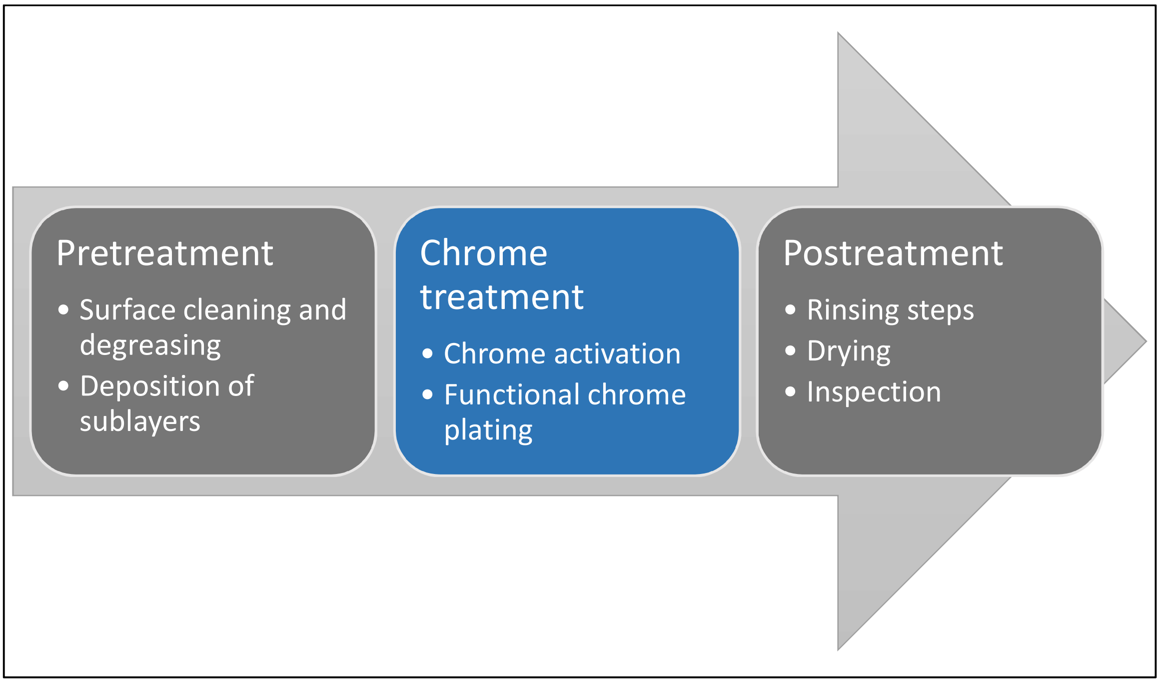

Figure 9-2: Overview of process steps – process steps involving Cr(VI) coloured in blue

Cascaded water rinsing to remove excess electrolyte in several subsequent steps to ensure 100% efficiency of rinsing of final articles. There is no drag-out of contaminated liquids with the product.

Multiple-stage cascade rinsing implemented:

9.1.1.2 Description of the Activities and Technical Processes Covered in the Exposure Scenarios

This CSR covers all work activities within the production facility and in proximity to the electroplating baths, attaching the brass parts on the racks, and those activities that require handling of Cr(VI) (e.g. sampling and maintenance). Other activities that are not related to Cr(VI), but to other metals (e.g. nickel), are not in scope of this assessment.

Operating conditions and risk management measures (RMM) are optimized to limit worker exposure (inhalation and dermal) to various components in the treatment solution and potential environmental exposure. Local exhaust ventilation (LEV) and use of mist suppressants are technical means to minimize concentrations of Cr(VI) and other components of treatment solutions in workplace air. Using wetting agent (Proquel OF) chemical fume suppressant reduces Cr(VI) emissions at the surface of the electroplating bath by producing a foam film around the anode and cathode and reducing the surface tension. Thus, Cr(VI) air emissions to the environment and employee occupational exposure are effectively reduced. The facilities also specify personal protective equipment (PPE) to minimize potential inhalation and dermal exposure. Equipment is maintained regularly.

Workers are skilled and receive regular training regarding chemical risk management and how to properly wear PPE.[1] The applicant has management systems in place ensuring high standards of industrial hygiene and

[1] The applicant’s work safety specialists conduct safety training with all workers at least once a year based on the standard operating procedures and the risk assessment results. Handling of Cr(VI) is especially emphasized to ensure safe handling. The training is documented. The effectiveness of the training is verified by regular workplace inspections.

housekeeping.[2]

9.1.1.3 Tonnage Information

The tonnage information of past and future amounts is compiled in Table 9-1.

Table 9-1: Tonnage information

Year	Purchased Volume of Chrome(VI)trioxide (solid)	Purchased Volume of Chrome(VI)trioxide (aqueous solution)
2017 - 2019	[redacted] [1-4] t	-
Since mid-2020	-	[redacted] [10-15] t

9.1.1.4 Types of exposure assessed and controlled

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

Table 9-2: Overview of exposure scenario and contributing scenarios (USE 1)

Identifiers	Market Sector	Title of exposure scenarios and the related contributing scenarios	Tonnage (t per year)
ES1	PC14	Bright chrome plating of brass sanitary objects - Use at industrial site - Functional chrome plating with decorative character (ERC 5) - PROC 1: Delivery and storage of raw material - PROC 13: Operation of automated plating line - PROC 4 Loading and unloading of racks (manual) - PROC 8b: Transfer of Cr(VI) - Decanting into dosing tanks and refilling baths - PROC 8b: Waste and wastewater treatment - PROC 8b: Sampling - PROC 15: Analysis of baths in laboratory - PROC 28: Regular Maintenance - Cleaning, repair and maintenance at the plating baths - PROC 28: Rare maintenance - Overhaul of plating lines	[redacted] [10 - 15] tonnes aqueous chromium (VI) trioxide solution (chromic acid)/year, equivalent to [redacted] [1 – 3] tonnes Cr(VI)

[2] The applicant has a certified quality management system according to ISO 9001:2015, a certification for occupational health and safety management system ISO 45001:2018 and a certification for environment management system ISO 14001:2015.

9.1.2 Introduction to the assessment

Explanation on the Approach Taken for the Exposure Scenario

Exposure estimates are based on measured data or are calculated with Advanced Reach Tool (ART) version 1.5.

The applicant measures residual Cr(VI) concentration in wastewater as requested by local regulations and exhaust air. These gathered data are used to determine environmental releases, and are the basis of the Human via the Environmental risk calculation (HvE) (see Annex I – Environmental Release Concentrations).

Cr(VI) is contained within the treatment process. Water used to rinse out the equipment is collected and disposed of as hazardous waste in an appropriate facility. Reductive treatment of any wastewater containing Cr(VI) additionally ensures negligible release of Cr(VI) to water. This is reflected in the environmental contributing scenario in section 9.2.1.

Cr(VI) concentration at the workplace is monitored. Recent monitoring data are available for 2020 from the applicant, and expressed as Cr(VI). Both static and personal air sampling were conducted. In addition, older monitoring data from 2015 are available. In 2018, the exhaust-ventilation system was renewed, bath rim exhausts were installed and the electroplating baths got a cover to ensure the best possible suction. The values obtained in 2015 from the static air sampling in the electroplating area are about twice as high as the recent values obtained in 2020, which is due to the renewal operations in 2018. The static air sampling values for air emission obtained in 2015 were not taken into account for the calculations, because they do not reflect the current situation on the applicants´ site. For the sake of completion, the available monitoring data for 2015 are shown in Annex II – Workplace Concentrations. Detailed information is provided in each contributing worker scenario.

Biomonitoring of hazardous substances is regulated in the German *Bekanntmachung von Arbeitsmedizinischen Regeln AMR 6.2 Biomonitoring* (February 2014) [2]. Thresholds for hazardous substances in urine and blood are given in the Technical Rule TRGS 903 *Biologische Grenzwerte* (BGW), amended March 2020, which does not contain a threshold for Cr(VI). The *Handlungsanleitung für die arbeitsmedizinische Vorsorge nach dem Berufsgenossenschaftlichen Grundsatz G 15 „Chrom-VI-Verbindungen"* DGUV 240/150 März 2009 [3], states a general population background concentration of 0.6 µg total Chromium per liter urine (normal concentration with creatinine of 0,3 – 3 g/l), established by the German MAK commission as biological reference value (*Biologischer Arbeitsstoff-Referenzwert* (BAR)) [4]. A concentration of 12 µg/l total Cr in urine and a concentration of 9 µg/l total Cr in blood is given as an exposure equivalent to a workplace air concentration of 30 µg/m^3 Cr(VI)trioxide (16 µg/m^3 Cr(VI)) [4].

Biomonitoring of chromium concentration in urine / blood is obligatory for electroplating employees and is carried out by the occupational physician. A urine level of 1 µg in urine and 3.7 µg in blood total Cr/l is used by the applicant´s medical department as reference value and triggers further measures at the discretion of the physician. Exceedance of the reference value will raise a "concern" in the examination report and then trigger a shortened interval for re-monitoring. Records are personal confidential medical data and not released by the doctor.

It is not possible to clearly assign biomonitoring results to certain activities. There are still technical challenges associated with biomonitoring data for hexavalent chromium. Concentrations derived from urine measurements represent a total level of chromium, since hexavalent chromium is reduced to trivalent chromium in the human body. Thus, Cr(VI) and Cr(III) cannot be distinguished in urinary samples. Regarding blood measurement, Cr(VI) can be specifically measured in red blood cells. However, the sensitivity is low, especially compared to plasma chromium concentrations, which itself is limited by its lack of specifity.[3],[4] Thus, concentrations derived from the measurements represent a total level of chromium. Biomonitoring is not further used for the quantitative risk assessment in this CSR. Annex III – Biomonitoring Data shows individual data from electroplating operators.

9.1.2.1 Environment

Scope and type of assessment

As there are no environmental endpoints specified in Annex XIV of the REACH Regulation, an evaluation of potential hazards to the environment is not required within the framework of this authorisation application. However, for reasons of completeness the applicant decided to provide this assessment.

Measures to prevent and limit release of Cr(VI) to the environment are provided as best practise at the applicant's site. Data demonstrate that environmental releases of Cr(VI) are well controlled. These data are reported in the environmental exposure scenario ES-EC1 in section 9.2.1.

In general, the treatment technology of wastewater on site reducing Cr(VI) to Cr(III) is highly effective. Thus, the residual concentrations of Cr(VI) in the effluent are mainly below the detection limit (0.005 mg/l). The exact process of wastewater treatment is further described in section 9.2.1.

Environmental releases of Cr(VI) to the air are well controlled. All workspaces with potential release to air are equipped with exhaust ventilation systems to

---

[3] https://www.hbm4eu.eu/the-substances/chromium-vi/ (accessed December 2020)

[4] SCOEL/REC/386 Chromium VI compounds, 2017

remove residual particles. Airwasher clean the air before release in to the environment.

9.1.2.2 Human via the Environment

Scope and type of assessment

Health hazard may potentially arise due to exposure of the general population via the environment. Because Cr(VI) is neither directly nor indirectly released to soil, exposure via soil is therefore considered negligible. The relevant potential exposure path is via the air through inhalation and oral exposure via food and water.

The scope of exposure assessment and type of risk characterization required for Human via the Environment are given in Table 9-3.

