CHEMICAL SAFETY REPORT

Legal name of applicant(s):	*APPH Ltd*
Submitted by:	*APPH Ltd*
Substance:	*Chromium trioxide [CAS 1333-82-0; EC 215-607-8]*
Use title:	*Use of chromium trioxide for functional chrome plating of aircraft components for civil & military sectors that meet the airworthiness certification requirements and hydraulic components for military vehicles*
Use number:	*1*

Public version

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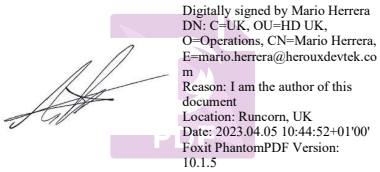
LIST OF ABBREVIATIONS

ACH	Air Changes Per Hour
AfA	Application For Authorization
APF	Assigned Protection Factor
ART	Advanced Reach Tool
BMGV	Biological Monitoring Guidance Value
Clocal	Local Concentrations
COSHH	Control Of Substances Hazardous To Health
Cr0	Zero Valent Chromium
CrIII	Trivalent Chromium
CrO3	Chromium Trioxide
CrVI	Hexavelent Chromium
CSR	Chemical Safety Report
DU	Downstream Users
ECS	Environmental Contributing Scenario
EEA	European Economic Area
ELR	Excess Lifetime Risk
EMS	Environmental Management System
EN 12941	A standard that specifies minimum requirements for powered filtering devices for respiratory protection
ERC	Environmental Release Category
ES	Exposure Scenario
EU	European Union
EUSES	European Union System For The Evaluation Of Substances
G#	Group Number (Workers)
HSE	Health, Safety And Environment
IBC	Intermediate Bulk Container
LEV	Local Exhaust Ventilation
LoD	Limit Of Detection
MRO	Maintenance, Repair And Overhaul
OC	Operating Conditions
OELVs	Occupational Exposure Limit Values
OHS	Occupational Health And Safety
PEC	Predicted Environmental Concentration
PNEC	Predicted No Effect Concentration
PPE	Personal Protective Equipment
PROC	Process Category
RAC	Risk Assessment Committee
RAR	Risk Assessment Report
RMM	Risk Management Measure
RPE	Respiratory Protective Equipment
SEA	Socio-Economic Analysis
TH3	Standard EN 12941 class of performance
TPM	Total Preventative Maintenance
TWA	Time Weighted Average
W/W	Weight By Weight
WCS	Worker Contributing Scenario
WEL	Workplace Exposure Limit
WWTP	Waste Water Treatment Plant

DECLARATION

The Applicant, APPH Ltd is aware of the fact that evidence might be requested by UK HSE to support information provided in this document.

Also, we 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 (05/04/2023) 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 the third party whose commercial interests are at stake.



Signature: Mario Herrera Hortal Date, Place: Runcorn, 05/04/2023

9. EXPOSURE ASSESSMENT (and related risk characterisation)

This exposure assessment for APPH Ltd, referred to as APPH from here on aims to provide reliable estimates for exposure to workers and to humans via the environment coming from the use of chromium trioxide at its site in Runcorn, UK from its the chrome plating process in the production and maintenance, repair and overhaul (MRO) of aircraft components for military and civilian sectors.

APPH's use of chromium trioxide for functional chrome plating is covered by the authorisation granted to Elementis with the authorisation number 37UKREACH/20/18/12. The authorisation decision was grandfathered to UK REACH following the entry into force of UK REACH on 01.01.2021. The expiry date for the review period granted is 21.09.2024.