Further details of the assessment Human via the Environment is provided in section 9.2.1.3.

Table 9-3: Type of risk characterization required for Human via the Environment (USE 1)

Route of exposure	**Type of risk characterisation**	**Hazard conclusion** **dose – response relationship (see RAC/27/2013/06 Rev.1) [1]**
Inhalation: Systemic, long-term (based on the assumption, that all inhaled material is respirable (worst case)	Quantitative (dose-response curve)	Relevant dose response curve, starting with zero excess risk at zero exposure, based on excess lifetime lung cancer mortality risk: **Exposure to 1 µg/m3 Cr (VI) relates to an excess risk of** **2.9 x 10-2** (based on 70 years of exposure; 24hr/day)
Oral: Systemic long-term	Quantitative (dose-response curve)	Relevant dose response curve, starting with zero excess risk at zero exposure, based on excess lifetime small intestine mortality risk: **Exposure to 1 µg/kg bw/day Cr (VI) relates to an excess risk of** **8 x 10-4** (based on 70 years of exposure; 24hr/day)

<u>Comments on assessment approach:</u>

For the risk assessment, it is assumed that all particles are in the respirable size range, thus no exposure via oral route due to inhalation of particles needs to be considered. In addition, the excess lifetime risk for intestinal cancer via oral route is more than one order of magnitude lower than that for lung cancer. Therefore the assessment of health impacts related to Human via the Environment is dominated by the potential risk of lung cancer via inhalation of Cr(VI). Food chain through drinking water and fish is assessed quantitatively.

Detailed information is provided in the environmental contributing scenarios section 9.2.1.

9.1.2.3 Workers

Scope and type of assessment

Cr(VI) is classified for several human health endpoints (H301, H310, H330, H314, H317, H334, H335, H340, H350, H361f and H372). For the purpose of the AfA, the focus of the assessment relates to the two endpoints Mutagenicity and Carcinogenicity as specified in Annex XIV of the REACH Regulation.

The scope of exposure assessment and type of risk characterization required for workers are described in Table 9-4.

Table 9-4: Type of risk characterization required for workers (USE 1)

Route of exposure	**Type of risk characterisation**	**Hazard conclusion** **dose – response relationship (see RAC/27/2013/06 Rev.1) [1]**
Inhalation: Systemic, long-term (based on the assumption, that all inhaled material is respirable (worst case)	Quantitative (dose-response curve)	High hazard (no threshold derived) Relevant dose response curve, starting with zero excess risk at zero exposure, based on excess lifetime lung cancer mortality risk: **Exposure to 1 µg/m3 Cr (VI) relates to an excess** **risk of 4 x 10-3** (based on 40 years of exposure; 8hr/day; 5 days/week)
Oral: Systemic, long-term	Quantitative (dose-response curve)	High hazard (no threshold derived) Relevant dose response curve, starting with zero excess risk at zero exposure, based on excess lifetime small intestine mortality risk: **Exposure to 1 µg/kg bw/day Cr (VI) relates to an excess risk of 2 x 10-4** (based on 40 years of exposure; 8hr/day; 5days/week)

Comments on assessment approach related to toxicological hazard:

The inhalation exposure is based on monitoring data at the actual workplaces to which this safety assessment applies or are based on ART modelling if no measurements are available.

Personal measured values are given in terms of Cr(VI) and are expressed as 8 hour Time Weighted Average (TWA).

Comments on assessment approach related to physicochemical hazards:

Not applicable. Physicochemical hazards are not subject to this CSR.

General information on risk management related to toxicological hazard:

Potential exposure of workers handling Cr(VI) during industrial use is restricted to the lowest possible level.

Only trained personnel are allowed to work in the electroplating and waste handling area. Staff are trained at least annually (and additionally when needed) according to an approved standard operating procedure.

Aqueous solutions of CrO_3 (chromic acid) have a low potential for generating mists. Nevertheless, wearing full face mask is mandatory for tasks that involve handling the Cr(VI) solution.

The following general risk management measures are implemented at the applicant`s site:

- Plating bath areas (catwalk, liquids handling and treatment) are enclosed or fenced.
- For all activities, a good standard of occupational hygiene is implemented. Employees are instructed, aware of the hazards and supervised to:
  - Avoid any direct contact with the chromic acid, Cr(VI) containing wastewater or contaminated parts;
  - Wear protective gloves and full face mask when direct contact with the substance is likely;
  - Wash off skin contamination immediately;
  - Avoid splashes and spills;
  - Avoid contact with contaminated tools and objects;
  - Clean up contamination/spills as soon as they occur;
  - Ensure regular cleaning of equipment and work area;

- The minimum standard of personal protective equipment are protective clothing, safety shoes, chemical-resistant gloves, and suitable eye protection.
- Annual training, covering, in particular, chemical hazards, hygiene practices to prevent / minimise exposure and to report any problems that may develop, is provided to all involved operators (plating, line, wastewater and maintenance staff). Employees who use respirators are trained in the proper storage, use and maintenance of the filter masks. This includes practical exercises with the masks and a qualitative fit test.
- Operators involved in plating activities are examined by biomonitoring annually (Cr is tested in urine and blood). All employees involved in the uses as described herein are registered in an internal database.

Operational conditions and risk management measures are provided in each of the contributing scenarios in section 9.2.

Personal Protective Equipment for activities with potential increased exposure levels

Respiratory protection:		Full face mask Dräger Panorma Nova, EN 138:1998, CL3 EPDM; XXX Filter: M45x3 A2B2E2K2Hg P3 R D with 99,95 % efficiency

Dermal protection:		DuPont Personal Protection, Tyvek®, Classic Plus Model CHA5, Protective Clothing Category III (Type 4B, Type 5, Type 6)
Dermal protection:		Chemical resistant nitrile gloves, Tricotril® 736, EN 388, EN 374-5

9.1.2.4 Consumers

<u>Scope and type of assessment:</u>

Chromium is deposited as a metal and lies on the carrier material (e.g. metal) as an end surface in neutral form, Chromium (0), and is therefore non-toxic. Therefore, there is no potential danger for users and consumers.

9.2 Exposure scenario ES1: Bright chrome plating of brass sanitary objects

The release of Cr(VI) to the environment is carefully controlled by the applicant and for release to water additionally monitored by regulators.

Table 9-5: Use descriptors applicable to this exposure scenario

Environment contributing scenario(s)		
ES1-ECS1	ERC5	Bright chrome plating of brass sanitary objects
Worker contributing scenario(s)		
ES1-WCS1	PROC1	Delivery and storage of raw material
ES1-WCS2	PROC13	Operation of automated plating line
ES1-WCS3	PROC4	Loading and unloading of racks (manual)
ES1-WCS4	PROC8b	Transfer of Cr(VI) - Decanting into dosing tanks and refilling baths
ES1-WCS5	PROC8b	Waste and wastewater treatment
ES1-WCS6	PROC8b	Sampling
ES1-WCS7	PROC15	Analysis of baths in laboratory
ES1-WCS8	PROC28	Regular Maintenance Cleaning, repair and maintenance at the plating baths
ES1-WCS9	PROC28	Rare maintenance Overhaul of plating lines

<u>Description of the activities and technical processes covered in the exposure scenario:</u>

A general description of the activities and technical processes is given in the introduction section 9.1. Further details on activities and processes are provided in the respective contributing scenarios.

<u>Explanation on the approach taken for the exposure scenario:</u>

Occupational exposure estimates are based on measured data or are calculated with Advanced Reach Tool (ART) version 1.5. Static measurements directly at the Cr(VI) electroplating baths are used to mark the worst case.

The applicant measures residual Cr(VI) concentration in wastewater as requested by local regulations and exhaust air. These gathered data are used to determine environmental releases, and are the basis of the Human via the Environment risk calculation.

Cr(VI) is contained within the treatment process. Water used to rinse out the equipment is collected and recycled, or disposed of as hazardous waste in an appropriate facility. Reductive treatment of any waste containing Cr(VI) additionally ensures negligible release of Cr(VI) to water. This is reflected in the environmental contributing scenario below.

Cr(VI) concentration at the workplace is monitored. Monitoring data are available for 2015 and 2020. Monitoring data from 2015 are not used for the risk calculation which is further explained in section 9.1.2. For the sake of completion, the available monitoring data 2015 are shown in Annex II – Workplace Concentrations.

In total 39 employees are involved in the working scenarios covered by this authorisation. The emission source for nine employees is near field exposure, for 26 employees far field exposure and for four employees near and far field exposure. Table 9-6 gives an overview of the number of employees related to the workplace scenarios.

Table 9-6: Number of Workers Related to the Working Scenarios

Workplace Scenario	Use description	Number of workers involved	Number per Shift	Overlaps of employees
WCS1	Delivery and storage of raw material	4	2	-
WCS2	Operation of automated plating line	4	2	Same employees as listed under WCS1 "Number of workers involved"
WCS3	Loading and unloading of racks	25-30	4-6	4 employees, same as listed under WCS1 "Number of workers involved"
WCS4	Decanting into dosing tanks and refilling baths	4	2	Same employees as listed under WCS1 "Number of workers involved"
WCS5	Waste and wastewater treatment	4	1	Same employees as listed under WCS1 "Number of workers involved"
WCS6	Sampling	4	1	Same employees as listed under WCS1 "Number of workers involved"
WCS7	Analysis of baths in laboratory	4	1	Same employees as listed under WCS1 "Number of workers involved"
WCS8	Regular Maintenance – Cleaning, repair and maintenance at the plating bath	4	2	Same employees as listed under WCS1 "Number of workers involved"

Workplace Scenario	Use description	Number of workers involved	Number per Shift	Overlaps of employees
WCS9	Rare maintenance – Overhaul of plating lines	10	3 (per session)	4 employees, same as listed under WCS1 "Number of workers involved"
	Rare maintenance – Overhaul of plating lines (licenced external company)	3	3 (per session)	-
Total number of employees		**39**		

Notes: only 4 employees are permanently involved directly in plating operations (WCS2) during the year. Maximum 30 employees are involved in WCS 3 and maximum 26 employees of them are involved in WCS 3 only. 6 employees (not working as plating line operators) are involved in WCS 9 "Rare maintenance Overhaul of plating lines" only.

9.2.1 Environmental contributing scenario ES1-ECS1: Bright chrome plating of brass sanitary objects

9.2.1.1 Condition of use

Amount used, frequency and duration of use
• Annual use at site: [redacted] [10 – 15] t of Cr(VI) acid with concentration of 500g Cr(VI) trioxide/l • Daily use at site (Cr(VI)): [redacted] [9 – 13] kg Cr(VI) / day [[redacted] [10 – 15] t H_2CrO_4 / year = [redacted] [1 – 4] t Cr(VI) / year = [redacted][9 – 13] kg Cr(VI) / day] Plating line operation: 245 days/year
Conditions and measures related to sewage treatment plant
• About 3600 m³ of wastewater per year are produced in the electroplating process. Wastewater is treated semi-automated in a batch process (Figure 9-3), which is continuously monitored by the plant operator. Only the control panel has to be operated manually. The plant operator records any incidents and monitoring results in the WWTP logbook.

- The wastewater is separated by type and composition and distributed to the respective collection tanks that are connected via pumps with the wastewater pre-treatment plant located underneath of the plating line. An additional separation of the wastewater generated in the electroplating takes place into chrome-containing and acid/alkaline wastewater. In a first step, wastewater is treated with sodium bisulphite to reduce Cr(VI) to Cr(III). The reducing agent is dosed with a slight excess, to achieve almost complete stoichiometric conversion. Reduction is performed and controlled by pH adjustment. In addition to the pH value measurement to set the required pH value of approximately 2.3, a redox electrode is also immersed in the solution, which shows the equivalence point. The potential of the solution changes significantly and the colour of the solution changes from red-brown to blue-green. After a period of 10 minutes, there must be no change in the potential or the pH value, to ensure that no reverse reduction can occur. The plant operator confirms the success of the chromium reduction and stops the treatment program. The treatment of wastewater can be continued. In a second step, acid/alkaline waste water is added, pH is increased and Cr(III) is precipitated as hydroxide. In order to avoid a reverse reaction in the neutralized wastewater (pH 9 – 9.5), sodium dithionite is added. In a third step, sludge is separated by means of a filter press, the resulting water is pumped through a gravel filter, processed with a cation-exchanger and pH is adjusted. Batches of wastewater are sampled, tested, and then released to the municipal sewer system.
- The treatment process is very efficient and the concentration of Cr(VI) is very low. The wastewater legal threshold is 0.1 mg Cr(VI)/l. The available monitoring data shows concentrations of Cr(VI) below 0.05 mg Cr(VI)/l (see Annex I – Environmental Release Concentrations).

Conditions and measures related to treatment of waste

- Solid material contaminated with Cr(VI) is classified and treated as hazardous waste according to EU and national regulations.
- Any solid, sludge, or liquid waste resulting from on-site wastewater treatment is sent to an external waste management company (licensed contractor) for disposal as hazardous waste. Sludge is analysed according to EPASWMethode3060A and DIN38405-T24(D24), respectively. Where Cr(VI) is under the detection limit, sludge is recycled to recover valuable materials (e.g. nickel). Emissions from the waste path are therefore negligible and are not further considered for the risk assessment.

Licensed contractor company: World Resources Company (WRC) GmbH (sludge waste), Remondis GmbH (liquid and solid waste)

Conditions and measures related to treatment of exhaust air

- For general ventilation of the plating area, fresh air is supplied with a total throughput of 22.000 m^3 / h via the central air conditioning system Figure 9-4)
- During the electroplating process, the baths are closed to ensure the best possible suction via the local exhaust ventilation (Figure 9-5). All chrome baths have bath rim exhausts that are connected to the exhaust system.
- Above the chrome plating baths, the conveyor system is encapsulated with local exhaust vented to the central air treatment unit (carriage suction). This prevents the release of chromic acid vapours when the racks are lifted out of the bath (Figure 9-6).
- The total exhaust air from Cr(VI)-containing processes is cleaned with a scrubber. The scrubber water is reused and feeds via a closed system into the cascaded water rinsing system.
- The chromium baths employ mechanical agitation by mechanical stirrer instead of an air injector to avoid forming chrome aerosols.

- Additionally, as described in section 9.1.1.2 a wetting agent is used on all chrome baths to prevent the release of chromic acid aerosols.
- The treatment process is very efficient and the concentration of Cr(VI) is very low. The air emission legal threshold is 0.15 g Cr(VI)/h set out in the German " Technical Instructions on Air Quality" of 24 July 2002 (TA Luft)[5] . The available monitoring data shows concentrations of Cr(VI) below 0.05 g Cr(VI)/h. For the environmental risk assessment, the values of the analytical measurements are used (see Annex I – Environmental Release Concentrations).

Figure 9-3: Waste water treatment batch

Figure 9-4: General ventilation "Quelltöpfe"

[5] https://www.umweltbundesamt.de/sites/default/files/medien/1/dokumente/taluft_stand_200207241.pdf

Figure 9-5: Closed chrome bath during electroplating process. Blue arrows indicate the position of the bath rim local exhaust ventilation on both sides of the chrome baths.

Figure 9-6: Conveyor system is encapsulated with local exhaust. Blue arrows indicate the position of the bath rim local exhaust ventilation. Green arrow indicates plastic straps that direct the exhaust air from the chrome bath into the conveyor. White arrow indicates the exhaust duct into which the exhaust air from the conveyor is sucked.

9.2.1.2 Releases

Table 9-7: Local releases to the environment

Release route	Release factor	Release	Release estimation justification, method and details
Water	Finale release factor: 0.0068% Local release rate: 0.72 g/day	0.1765 kg/a	Monitoring: Measurements based on Cr(VI) wastewater concentrations (see Annex I – Environmental Release Concentrations)
Air	Final release factor: 0.0093% Local release rate: 0.99 g/d	0.2415 kg/a	Monitoring: Measurements based on Cr(VI) concentration in stack exhaust air (see Annex I – Environmental Release Concentrations)
Soil	Final release factor: 0 %	0	No release to soil. All waste is collected by a certified hazardous waste treatment company.

Releases to Waste

Release factor of waste from the process: 0 %

The following waste is generated at the applicant`s site related to Cr(VI):

- Chromic acid
- Filter cloth
- Sludge
- Filter cakes

As described in the Conditions of Use table (section 9.1.1.1), all waste is collected and disposed as hazardous waste by an external waste management company (licensed contractor).

9.2.1.3 Exposure and Risks for the Environment and Humans via the Environment

Two routes of intake of Cr(VI) from the applicant`s activities by the general population have been considered:

A: Oral Uptake by Drinking Water and Eating Fish:

An estimation of oral exposure of the general population via environment has been made using assumptions following arguments given in the environmental section of the EU RAR 53 report (2005) [5] as follows:

1. Cr(VI) emitted via air is relatively stable under the conditions present in the atmosphere and are associated with particles. Cr(VI) reduction to Cr(III) can occur in the presence of reducing agents in the air. Estimates of atmospheric half-life for Cr(VI) reducing to Cr(III) range from 16h to 4.8 days [6]. Cr is removed from the atmosphere by dry and wet (rain out) and deposition, whereby most deposition is via the rain.
2. Air emissions are taken from monitoring reports (see 9.2.1.2 *Releases* above). Because atmospheric Cr(VI) containing particles can be transported by the wind, before they fall or are washed from air onto the land and water surface, and taking conversion of Cr(VI) to Cr(III) into account [5, 6, 14, 15], 50% of the air emissions are assumed to deposit in the neighbourhood. However, based on a worst case decision 100% of the air emissions are contributed to the wastewater Cr(VI) contamination.
3. Cr(VI) leaving the site with wastewater ends up in drinking water and in fish as potential human exposure route.
4. The total amount released is: 0.1765 kg/a Cr(VI) (see section 9.2.1.2 or Annex I – Environmental Release Concentrations) through wastewater discharge; plus 100 % of air emissions (0.2415 kg/a + 0.1765kg/a) = 0.418 Cr(VI) kg/a. This wastewater release rate has been used to calculate the oral Human via the Environment exposure.
5. Receiving water flow rate (rhine) of 97.2 m^3/s ($8.39*10^6$ m^3/day) gives a local predicted environmental concentration (PEC_{local}): 1.71 g/day / $8.39*10^9$ L/day = $2.03*10^{-4}$ µg Cr(VI)/l.
6. The substance has been assumed to be not biodegradable. A bioconcentration factor for fish of 1 L/kg and a biomaginfication factor (BMF) of 2 has been applied [5].
7. For humans, 70 kg body weight and a daily intake of 2 liter water per day has been applied [7].

Contribution to oral intake for Human via the Environment from local contribution:

Human via the Environment - Fish

$PEC_{oral, predator} = PEC_{water/local} * BCF_{fish} * BMF$

Application of the formula yields:

PEC*local/oral,predator* = $2.03*10^{-4}$ μgCr(VI)/l * 1 l/kg * 2 = $4.07*10^{-4}$ μg/Cr(VI)/kg wet fish

Daily human (70 kg) intake via fish (0.115 kg fish/day) [7]:

$4.07*10^{-4}$ μg/Cr(VI)/kg * 0.115 kg/d / 70 kg= $6.68*10^{-7}$ μg Cr(VI)/kg bw/day

Human via the Environment – Drinking water

Daily human (70 kg) intake via water (drinking water based on 100 % sourced from surface [7]):

Daily human intake via drinking water:

$2.03*10^{-4}$ μgCr(VI)/l * 2 l/d / 70 kg = $5.81*10^{-6}$ μg Cr(VI)/kg bw/day

Table 9-8: Man via Environment – PEC_{local}

Man via Environment – PECs	Local
Oral, contributions from drinking water	$5.81*10^{-6}$ μg Cr(VI)/kg bw /day
Oral, contributions from fish	$6.68*10^{-7}$ μg Cr(VI)/kg bw/day

Based on a worst-case assumption drinking water sourced 100% from surface water [7] the concentration in (*local*) drinking water is $2.03*10^{-4}$ μg Cr(VI)/l. In Germany the background concentration of Cr(VI) in drinking water is between 0.06 and 0.51 μg/l (Stiftung Warentest, July 2019 [8]); UBA threshold < 0.3 μg/l [9].

The excess lifetime intestinal cancer risk for the general population for oral intake of Cr(VI) was determined by RAC [1] as:

Exposure to 1 μg/kg bw/day Cr (VI) relates to an excess risk of 8 x 10^{-4}

This yields an excess cancer risk from man via environment exposure due to chrome plating activities of:

Excess risk for local population =
($5.81*10^{-6}$ + $6.68*10^{-7}$) μg/kg bw/day * $8*10^{-4}$ μg/kg bw/day = $5.18*10^{-9}$**.**

Müllheim has a population of 18,286 with a population density of 316 persons per km^2 [10].

Hence, the **potential intestinal cancer cases** from oral uptake of the (*local*) general population is **$9.48*10^{-5}$.**

B: Inhalation Uptake by Direct Exposure via Air Emissions

The predicted exposure of the local population (PEC_{local}) from Cr(VI) in air is calculated from the release of a single point source (chromic acid scrubber stack) at the site. Chromate concentration from other sources on the regional scale ($PEC_{regional}$) has been considered negligible. Only the local exposure has been thus considered for the exposure via air emissions.

The maps in the picture below shows the location of the applicants' site. The applicant is situated in a business park. A business park is an area specially designated and landscaped to accommodate business offices, warehouses, light industry. A 100 m radius was chosen based on REACH guidance R.16 Annex A.16 - 3.3.2 [7]. As can be seen below, the concentration of Cr(VI) in air 100 m from the point source is in the 10^{-4} $\mu g/m^3$ range. The concentration will significantly decrease exponentially with every additional meter away from the point source.