Workplace exposure limits (WELs) are British occupational exposure limits and are set in order to help protect the health of workers. WELs are concentrations of hazardous substances in the air, averaged over a specified period of time, referred to as a time-weighted average (TWA). Substances that have been assigned a WEL are subject to the requirements of COSHH. The WEL values for CrVI compounds are given in Table 1. A so-called biological monitoring guidance value (BMGV) has also been set for CrVI compounds and the value is 10 μmol/mol creatinine (ca. 6.3 μg/l) in post-shift urine. BMGV values are non-statutory and are intended to be used as tools in meeting the employer's primary duty to ensure adequate control under COSHH. Where a BMGV is exceeded, it does not necessarily mean that any corresponding airborne standard has been exceeded or that ill health will occur. It is intended that where they are exceeded, this will give an indication that investigation into current control measures and work practices is necessary

APPH has technical and organisational measures in place to prevent and reduce worker exposure to the extent possible. It has occupational exposure monitoring campaigns in place. In particular, it has a biomonitoring program in place for more than 20 years and no value has been above the BMGV.

Table 1. Workplace Exposure Limit (WEL) values for CrVI

Substance	**Workplace exposure limit**		**Comments**
	Long-term exposure limit (8-hr TWA reference period) (mg/m^3)	**Short-term exposure limit (15-minute reference period) (mg/m^3)**	
Chromium (VI) compounds (as Cr)	0.01 0.025 (process generated)[1]	-	Carc, sen, BMGV
[1] 'Process generated' refers to exposures to Chromium (VI) Compounds generated as a result of a work process, such as fumes from welding.			

Table 2. Biological Guidance Monitoring value (BMGV) for CrVI

Substance	**Biological monitoring guidance values**	**Sampling time**
Chromium VI	10 μmol chromium/mol creatinine in urine	Post shift

9.1 Introduction

9.1.1. Overview of uses and Exposure Scenarios

The highest annual forecast tonnage used at the site is the value used in the assessment; #B [0.5-1.5] tonnes chromium trioxide/year (#B [0.25-0.75] tonnes CrVI).

APPH has 1 chrome plating line at its Runcorn site for chrome plating engineering components in the production and maintenance, repair and overhaul (MRO) of aircraft components for military and civilian sectors. The chrome plated components include structural parts of landing gear systems as well as items such as hydraulic units (e.g. actuators, valves, accumulators) and flight controls. In addition, APPH chrome plates hydraulic components for military vehicles. The plating process was designed in 1995 as a manual process due to variety in the sizes and shapes of the components plated. Retro-fitting automation is not possible without major rebuilding. The plating line is not segregated in the plant for the same reason.

Table 3 lists the exposure scenario (ES) assessed in this CSR.

Table 3. Overview of exposure scenarios

Identifiers*)	Market Sector	Titles of exposure scenarios	Tonnage (tonnes per year)
ES 1 IW-1	Industrial end use at site	Industrial use of CrO3 for chrome plating engineering components	#B [0.5-1.5] (approx. #B [0.25-0.75] CrVI)

The environmental contributing scenario and worker contributing scenarios are summarised in Table 4.

Table 4. Overview of Contributing Scenarios

Contributing scenario	ERC / PROC	Name of the contributing scenario	Size of the exposed population
ES 1:			
ECS1	ERC 6b	Industrial use of CrO_3 in the production of chrome plated engineering components	Regional: 20M Local:10t
WCS 1	PROC 1	Delivery and storage of CrO_3	#B[1-10]
WCS 2	PROC 13	Manual chrome plating operations	#B [5-50]
WCS 3	PROC 8b	Sampling chromate baths	#B [1-10]
WCS 4	PROC 8b	Concentration adjustment of baths	#B[1-10]
WCS 5	PROC 28	Regular maintenance	#B[1-10]
WCS 6	PROC 28	Rare maintenance	#B[1-10] +#B [2-20] (external)
WCS 7	PROC 8b	Waste and wastewater management	#B [1-10]
WCS 8	PROC 0	Far field exposure – tasks done in the hall	#B [5-50]

9.1.2. Introduction to the assessment

This Chemical Safety Report (CSR) and related exposure scenario has been prepared to support the APPH application for authorisation (AfA) for the continued use of chromium trioxide in functional chrome plating in the production and maintenance, repair and overhaul (MRO) of aircraft components for military and civilian sectors and hydraulic components for military vehicles at its site in Runcorn, UK.