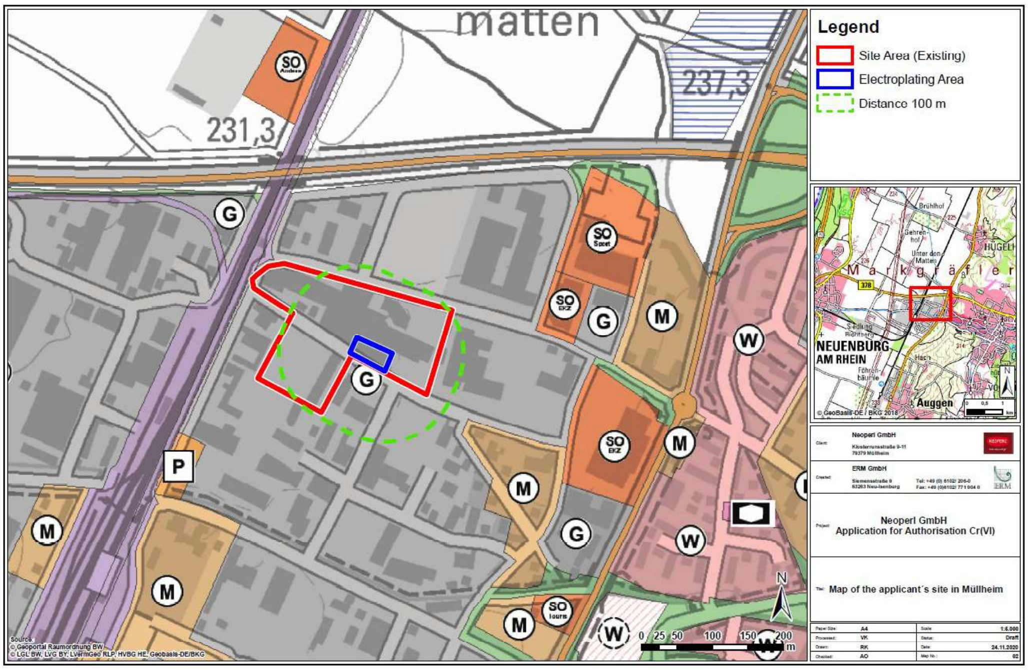

Figure 9-7: Map of applicant´s site in Müllheim. Grey colour represents Business Park. Chromic acid scrubber stack located in the Electroplating Area (blue)

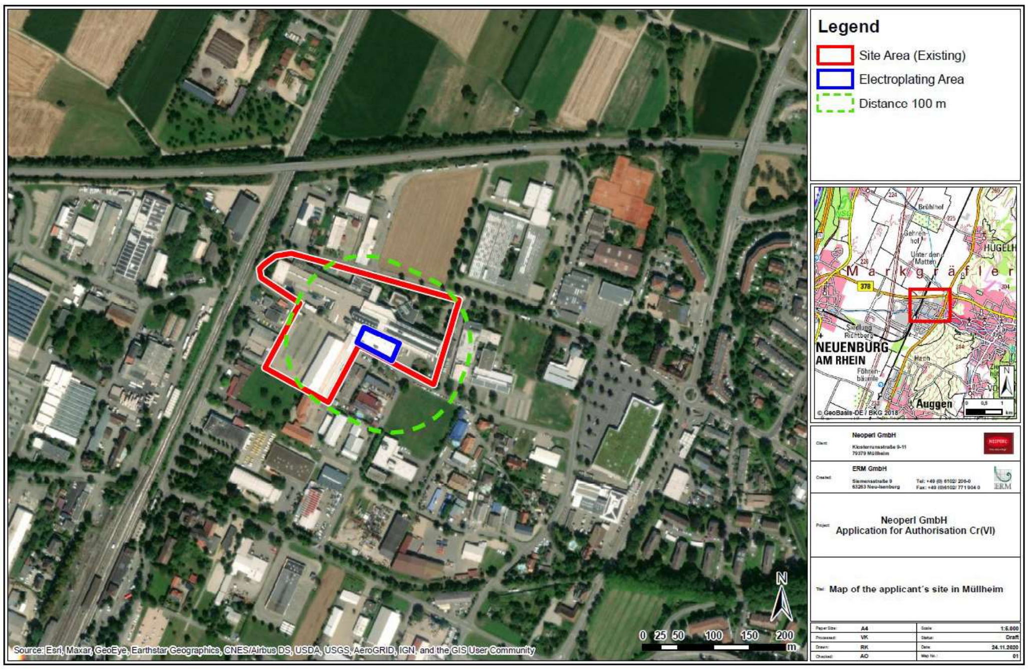

Figure 9-8: Arial map of applicant´s site in Müllheim

$$Clocal_{air} = \max\left(Elocal_{air}\,,\ Estp_{air}\right) \cdot Cstd_{air}$$ (Equation R.16-24)

$$Clocal_{air,ann} = Clocal_{air} \cdot \frac{Temission}{365}$$ (Equation R.16-25)

Explanation of symbols

$Elocal_{air}$	local direct release rate to air during episode	[kg·d⁻¹]	Chapter R.16.2.1
$Estp_{air}$	local indirect release to air from STP during episode	[kg·d⁻¹]	Equation R.16-19
$Cstd_{air}$	concentration in air at source strength of 1 kg·d⁻¹	[mg·m⁻³]	2.78.10⁻⁴
T emission	number of emission days equal to: annual use (kg·y⁻¹) / daily use (kg·d⁻¹)	[d·y⁻¹]	Chapter R.16. 2.2
$Clocal_{air}$	local concentration in air during release episode	[mg·m⁻³]	
$Clocal_{air,ann}$	annual average concentration in air, 100 m from point source	[mg·m⁻³]	

Figure 9-9: Calculation of C_{local} according to REACH Guidance R.16 [7]

Application of the formula yields: The average concentration within 100 m distance of the source (using emission rate of 0.99 g/day):

Clocalair,ann = 9.90×10^{-4} [kg/day] * 2.78×10^{-4} [mg/m³] [kg/day] * (245 [days]/365 [days]) = 1.85×10^{-7} mg/m³ = 1.85×10^{-4} µg Cr(VI)/m³

The local concentration is below the "target" air concentration of 1.7 ng Cr(VI) / m³, which was defined as acceptable level for neighbours living close to industrial and urban Cr(VI) emission sources. [11]

The neighbourhood is characterized as follows:

Industrial / business worker within 100 m radius: the applicant's own site (622 employees), the building across the street to the east from the side, three buildings next to the applicants´ site to the south of the electroplating department and one building to the north of the site. Three buildings to the south are on the edge of the 100 m distance border, so for the "worst case" estimation, these are included in the calculation. This results in an estimation of 900 persons.

Local population: It was estimated, that one of the buildings within the 100 m radius is used also as home for the business owner. This results in an estimation of 5 persons.

Total excess risk for neighbourhood:
Local population: 1.85×10^{-4} µg/m³ * 5 * 2.9×10^{-2} (lung cancer per µg/m³) **= 2.68×10^{-5} potential lung cancer cases** (based on 70 years of exposure; 24hr/day)

Workers: 1.85×10^{-4} µg/m³ * 900 * 4×10^{-3} (lung cancer per µg/m³) **= 6.65×10^{-4} potential lung cancer cases** (based on 40 years of exposure; 8hr/day; 5 days/week)

Risk Characterisation Conclusion

There is a cancer risk induced by the chrome plating operations via the environment, which has been assessed quantitatively and which adds to the overall risk to be evaluated in the Socioeconomic Assessment.

9.2.2 ES1 – WCS1: Worker contributing scenario 1 - Delivery and storage of raw material (PROC1)

At the applicants' site, Cr(VI) is delivered as aqueous solution (chromic acid) in intermediate bulk containers (IBCs) (Figure 9-10). Containers are unloaded and transferred into the warehouse by the plating operators. Chromic acid is kept in separate, lockable areas. There is no potential for exposure.

Figure 9-10: IBC Containing aqueous solution of Cr(VI)O3

9.2.2.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure

- Duration of activity: <*0.5 hour*
- Frequency: *2 - 4 times / year*
- Number of workers involved: *4 (2 per shift) – operator of plating line, thus same employees as in WCS2*
- Emission source: *No*
- Concentration: *500 g Cr(VI) trioxide / l*

Technical and organizational measures

- Place of use: *Indoor*
- Process temperature: *Room temperature (15 – 40°C)*

• General ventilation: *2 – 3 air changes / hour* • Local exhaust ventilation: *No*
Conditions and measures related to personal protection, hygiene and health evaluation
• Respiratory protection: *No* • Dermal protection: *No* • Eye protection: *No*
Other conditions affecting workers exposure
• Access restriction to warehouse

9.2.2.2 Exposure and Risks for Workers

Plating operators are sharing the work and exposure to Cr(VI) in this WCS. Exposure and risk to workers from this scenario are contained in the overall exposure of plating operators in the ES1-WCS2, which is operation of the plating line, summarized in section 9.2.3.

The static measurements in 2020 are conducted to monitor the background concentration of Cr(VI) in the warehouse. Complete data can be found in Annex II – Workplace Concentrations.

The exposure concentrations and Excess Lifetime Risk related to this activity is covered by the scenario ES1-WCS2 (Table 9-9). For workplace, concentration details see in Annex II – Workplace Concentrations.

9.2.3 ES1 – WCS2: Worker contributing scenario 2 - Operation of automated plating line (PROC13)

In the automatic line, the racks with parts move at a predefined pace through different baths, including chrome activation and nickel baths and several rinsing baths in between. The content of the chrome bath is 11 m^3. The concentration of the chromium electrolyte is in the range of [redacted] [100 – 400] g/l. The concentration of the chrome activation in the adjacent bath, with a content of 2m^3 is approximately [redacted] [4 – 8] g/l.

The electroplating line and catwalk is not a permanent workplace for any regular activities. The WCS 2 scenario covers short walks by the plating line operator to visually inspect the electrolyte. For most of the time within this scenario, the electroplating line operator is not on the line but working at the control panel.
The entire daily working time to operate the electroplating line is covered in three shifts. Within these shifts, the regular workplace inspections are conducted. Inspections by work safety group (occupational physician, safety officer, management) take place once a year. Further annual inspections take

place within internal and external audits based on the management system ISO 9001, ISO 14001. 6S / 5S audits take place quarterly.

Beside the electroplating line, working in the wastewater treatment area and at the control penal in a separate room are regularly necessary. About 90% of the work is related to the operation of the plating line and about 10 % to wastewater treatment. Sporadic working in the container room and chrome warehouse is also necessary. Activities per work shift of the plating line operator include the following:

- Control operations (WCS2)
- Sampling (WCS6, section 9.2.7)
- Regular maintenance - Cleaning, repair and maintenance at the plating bath (WCS8, section 9.2.9)
- Analysis of baths in laboratory (WCS7, section 9.2.8)

In this exposure scenario the task control operations is assessed.

9.2.3.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure
• Duration of activity: *5 – 10 minutes / shift* • Frequency: *daily (5 days / week)* • Annual hours worked per employee: *41 h* *(245 operation days * 2 hours)* • Frequency: 5 *days / week* • Number of workers involved: *4 (2 per shift)* • Emission source: *Near field exposure* • Concentration: [redacted] *[100-400] g/l*
Technical and organizational measures
• Place of use: *Indoor* • Room temperature: *15 - 40°C* • General ventilation: *22,000 m³/h* • Local exhaust ventilation: *max. 8,000 m³/h*
Conditions and measures related to personal protection, hygiene and health evaluation
• Respiratory protection: *No* • Dermal protection: *Chemical safety gloves (EN 388, EN 374-5*) • Eye protection: *No*

Other conditions affecting workers exposure
• Place of use: *Indoor* • Process temperature: *Above room temperature* (*44°C)*

#worst-case; value without vacation days

9.2.3.2 Exposure and Risks of Workers

The exposure concentrations and Excess Lifetime Risk related to this activity are presented in Table 9-9. For workplace concentration details see in Annex II – Workplace Concentrations.