An entry for Chromium trioxide was included on Annex XIV of the REACH Regulation due to its intrinsic properties as a carcinogen (Carc.1A) and mutagen (Muta.1B). As per Art, 62(4)(d), an application for authorisation needs to solely consider those potential risks coming from the intrinsic properties given in the entry. Accordingly, the report only considers potential human health impacts and does not consider potential environmental impacts. However as humans many be exposed via the environment, this is considered in the assessment.

9.1.2.1. Environment

As outlined above, potential risks to the environment are not considered in the CSR.

9.1.2.2. Humans via the Environment

Humans may be potentially exposed to CrVI via the environment due to air emissions from the site and via the food chain due emissions to wastewater from the site. An assessment of the oral exposure via the food chain and inhalation exposure to local and regional populations has been performed in this CSR. The Runcorn site has ISO14001 certification for its environmental management system (EMS). CrVI emissions to the environment are controlled by APPH and monitored according to national legislation. The monitoring is done by certified external service providers. As APPH has measures in place to prevent and minimise release of CrVI to the environment, releases to air are very low and negligible for soil and water. These measures are described in the next sections.

Releases to wastewater

There is no release of CrVI containing wastewater from the site. All CrVI containing wastewater that is not recycled to top up bath volume is collected and taken for treatment off-site by an authorised waste contractor. CrVI containing rinse waters are collected in the sump within bund area and pumped to a holding tank for collection by tanker from authorised waste contractors for treatment off-site. The CrVI in the wastewater is ca. 0.01-0.3 % (w/w). There are spill protocols integrated into the site EMS system.

The chromic acid baths are above ground with secondary containment in case of spills. The line is located within a bunded area. The baths are reinforced and lined with PVDF. There are regular visual checks for leaks and there are high sump alarms to detect leaks . Spent acid is collected by tanker by authorised waste contractors for treatment off-site. The solid waste streams produced continually during normal work activities (including empty CrO_3 drums, cloths, absorbing material, used PPEs) are collected and kept in closed waste storage bins.

APPH therefore has measures in place to ensure that there are no releases of CrVI to the aquatic compartment.

Releases to air

CrVI may be released to workplace air from the chromic acid baths during the plating process. Mist suppressants are added to the chromic acid baths to prevent aerosol formation during plating. There is LEV (fixed extraction hoods) installed in all chromic acid baths and LEV is on 24/7. The LEV exhaust gas passes through wet scrubbers before release from stacks at the site. There is a horizontal wash unit incorporating knitted polypropylene mesh pads and two sets of water spray to wash the exhaust air. The CrVI content of treated exhaust gas is tested annually by external providers according to standard protocols for sampling and analysis. The effectiveness of the abatement is > 99 %. The scrubber wash water is collected in the sump and removed as waste water. The ventilation and abatement system has scheduled regular maintenance.

Figure 1. Photo of the scrubber unit in place

Releases to soil

There are no releases to soil due to the technical and organisational measures in place at the site.

All waste streams containing CrVI are collected on site and collected for treatment off-site as hazardous waste in accordance with UK regulations.

Table 5. Environmental RMMs at the APPH site

Compartment	RMM	Stated effectiveness
Air	Wet scrubber – all CrVI containing exhaust air is treated before release	> 99 %
Water	All CrVI containing wastewater is collected and taken for treatment off-site	100 %
Soil	All CrVI containing waste is collected by authorised waste contractors	100 %

Scope and type of assessment:

The exposure and risk is expressed as CrVI. Exposure to CrVI causes lung cancer via the inhalation route and intestinal cancer via the oral route. All airborne CrVI particles are assumed to be respirable and oral exposure to non-respirable particles is not considered for the following reasons;

(i) Exposure calculations (airborne concentrations) do not give different particle size (inhalable/thoracic/respirable)

(ii) The additional lifetime risk (ELR) of intestinal cancer is one order of magnitude lower than that of lung cancer. The assessment of health effects is thus dominated by the potential risk of lung cancer due to CrVI inhalation

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

Oral exposure due to inhalation of non-respirable particles is therefore not considered in this assessment. As the potential risk of lung cancer is one order of magnitude greater than the potential risk of intestinal cancer, this is a worst-case approach. The additional risk of intestine cancer via oral exposure via the food chain (drinking water and fish) is assessed quantitatively.

The scope and type of assessment is summarised in Table 6.

Table 6. Type of risk characterisation required for human via the environment

Route of exposure and type of effects	Type of risk characterisation	Hazard conclusion RAC/27/2013/06 Rev.1
Inhalation: Systemic Long Term	Quantitative	Lung cancer: ELR = 2.9E−02 per µg CrVI/m³ for 70 years
Oral: Systemic Long Term	For inhalation of particles: not needed. Assume all inhaled material is respirable (worst case). For food chain: quantitative	Intestinal cancer: ELR = 8.0E−04 per µg CrVI/kg bw/d for 70 years

9.1.2.3. Workers

The Exposure Scenario gives the operating conditions (OCs) and risk management measures (RMMs) in place at the APPH site to minimise exposure.

The following technical risk management measures are in place

- All chromic acid baths have LEV installed (see Figure 2) and it is on 24/7
- Mist suppressants are used in the plating baths to prevent aerosol formation during plating

The plating hall is in a segregated area. The LEV flowrate is monitored and there is a visual alarm if airflow decreases or stops. The alarm triggers a manual shutdown of plating on the line.

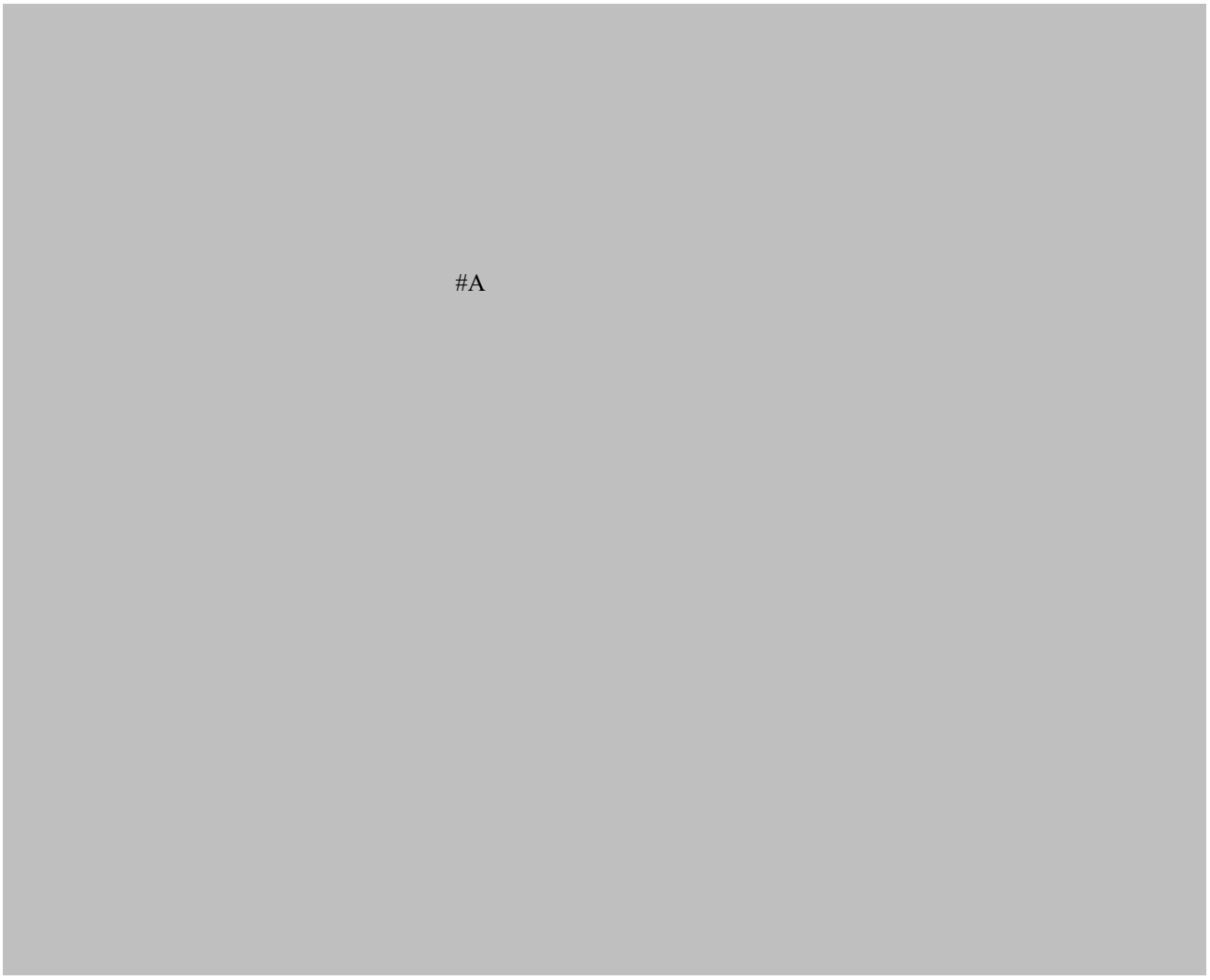


Figure 2. LEV positions on the chromic plating baths (arrows)

The following operational risk management measures are in place:

- There are documented procedures in place for plating production and for emergencies including spills, splashes and leaks. All operators are trained on the procedures.
- There are training programs in place for new workers and regular refresher training. Only trained operators are permitted to work in the hall. Training is given for any change in environmental management system (EMS) documentation. Training records are kept. The training includes how to work safely with chemicals, which PPE and RPE to use for their tasks, how to employ and fit them properly, and which procedures to follow to minimize the risks. Details of the programs are given Appendix I.
- All RPE is used as per the manufacturers' instructions on fitting, filter replacement, cleaning, storage and disposal. Fit testing training will be implemented in Q2 2023 for all employees who use RPE and fit testing will be integrated into the existing protocols for PPE and RPE usage.