Table 9-9: Exposure concentration for workers for CS2

Route of exposure and type of effects	Method of assessment	Exposure conc. ($\mu g/m^3$)	Exposure value corrected for PPE ($\mu g/m^3$)	Exposure value corrected for PPE and frequency* ($\mu g/m^3$)	Excess Lifetime Risk
Inhalation Local Long-term	Monitoring	0.05	-	0.05	0.0002

*No adjustment factors for PPE and frequency applicable. Workers do not wear respiratory masks and are exposed to the measured concentration for the complete shift.

The Excess Lifetime Risk is calculated as follows:

ELR = Exp. Conc. (8h TWA) * 0.004 (ELR at 1 µgCr(VI)/m3)

Remarks on Exposure Data

The exposure estimate for risk characterisation of this workplace is based on recent measured data in 2020 from personal sampling.

Additional static measurements in 2020 are conducted to monitor the background concentration of Cr(VI) at the chrome bath (Figure 9-11). Complete data can be found in Annex II – Workplace Concentrations.

Figure 9-11: Chrome bath with static measurement point

9.2.3.3 Risk Characterisation Conclusion

Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived for this contributing scenario:

$2.00*10^{-4}$ per exposed worker.

9.2.4 ES1 – WCS3: Worker contributing scenario 3 - Loading and unloading of racks (PROC4)

Racks are manually or automatically loaded before and unloaded after treatment. This workplace is located several meters (>5 m) away from the plating line. Plating line operators are also involved in this task; they are the only workers at this workplace who enter the plating line (catwalk). Exposure scenario of plating line operators is covered under WCS2 (section 9.2.3).

Finished parts and carriers (racks) are free of chromic acid contamination, thus there is no need to manually clean parts or wear gloves for chemical protection. Gloves are nevertheless worn to protect products, not employees.

If manually, in total, 25 to 30 workers in two to three shifts with 4 to 6 workers per shift, load and unload parts from the input modules and carry out visual control of finished parts.

Per day on average, 250,000 product pieces are coated and 400 m^2 product surface is coated.

9.2.4.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure

- Duration of activity: *8h / shift (2- 3 shifts)*
- Frequency: *6 days / week*
- Number of workers involved: *25 -30 (4 - 6 per shift) – four employees of the total are operator of plating line, thus these four are the same employees as in WCS2*
- Emission source: *Far field exposure*
- Concentration: *Finished parts and carriers (racks) are free of chromic acid contamination*

Technical and organizational measures

- Place of use: *Indoor*
- Room temperature: *15 – 40°C*
- General ventilation: *2 – 3 air changes / hour*
- Local exhaust ventilation: *No*

Conditions and measures related to personal protection, hygiene and health evaluation

- Respiratory protection: *No*
- Dermal protection: *No*
- Eye protection: *No*

Other conditions affecting workers exposure

- Ear protection used
- Process temperature: *Room temperature*

9.2.4.2 Exposure and Risks of Workers

The exposure concentrations and Excess Lifetime Risk related to this activity are presented in Table 9-10. For workplace concentration details see Annex II – Workplace Concentrations.

Table 9-10: Exposure concentration for workers for CS3

Route of exposure and type of effects	**Method of assessment**	**Exposure conc. (µg/m³)**	**Exposure value corrected for PPE (µg/m³)**	**Exposure value corrected for PPE and frequency* (µg/m³)**	**Excess Lifetime Risk**
Inhalation Local Long-term	Monitoring	0.02	-	0.02	0.00008

* No adjustment factors for PPE and frequency applicable. Workers do not wear respiratory masks and are exposed to the measured concentration for the complete shift

The Excess Lifetime Risk is calculated as follows:

ELR = Exp. Conc.* 0.004 (ELR at 1 µgCr(VI)/m3)

Remarks on Exposure Data

The exposure estimate for risk characterisation of this workplace is based on recent measured data in 2020 from static sampling. Complete data can be found in Annex II – Workplace Concentrations.

Figure 9-12: Loading and unloading area with the location of the static measurement point (Source: Monitoring report Müller-BBM – M156965/01, 2020)

9.2.4.3 Risk characterisation Conclusion

Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived for this contributing scenario:

$8.00*10^{-5}$ per exposed worker.

9.2.5 ES1 – WCS4: Worker contributing scenario 4 – Transfer of Cr(VI) – Decanting into dosing tanks and refilling baths (PROC8b)

Cr(VI) trioxide is delivered as aqueous solution in IBC containers and can then be dosed directly from the basement into the chrome bath in the ground floor (automatic continuous addition). These containers are only opened when the empty IBC needs to be replaced by a full IBC. During the replacement, the plating operator removes the drum pump from the empty container and places it into the full container. Complete task takes up no more than 5 - 20 minutes. The task to connect the pump needs 1 – 2 minutes every 4 – 6 months.

This short exposure time to the largely closed container when connecting the pump does not result in any relevant additional exposure.

9.2.5.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure

- Duration of activity: *1 -2 minutes*
- Frequency: *6-9 times / year*
- Annual hours worked per employee: *18 minutes / year*
- Number of workers involved: *4 (2 per shift) – operator of plating line, thus same employees as in WCS2*
- Emission source: *Near field exposure*
- Concentration: *500 g Cr(VI) trioxide / l*

Technical and organizational measures

- Place of use: *Indoor*
- Room temperature: *15 - 40°C*
- General ventilation: *2 – 3 air changes / hour*
- Local exhaust ventilation: *No*

Conditions and measures related to personal protection, hygiene and health evaluation

- Respiratory protection: *Yes (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D with* 99,95 % efficiency*)*
- Dermal protection: *Chemical safety gloves (EN 388, EN 374-5*)

Other conditions affecting workers exposure

- Process temperature: *Room temperature*

9.2.5.2 Exposure and Risks of Workers

The exposure concentrations and Excess Lifetime Risk related to this activity are presented in Table 9-11. For workplace concentration details see Annex II.

Table 9-11: Exposure concentration for workers for CS4

Route of exposure and type of effects	Method of assessment	Exposure conc. (µg/m³)	Exposure value corrected for PPE* (µg/m³)	Exposure value corrected for PPE and frequency# (µg/m³)	Excess Lifetime Risk
Inhalation Local Long-term	ART	15	0.0075	$7.65*10^{-7}$	$4.59*10^{-9}$

*Full face mask with 99.95% efficiency. (Protection factor is based on the used class 3 filter, which refers to an efficiency of 99.95% according to the EN standard. Testing efficiency through self-test, sealing the aspiration port, creating a vacuum)
#Adjustment for frequency: 18 minutes per year represent 0.02% of the workday.

The Excess Lifetime Risk is calculated as follows:

ELR = Exp. Conc. (8h) * 0.004 (ELR at 1 µgCr(VI)/m3)

Remarks on Exposure Data

No personal or static measurements are available for this workplace. Exposure to Cr(VI) in this worker scenario is calculated with Advanced Reach Tool (ART) version 1.5. The risk of this task is reduced by wearing mandatory a full face mask.

The following data is used to run ART:

- Substance product type: Liquid
- Process temperature: Room temperature
- Vapour pressure: 0.001 Pa
- Liquid weight fraction: 0.5
- Viscosity: Low
- Activity class: Activities with relatively undisturbed surfaces (no aerosol formation)
- Situation: Open surface < 0.1 m^2
- Process fully enclosed?: No
- Effective housekeeping practices in place?: Yes
- Work area: Indoors
- Room size: 1000 m^3
- No localised controls
- Ventilation rate: 3 air changes per hour (ACH)

9.2.5.3 Risk Characterisation Conclusion

Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived for this contributing scenario:

$4.59*10^{-9}$ per exposed worker.

9.2.6 ES1 – WCS5: Worker contributing scenario 5 - Waste and wastewater treatment (PROC8b)

The entire wastewater treatment is located in the basement.

Because this a fully enclosed process, no exposure to workers is expected apart from one or two short samplings per day of the final wastewater before it is released to the public sewer system. This task takes up 30 minutes two to three times per day.

Sampling is carried within the German self-control regulation (*Verordnung des Umweltministeriums über die Eigenkontrolle von Abwasseranlagen (Eigenkontrollverordnung - EKVO)*) which is required according to §61 of the Water Resources Act. Each treated wastewater batch is tested, and the parameters to be checked including Cr(VI) are documented in the operating log. Wastewater can only be discharged if the values are in compliance with required limit values.

Small amounts of Cr(VI) are released from the applicant's wastewater treatment plant, where residual Cr(VI) is reduced to Cr(III). The resulting Cr(III) is then precipitated and disposed of with licensed waste management companies, as described in Chapter 9.2.1.

Other process waste (e.g. waste from cleaning activities and concentrated waste acid from baths) is stored in closed containers, which are collected by licensed waste management companies that treat, incinerate, and dispose of incineration residues.

9.2.6.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure

- Duration of activity: *0.5 hours*
- Frequency: *2 – 3 / day (5 days / week)*
- Number of workers involved: *4 (1 / shift) – operator of plating line, thus same employees as in WCS2*
- Emission source: *Near field exposure*
- Concentration: *residual concentration of Cr(VI) in the effluent mainly below detection limit (0.005 mg/l)*

Technical and organizational measures

- Place of use: *Indoor*
- Room temperature: *15 - 40°C*
- General ventilation: *2 -3 air changes / hour*
- Local exhaust ventilation: *No*

Conditions and measures related to personal protection, hygiene and health evaluation
• Respiratory protection: *Non* • Dermal protection: *Non* • Eye protection: *Non*
Other conditions affecting workers exposure
• Process temperature: *room temperature*

9.2.6.2 Exposure and Risks of Workers

Plating operators are sharing the work and exposure to Cr(VI) in this WCS. The task wastewater treatment is in part within the work shift of the plating line operator. For this task, the plating line operator moves to the basement. For the plating line operator, personal exposure measurements are conducted, thus, the measurements also include WCS wastewater treatment. Exposure and risk to workers from this scenario are contained in the overall exposure of plating operators in the ES1-WCS2, which is operation of the plating line, summarized in section 9.2.3.

The static measurements in 2020 are conducted to monitor the background concentration of Cr(VI) at the waste water treatment plant (Figure 9-13). As can be seen in Annex II – Workplace Concentrations, concentrations in the Cr(VI) the static measurements are below the personal measurements from the plating operators, thus the personal measurements are used for risk calculations.

The exposure concentrations and Excess Lifetime Risk related to this activity is covered by the scenario ES1-WCS2 (Figure 9-9). For workplace, concentration details see Annex II – Workplace Concentrations.

Figure 9-13: Wastewater treatment area. The white arrow points to the measuring station (Source: Monitoring report Müller-BBM – M156965/01, 2020)

9.2.7 ES1 – WCS6: Worker contributing scenario 6 - Sampling (PROC8b)

The plating line operator picks one or more samples at the bath(s), and then transfers them in a closed flask to the laboratory. This takes at most 30 minutes two times per month. The worker has to wear adequate PPE including respiratory mask and the plant must remain in a safe condition (no plating activity during sampling). The bath is opened from the control panel and the sample is taken using a telescopic arm and then transferred in a closed flask to the laboratory.

9.2.7.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure
• Duration of activity: *0.5 hours* • Frequency: *1 - 2 / month* • Number of workers involved: *4 (1 per shift) – operator of plating line, thus same employees as in WCS2* • Emission source: *Near field exposure* • Concentration: [redacted] *[100-400] g/l*

Technical and organizational measures
• Place of use: *Indoor* • Room temperature: *15 - 40°C °C* • General ventilation: *22,000 m³/h* • Local exhaust ventilation: *max. 8,000 m³/h*
Conditions and measures related to personal protection, hygiene and health evaluation
• Respiratory protection: *Yes (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D, with* 99,95 % efficiency*)* • Dermal protection: *Chemical safety gloves (EN 388, EN 374-5*)
Other conditions affecting workers exposure
• Process temperature: *Above room temperature (44°C)*

9.2.7.2 Exposure and Risks of Workers

Plating operators are sharing the work and exposure to Cr(VI) in this WCS. Exposure and risk to workers from this scenario are contained in the overall exposure of plating operators in the ES1-WCS2, which is operation of the plating line, summarized in section 9.2.3.

The exposure concentrations and Excess Lifetime Risk related to this activity is covered by the scenario ES1-WCS2 (Figure 9-9). For workplace, concentration details see found Annex II – Workplace Concentrations.

Figure 9-14: Covered chrome bath with measurement point (Source: Monitoring report Müller-BBM – M156965/01, 2020)

9.2.8 ES1 – WCS7: Worker contributing scenario 7 - Analysis of baths in laboratory (PROC15)

The laboratory analysis is not subject of the present CSR because the condition of use falls under the exemption criteria described in ECHA QA 585 [12]:

"Under Article 3(23) of REACH, scientific research and development means any scientific experimentation, analysis or chemical research carried out under controlled conditions in a volume **less than one tonne per year**. Thus, the use of an Annex XIV substance in analysis is exempted from authorisation under Article 56(3) if **the substance is used, on its own or in a mixture, in analytical activities such as monitoring and quality control** where these activities are carried out under controlled conditions and in a volume not exceeding one tonne per year and per legal entity. " [10]

Based on the exemption, this contributing scenario is not quantitatively considered in the CSR but the conditions under which the laboratory analysis take place are described qualitatively.

9.2.8.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure

- Duration of activity: *0.5 hour*
- Frequency: *1-2 times / month*
- Number of workers involved: *4 (1 per shift) – operator of plating line, thus same employees as in WCS2*
- Emission source: *Near field exposure*
- Concentration: [redacted] *[100-400] g/l and 500 g Cr(VI) trioxide / l*

Technical and organizational measures

- Place of use: *Indoor*
- Process temperature: *Room temperature (15 – 25°C)*
- Local exhaust ventilation: *Yes, fume cupboard*

Conditions and measures related to personal protection, hygiene and health evaluation

- Respiratory protection: *No*
- Dermal protection: *No*
- Eye protection: *Yes*

Other conditions affecting workers exposure

- Partial enclosure: lab analysis only to be performed in fume cupboard

9.2.8.2 Risk characterisation conclusion

This contributing scenario is exempted from the authorisation application as described in Section 9.2.8, therefore no quantitative assessment was performed and no exposure or Excess Lifetime Risks were determined.

9.2.9 ES1 – WCS8: Worker contributing scenario 8 – Regular Maintenance – Cleaning, repair and maintenance at the plating bath (PROC28)

This scenario includes cleaning, repair and any other work performed outside of the plating line and near the baths and are conducted by the responsible line operators. The tasks also include for example, filter change, change of connections and under circumstances change of filter candle.

A massive and transparent plastic curtain separates the chrome bath from the passage area. In this ventilation-trapped area, maintenance work can also be sporadically necessary. Behind this curtain, a static measurement was conducted (Figure 9-15). One of the measured value showed the highest Cr(VI) concentration (0.09 µg Cr(VI)/m³) from all measurements in 2020 and thus, the value can be considered as worst-case.

Figure 9-15: Static measurement behind the massive, transparent plastic curtain behind the chrome bath. The white arrow points to the measuring station (Source: Monitoring report Müller-BBM – M156965/01, 2020)

9.2.9.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure
• Duration of activity: *10 minutes* • Frequency: *1 / week* • Annual hours worked per employee: *350 minutes* • Number of workers involved: *4 (2 per shift) – operator of plating line, thus same employees as in WCS2* • Emission source: *Near field exposure* • Concentration: [redacted] *[100-400] g/l*
Technical and organizational measures
• Place of use: *Indoor*

- Room temperature: 15 – 40 °C
- General ventilation: *22,000 m^3/h*
- Local exhaust ventilation: *max. 8,000 m^3/h*

Conditions and measures related to personal protection, hygiene and health evaluation

- Respiratory protection: *Yes (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D, with* 99,95 % efficiency
- Dermal protection: *Protective clothing (long sleeves) and chemical safety gloves (EN 388, EN 374-5*)

Other conditions affecting workers exposure

- Process Temperature: *Room temperature*

9.2.9.2 Exposure and Risks of Workers

The exposure concentrations and Excess Lifetime Risk related to this activity are presented in Table 9-12.

Table 9-12: Exposure concentration for workers for CS6

Route of exposure and type of effects	**Method of assessment**	**Exposure conc. (µg/m³)**	**Exposure value corrected for PPE* (µg/m³)**	**Exposure value corrected for PPE and frequency# (µg/m³)**	**Excess Lifetime Risk**
Inhalation Local Long-term	ART	0.088	0.000044	$1.31*10^{-7}$	$5.24*10^{-10}$

*Full face mask with 99.95% efficiency. (Protection factor is based on the used class 3 filter, which refers to an efficiency of 99.95% according to the EN standard. Testing efficiency through self-test, sealing the aspiration port, creating a vacuum)
#Adjustment for frequency: 350 minutes per year represent 0.42% of the workday.

The Excess Lifetime Risk is calculated as follows:

ELR = Exp. Conc. (8h) * 0.004 (ELR at 1 µgCr(VI)/m3)

Remarks on Exposure Data

Limited personal measurements are available for this workplace. Exposure to Cr(VI) in this worker scenario is calculated with Advanced Reach Tool (ART) version 1.5. The risk of this task is reduced by wearing mandatory a full-face mask.

The following data is used to run ART:

- Substance product type: Liquid
- Process temperature: Room temperature
- Vapour pressure: 0.001 Pa
- Liquid weight fraction: 0.3
- Viscosity: Low
- Activity class: Handling of contaminated objects
- Situation: Activities with treated/contaminated objects (surface 1-3 m^2)
- Contamination level: Contamination < 10 % surface
- Process fully enclosed?: No
- Effective housekeeping practices in place?: Yes
- Work area: Indoors
- Room size: Large workrooms only
- Localised controls: Fixed capturing hood (90.00 % reduction)
- Ventilation rate: 3 air changes per hour (ACH)

9.2.9.3 Risk Characterisation Conclusion

Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived for this contributing scenario:

$5.24*10^{-10}$ per exposed worker.

9.2.10 ES1 – WCS9: Worker contributing scenario 9 – Rare maintenance – Overhaul of plating lines (PROC28)

Twice per year, the baths are completely drained and cleaned in this scenario. About 90% of the chromic acid is pumped into a recycling tank placed nearby, and is reused afterwards. Sludge and the remaining chromic acid is removed from the baths by a worker who climbs inside and removes it manually. Afterwards the baths are cleaned. The bath rim ducts and drip trays are removed and cleaned and a functional check of the local exhaust ventilation is conducted. Anodes are inspected and replaced as necessary. Fly bars and handling systems are refurbished. Pump performance is checked; however, line breaking is only done where absolutely necessary. Sludge and washing water is disposed by the external company.

Removing of sludge and cleaning the baths is performed by workers of a licenced external company, which also disposes the sludge. Any other work is performed by the plating operators, but maintenance employees are also present nearby. All tasks are performed under advanced professional safety and health controls. During maintenance of the Cr(VI)-containing baths, the plating line becomes a restricted area and only workers, who are trained on the maintenance-specific SOP, are allowed into the plating area. Specific personal protective equipment must be worn and are described in the table below. In addition, all baths, which are not maintained, are covered to prevent workers from the potential risk of falling into these.

Overview of the different tasks within this scenario (Step 1 – 7):

1. Pump out chromic acid into IBCs – *Internal worker*
Drum pump is used to pump chromic acid from the bath into IBCs. One worker is operating the drum pump and another is by the IBC standing nearby / in visual contact. The IBCs are closed and stored nearby the chrome bath during the cleaning process. The containers are new and approved for chromic acid. After filling, the IBCs are closed. The storage area / maintenance area is protected with PVC foil.
Duration of activity: 1 to 3.5 hours

2. Removing sludge and the remaining chromic acid from the baths – *External company*
Climbing inside and removing it manually. For removing the sludge, a rubber blade is used. The residues in the bath are rinsed out to clean the bath.
The sludge is stored in drums. Liquids are sucked into IBCs.

3. Removing and cleaning of bath rim ducts and drip trays – *External company*
Bath rim ducts and drip trays are placed on the ground of the cleaned bath and rinsed

4. Functional check for the local exhaust ventilation – *Internal worker*
Functional test via control panel

5. Refurbishing of fly bars and handling systems and inspection and replacing (if necessary) of anodes – *Internal worker*
Tasks conducted in the cleaned bath

6. Refilling of chrome bath – *Internal worker*
Duration of activity: 1 to 3.5 hour

7. Control of pump performance – *Internal worker*
Functional test via control panel

External company	Duration of activity
Step 2 and 3:	8 hours

Internal worker	
Step 1:	1 – 3.5 hours
Step 4:	0.25 hour
Step 5:	0.5 hour
Step 6:	1 – 3.5 hours
Step 7:	0.25 hour
Total:	max. 8 hours

Measurements to reduce workers exposure:

- Respiratory protection: Full-face mask (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D, with 99,95 % efficiency)
- Dermal protection: Protective clothing (long sleeves) and chemical safety gloves (EN 388, EN 374-5)
- The maintenance area including the entire disposal route is protected with PVC foil that is disposed of via the licenced external company.

9.2.10.1 Conditions of Use

Frequency and duration of use, number of workers involved, exposure
• Duration of activity (internal worker): 8 *hours*
• Duration of activity (external worker): *8 hours*
• Frequency (internal and external worker): *2 times/year*
• Annual hours worked per employee: *8 hours*
• Number of workers involved: *internal 3 of 10 and external 3*
• Emission source: *Near field exposure*
• Concentration: [redacted] *[100-400] g/l*
Technical and organizational measures
• Place of use: *Indoor*

- Room temperature: *15 - 40°C*
- General ventilation: *22,000 m^3/h*
- Local exhaust ventilation: *max. 8,000 m^3/h*

Conditions and measures related to personal protection, hygiene and health evaluation

- Respiratory protection: *Yes (CL3 EPDM, Filter: M45x3 A2B2E2K2Hg P3 R D, with* 99,95 % efficiency)
- Dermal protection: *Protective clothing (long sleeves) and chemical safety gloves (EN 388, EN 374-5*)

Other conditions affecting workers exposure

- Process temperature: *Room temperature*

9.2.10.2 Exposure and Risks of Workers

The exposure concentrations and Excess Lifetime Risk related to this activity are presented in Table 9-13. For workplace concentration details see Annex II – Workplace Concentrations.

Table 9-13: Exposure concentration for workers for CS9

Worker	Route of exposure and type of effects	Method of assessment	Exposure conc. (µg/m³)	Exposure value corrected for PPE* (µg/m³)	Exposure value corrected for PPE and frequency# (µg/m³)	Excess Lifetime Risk
internal worker	Inhalation Local Long-term	ART	12	0.006	$4.90*10^{-5}$	$1.96*10^{-7}$
external worker	Inhalation Local Long-term	ART	12	0.006	$4.90*10^{-5}$	$1.96*10^{-7}$

*Full face mask with 99.95% efficiency. (Protection factor is based on the used class 3 filter, which refers to an efficiency of 99.95% according to the EN standard. Testing efficiency through self-test, sealing the aspiration port, creating a vacuum)
#Adjustment for frequency: 16 (8 hours x 2 times per year) hours per year represent 0.82% of the workday.

The Excess Lifetime Risk is calculated as follows:

ELR = Exp. Conc. (8h) * 0.004 (ELR at 1 µgCr(VI)/m3)

Remarks on Exposure Data

No personal measurements are available for this workplace. Exposure to Cr(VI) in this worker scenario is calculated with Advanced Reach Tool (ART) version 1.5. The risk of this task is reduced by wearing mandatory a full-face mask.

The following data is used to run ART:

- Substance product type: Liquid
- Process temperature: Room temperature
- Vapour pressure: 0.001 Pa
- Liquid weight fraction: Main component
- Viscosity: Low
- Activity class: Handling of contaminated objects
- Situation: Activities with treated/contaminated objects (surface > 3 m^2)
- Contamination level: Contamination > 90 % of surface
- Process fully enclosed?: No
- Effective housekeeping practices in place?: Yes
- Work area: Indoors
- Room size: Small workrooms only
- Localised controls: Fixed capturing hood (90.00 % reduction)
- Ventilation rate: 3 air changes per hour (ACH)

9.2.10.3 Risk Characterisation Conclusion

Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived for this contributing scenario:

$1.96*10^{-7}$ per exposed worker.

10 RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

10.1 Human health (related to combined, shift-long exposure)

Table 10-1: Total Combined Risk of plating operators

WCS	Description	Excess risk	Number of affected workers	Excess cancer cases
2 (risk includes scenario 1, 5 and 6)	Operation of automated plating line (including Delivery and storage of raw material, Waste and wastewater treatment and Sampling)	$2.00*10^{-4}$	4	$8.00*10^{-4}$
4	Transfer of Cr(VI) – Decanting into dosing tanks and refilling baths	$4.59*10^{-9}$	4	$1.84*10^{-8}$
8	Regular Maintenance – Cleaning, repair and maintenance at the plating bath	$5.24*10^{-10}$	4	$2.10*10^{-9}$
9	Rare maintenance – Overhaul of plating lines	$1.96*10^{-7}$	4	$7.84*10^{-7}$
Combined potential lung cancer risk $8.01*10^{-4}$				

Note: The ART modelled exposure for WCS 9 is lower than the WCS 4 because local exhaust ventilation is available for WCS 9 but not for WCS 4. A 90 % reduction based on local exhaust ventilation is taken into account for the calculation of the WCS9.

Table 10-2: Total excess cancer cases for workers

WCS	Description	Excess risk	Number of affected workers	Excess cancer cases
2 (risk includes scenario 1, 5 and 6)	Operation of automated plating line (including Delivery and storage of raw material, Waste and wastewater treatment and Sampling)	$2.00*10^{-4}$	4	$8.00*10^{-4}$
3	Loading and unloading of racks	$8.00*10^{-5}$	26	$2.08*10^{-3}$
4	Transfer of Cr(VI) – Decanting into dosing tanks and refilling baths	$4.59*10^{-9}$	4	$1.84*10^{-8}$
7	Analysis of baths in laboratory	exempted	-	-
8	Regular Maintenance – Cleaning, repair and maintenance at the plating bath	$5.24*10^{-10}$	4	$2.10*10^{-9}$
9	Rare maintenance – Overhaul of plating lines	$1.96*10^{-7}$	13	$2.55*10^{-6}$
Total excess cancer cases $2.88*10^{-3}$				

10.2 Humans via Environment (combined for all emission sources)

Table 10-3: Total Excess Cancer Cases for Human via Environment

Source	Potential lung /intestinal cancer cases
Oral, local, general population	$9.48*10^{-5}$
Air, local, general population	$2.67*10^{-5}$
Air, local, workers	$6.62*10^{-4}$
Total potential excess lung / intestinal cancer cases:	$7.87*10^{-4}$

REFERENCES

[1] Application for Authorisation: Establishing a Reference Dose Response Relationship for Carcinogenicity of Hexavalent Chromium; Committee for Risk Assessment; RAC/27/2013/06 rev 1; 2013

[2] Bekanntmachung von Arbeitsmedizinischen Regeln – hier: AMR 6.2 Biomonitoring; Bek. d. BMAS v. 02.12.2013 - IIIb1-36628-15/1; Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BauA); 2014

[3] Information – Handlungsanleitung für die arbeitsmedizinische Vorsorge – nach dem Berufsgenossenschaftlichen Grundsatz G15 „Chrom-VI-Verbindungen“; BGI/GUV-I 504-15; Deutsche Gesetzliche Unfallversicherung; 2009

[4] MAK-und BAT-Werte-Liste 2020; Ständige Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe; Mitteilung 56; Deutsche Forschungsgemeinschaft; 2020

[5] European Union Risk Assessment Report; Volume 53 (Chromium Trioxide, Sodium Chromate, Sodium Dichromate, Ammonium Dichromate and Potassium Dichromate); 2005

[6] Chromium (VI) Handbook; Independent Environmental Technical Evaluation Group (IETEG); Jaques Guertin et al.; 2005

[7] Guidance on Information Requirements and Chemical Safety Assessment. Chapter R.16: Environmental exposure assessment; Version 3.0; EHCA; 2016

[8] Stiftung Warentest; https://www.test.de/Trinkwasser-im-Test-5049894-5049900/ (accessed March 2020)

[9] Potentielle Schädlichkeit von Chrom im Trinkwasser. Einordnung der epidemiologischen Befunde zum Krebsrisiko nach Exposition von Populationen gegenüber Chrom(VI) im Trinkwasser und Vorschlag zur Ableitung einer Expositions-Risikobeziehung; Bericht zum Sondervorhaben des Umweltbundesamtes FKZ 363 01 399; Markus Roller; 2012

[10] Landeskundliches Informationssystem Baden–Württemberg; https://www.leo-bw.de/detail-gis/-/Detail/details/ORT/labw_ortslexikon/8686/ort (accessed July 2020)

[11] Bericht des Länderausschusses für Immissionsschutz (LAI) „Bewertung von Schadstoffen, für die keine Immissionswerte festgelegt sind - Orientierungswerte für die Sonderfallprüfung und für die Anlagenüberwachung sowie Zielwerte für die langfristige Luftreinhalteplanung unter besonderer Berücksichtigung der Beurteilung krebserzeugender Luftschadstoffe“; 61.0-06; 2004

[12] ECHA QA 585; https://echa.europa.eu/de/support/qas-support/browse/-/qa/70Qx/view/ids/585 (accessed March 2020)

[13] DGUV-Information 213-505, Verfahren zur Bestimmung von sechswertigem Chrom; Deutsche Gesetzliche Unfallversicherung; 2017

[14] Toxicological Profile for Chromium; U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service Agency for Toxic Substances and Disease Registry; September 2012

[15] S. Squibb, Elizabeth T. Snow, in Handbook of Hazardous Materials, 1993

ANNEX I – ENVIRONMENTAL RELEASE CONCENTRATIONS

Release via exhaust air:

The following data was used to calculate the emission of Cr(VI) into air. Air samples have been analysed according to DIN EN 13284-1:2018-02 and according to *Verfahren zur Bestimmung von sechswertigem Chrom DGUV-Information* 213-505 [13]. The limit of quantification of the method is 0.4 µg/m3. The limit of detection is not explicitly stated for this method, but is usually in the order of 1/3 of the limit of quantification. For the applicant, there is no requirement from an authority for regular air emission, thus limitated data are available. However, from 2019 the applicant conducts measurements on air emission on a regular basis.
Since 2019 a new exhaust-ventilation system is in place at the applicant´s site with the aim of reducing air emission of Cr(VI) by half of the required limit value (0.15 g/h and 0.05 mg/m^3, respectively) set out in the German " Technical Instructions on Air Quality" of 24 July 2002 (TA Luft)[6]

Table I-1: Concentration of Cr(VI) in air emissions. Values taken from reports provided by "IFU GmbH, Gewerbliches Institut für Fragen des Umweltschutzes".

Year	Max. concentration [mg/ m³]	Max. concentration [g/h]	Max. concentration [g/a]
*2015**	*0.0264*	*0.144*	-
*2019**	*0.01*	*0.08*	-
2020	0.004	0.037	217.56

* The values for air emission obtained in 2015 and 2019, were not taken into account for the calculations, because they do not reflect the current situation on the applicants´ site:
-2015: exhaust ventilation system in 2015 is obsolete; new exhaust ventilation system in place since 2019
-2019: Improvement of new exhaust ventilation system in 2020 (replacement of exhaust-ventilator).
[Regular air measurements take place once a year. The measurement in 2019 was in February. The main reconstruction of the air system started in December 2018. However, to achieve the targeted cleaning performance, various optimisations were needed. Overall, all these optimisation measures were running until the end of 2019. Optimisation measures included a new fan motor, new silencer, changed demister panel (Demisterkissen) requirements, cleaning of the old pipelines, measurement of the air volume and air speeds, adjustments to the cross-sections, and others. Thus, the values for air emission obtained in 2019, were not taken into account for the calculations, because they do not reflect the current situation on the applicants´ site. As can be seen in Table I-1, the improvements are reflected in the reduction in air emissions from 2015 to 2019 and from 2019 to 2020. The decreased value from 2015 to 2019 can be attributed to the main reconstruction that took place in December 2018 and the decreased value in 2020 reflects the additional optimisation measures that were carried out in 2019.]

6 https://www.umweltbundesamt.de/sites/default/files/medien/1/dokumente/taluft_stand_200207241.pdf

Plating line operation: 245 days/year with 16 hours /day and with ventilation air 24 h / day

Table I-2: Calculation of release factor of Cr(VI) into air

Year	Concentration of Cr(VI) released into air (kg/a)	Annual amount of Cr(VI) used (kg/a)	Release factor (%)
2020	[redacted]	[redacted]	0.0093

<u>Release via wastewater:</u>

The residual Cr(VI) concentration in wastewater is measured annually by the accredited laboratory *Gewerbliches Institut für Umweltanalytik* (GIU) GmbH as requested by the local authority. Concentrations were determined according to DIN 38 405 (D24) with a limit of quantitation (LOQ) of 0.01 mg/l. In addition, the applicant measures wastewater quarterly by the accredited laboratory *Gewerbliches Institut für Fragen des Umweltschutzes* (IFU) GmbH. Since the detection limit for Cr(VI) in the analytical method used by IFU GmbH is lower, these values were used for the calculations.

The values presented in Table I-2 were used for the environmental release of Cr(VI) via wastewater. Concentrations were determined according to DIN 38 405 (D24) from 2015 to 2019 and according to DIN EN ISO 18412 (D40) 2007-02 since 2020, both methods with a Limit of Detection (LOD) of 0.005 mg/l.

Values provided by GIU GmbH are presented in Table I-3. All values are below the legal threshold of 0.1 mg Cr(VI)/L according to the German Waste Water Ordinance ("Abwasserverordnung, AbwV"). The majority of the available monitoring data demonstrate concentrations of Cr(VI) below the respective detection limit (0.005 mg Cr(VI)/l), and the remaining results are below or equal 0.03 mg Cr(VI)/l. There is no known reason for the values above the detection limit but all values are significantly below the legal threshold. The increase of the Cr(VI) amount in 2020 was based on an substitution of the electrolyte in the chrome bath. This was due to an increased contamination of the chrome bath with “foreign” metal ions (e.g. copper, zinc), caused by fallen product parts from the rack into the chrome bath. The difference in the chrome bath had to be concentrated with new Cr(VI). The discharge into the wastewater was not increased because the amount of substituted material was disposed of via a licensed contractor company (Remondis GmbH).

Table I-3: Concentration of Cr(VI) in wastewater emissions. Values taken from reports provided by IFU GmbH

Year	**Amount of wastewater (m^3/a)**	**Cr(VI) in wastewater (mg/l)***	**Cr(VI) in wastewater (kg/a)**	**Annual amount of Cr(VI) used (kg/a)****	**Release factor (%)**
2015	3333.6	0.0085	0.0283	[redacted]	[redacted]
2016	3391.4	0.0050	0.0170	[redacted]	[redacted]
2017	3687.0	0.0225	0.0830	[redacted]	[redacted]
2018	3347.9	0.0250	0.0837	[redacted]	[redacted]
2019	3496.4	0.0050	0.0175	[redacted]	[redacted]
2020	3580.4	0.0155	0.0555	[redacted]	[redacted]
90th Percentile					0.0068

* Value based on 90th percentile of four measurements. Exception for 2018, value based on three measurements
** 2017 to 2019: [redacted] [1-4]t Cr(VI)trioxide (solid); Since 2020: [redacted] [10-15]t Chrome(VI)trioxide (aqueous solution)

Plating line operation: 245 days/year with 16 hours /day

Table I-4: Concentration of Cr(VI) in wastewater emissions. Values taken from reports provided by GIU GmbH

Year	**Cr(VI) in wastewater (mg/l)**
2015 - 2020	<0.01

ANNEX II – WORKPLACE CONCENTRATIONS

Recent monitoring data from June and October 2020 are available and the applicant will conduct from now on measurements annually.

Sampling was undertaken in accordance with generally approved inhalation exposure monitoring strategies described in the German *Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung* (IFA), IFA-*Arbeitsmappe, Band 1 und 2, Messung von Gefahrstoffen, Erich Schmidt-Verlag, Bielefeld,* updated twice a year. Analytical determination of Cr(VI) is carried out photometrically. The quantitation limit of the method is given by company Mueller BBM as 0.25µg Cr(VI) / sample.

The quantitation limit of 0.25µg Cr(VI)/sample is related to the analysis method used to analyse the amount of Cr(VI) of the filter sample obtained from the measuring devices used for the workplace measurements.
The concentration values stated in Table II-1 are calculated based on the results obtained from the filter analysis [µg/sample] and divided by the sample volume [m3].
For example:
0.25 µg/sample / 4 m3 = 0.0625 µg/m3
This is the reason why the values in Table II-1 are lower than the quantitation limit of the analytical method.

Personal samples were located within the breathing zone and are expressed as 8 hour Time Weighted Average (TWA). Static samples were located at strategic positions to mark the worst case.

The table below provides all available workplace monitoring data, which have been considered for the risk characterisation.

Table II-1: Monitoring data from 2020 provided by the company Müller-BBM GmbH

	June 2020		**October 2020**	
Sampling location / Work activity	**Duration (hour)**	**Concentration (µg Cr(VI)/m³)**	**Duration (hour)**	**Concentration (µg Cr(VI)/m³)**
Static - Chrome bath[a]	4	0.06	3.4	0.02
Static – Loading/Unloading[b]	4	0.02	3.75	0.02
Static – Behind the chrome bath (behind plastic curtain)**	5	0.09	4.6	<0.03

	June 2020		**October 2020**	
Static – Chrome warehouse	5	0.02	4.5	0.04
Static - Warehouse (used for other substances)	2.1	0.02	2.3	<0.02
Static – Wastewater area	4.6	0.02	3.7	<0.01
Personal[c] – Plating operator, morning shift	4***	0.04*	2.5****	0.04**
Personal[c] – Plating operator, evening shift	4***	0.05*	2.6****	<0.03*

*No maintenance work during the measurement period

**Maintenance work during the measurement period: Filter change (wastewater treatment plant), removal and readjustment of level controller (chrome bath)

***Description of activity: Operating the plating line, waste water treatment, sampling, storage room activities

**** Description of activity: Operating the plating line, waste water treatment, sampling, refilling chrome bath, storage room activities, maintenance work (Filter change (wastewater treatment plant), removal and readjustment of level controller (chrome bath))

[a]Measurements at the workplace of the plating line operators (Figure 9-11).

[b]In this area "behind the chrome bath (behind plastic curtain)" (Figure 9-15), maintenance work can sporadically be necessary. This is not the workplace of the plating line operator.

[c]The personal samples were taken at breathing level. The following sampling system was used: Personal-Air-Sampler GSA SG10-2 - volume flow rate [l/min] 10. The sampling takes place as E-dust ("inhalable dust") on quartz filters and the filter is eluted and the chromium content is determined by photometric analysis. The quantitation limit of the method is 0.25µg Cr(VI) / filter sample. The resulting amount of Cr(VI) [µg/sample] is divided by the sample volume [m3].

The below table shows the monitoring data from the year 2015. These values have not been used, because they do not reflect the current situation on the applicants´ site. In 2018, the exhaust-ventilation system was renewed, bath rim exhausts were installed and the electroplating baths got a cover to ensure the best possible suction.

Table II-2: Monitoring data from 2015 – not used for calculations

Sampling location / Work activity	**Duration (hour)**	**Concentration (µg Cr(VI)/m³)**
Static - Chrome bath	5	0.10
Personal – Loading/Unloading	5	0.09
Personal – Plating operator – Labour, wastewater, chrome bath	5	0.02

ANNEX III – BIOMONITORING DATA

Year	**Cr-concentrarion urin – limit value 1µg/l**	**Cr-concentration blood – limit value 3,7µg/l**
2015	<0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
	0.6	<1.0
	0.7	<1.0
	<0.6	<1.0
	0.9	<1.0
	not detected	<1.0
	<0.6	<1.0
	0.7	<1.0
	not detected	<1.0
	0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
	0.6	<1.0
Remarkably values	Of 16 tested employees: **0** remarkably	Of 16 tested employees: **0** remarkably
2016	0.8	<1.0
	0.9	<1.0
	<0.6	<1.0
	<0.6	<1.0
	0.7	<1.0
	<0.6	<1.0
	0.8	<1.0
	0.7	<1.0
	<0.6	<1.0
	0.7	<1.0
	not detected	<1.0
	0.7	<1.0
	0.9	<1.0
	0.6	<1.0
	<0.6	<1.0
	1.0	<1.0
	<0.6	<1.0
	<0.6	<1.0
Remarkably values	Of 18 tested employees: **0** remarkably	Of 18 tested employees: **0** remarkably

Year	Cr-concentrarion urin – limit value 1µg/l	Cr-concentration blood – limit value 3,7µg/l
2017	<0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
	0.6	<1.0
	1,0	1.5
	<0.6	<1.0
	<0.6	<1.0
	0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
	1.0	<1.0
	0.7	<1.0
	<0.6	<1.0
	1.0	<1.0
	0.8	<1.0
	<0.6	<1.0
	<0.6	<1.0
	<0.6	<1.0
Remarkably values	Of 18 tested employees: **0** remarkably	Of 18 tested employees: **0** remarkably
2018	1,0	1.0
	1.0	1.0
	<0.6	<1.0
	1.0	1.1
	1.0	<1.0
	0.7	1.1
	1.0	<1.0
	<0.6	<1.0
	<0.6	1.3
	1.1	<1.0
	<0.6	<1.0
	1.0	<1.0
	1.0	<1.0
	1.0	1.2
	1.0	1.0
	0.8	<1.0
Remarkably values	Of 16 tested employees: **0** remarkably	Of 16 tested employees: **0** remarkably
2019	0.8	<1.0
	0.6	1.1
	<0.6	<1.0
	<0.6	<1.0
	0.7	<1.0
	<0.6	<1.0
	0.6	<1.0
	0.8	<1.0
	0.6	<1.0
	0.8	<1.0
	<0.6	<1.0
	<0.6	<1.0

Year	Cr-concentrarion urin – limit value 1µg/l	Cr-concentration blood – limit value 3,7µg/l
	0.7	<1.0
	0.9	<1.0
	0.9	<1.0
	<0.6	<1.0
	<0.6	<1.0
	1.0	<1.0
	<0.6	1.0
	<0.6	<1.0
Remarkably values	Of 20 tested employees: **0** remarkably	Of 20 tested employees: **0** remarkably
2020	0.9	<1.0
	0.6	<1.0
	0.6	not determined
	0.6	not determined
	0.7	not determined
	0.6	not determined
	0.6	<1.0
	0.6	<1.0
	0.9	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.6	<1.0
	0.9	<1.0
	0.7	<1.0
Remarkably values	Of 22 tested employees: **0** remarkably	Of 18 tested employees: **0** remarkably

Biomonitoring of workers in urine and blood is performed once a year

ANNEX – JUSTIFICATIONS FOR CONFIDENTIALITY CLAIMS

The confidentiality claims made in this report generally fall into two cases. Those cases and their justification are described below. Following that explanation is a summary table, which enumerates each instance of confidential information, which has been redacted in this report.

- **Blank 1**: Proprietary manufacturing information

  The details of how the applicant makes its products are confidential for the following reasons.

  - Demonstration of commercial interest. The details of product manufacture are closely held to prevent competitors from replicating procedures and procedures conditions. These details are only shared under strong non-disclosure agreements and are not made publicly available.
  - Demonstration of potential harm. If process information were to be revealed, competitors could try to copy the design and process, leading to loss of knowhow and market position. Even a portion of the full process information could be used to "reverse engineer" the process.
  - Limitation to validity of claim. This claim is valid indefinitely.

- **Blank 2:** Cost and time information

  - Demonstration of commercial interest. Information on the cost and time to substitute Cr(VI) could be used to calculate the applicant's production cost and Cr(VI)-free products forecasted availability, which could be used by competitors to gain a market advantage or by suppliers to drive up the value of crucial materials. This also applies to historical investments incurred by the applicant as well as business performance figures, applicant´s market position, applicant client's names and suppliers.
  - Demonstration of potential harm. Disclosure of the cost and time of substitution could harm the applicant's business by giving insights to competitors and revealing potential vulnerabilities to suppliers.

    Limitation to validity of claim. This claim is valid indefinitely.