- The LEV and abatement systems are regularly maintained as per scheduled maintenance programs and records are kept.

- Occupational monitoring programs are in place and the results are used to review operating conditions and risk management measures to further reduce exposure to the extent possible

There are dedicated changing facilities for operators to change their clothing before and after shifts. An external provider supplies the PPE and laundry services. For tasks where there is potential for exposure via inhalation, RPE is worn. An overview of PPE and RPE used for specific worker contributing scenarios is given in Table 7 and Table 8

All operators from external service providers doing tasks where there is potential for exposure, are trained in accordance with the same requirements by their employers as described in company policy “Control of Facilities Contractors Policy and Procedure” and integrated permit to work system. The checklist to be completed by external contractors pre-work and the” Visitors and Contractors HS&E Briefing leaflet” is given in Appendix 1.

Table 7. Overview of the PPE used by the workers performing tasks described in WCS 1-8

	Type of PPE	Conforming to the following standards	Photo	Relevant for
Safety footwear	Safety shoes S3	EN ISO 20345:2011 S3 WR HRO SRC		WCS 1-8
	Safety boot S5	EN ISO 20345 S5 HRO SRA CI FO		WCS 1-8
Eye and face protection	Safety glasses	CE Certified • EN166 • EN170 • EN172 • Optical Class 1 - Continuous work		WCS 1-8
	Faceshield	EN166 2.3 B9		2, 3, 5, 6, 7
Gloves	Chemical resistant gloves	EN 388: 2003 Rating: 4121 EN 374: 2003 Rating: 364 (JKL)		2-7

	Technical gloves	• CE Category III • EN ISO 374-1:2016 Type B JKPT • EN 374:2003 • EN 420:2003 + A1:2009 • EN ISO 374-5:2016 Virus • FDA21 CFR 177-2600 • ISO 9001		1
Protective clothing	Protective coveralls	• CE Category III, Type 5 & 6 • EN1073-2 • EN1149-5 Antistatic		4, 5*, 6*
	Overalls work clothing	Fabric to EN13034 or equivalent		1-8
	Apron	• EN14605:2005 + A1:2009 Type PB [4]		4*, 6*

Respiratory protection	3M Versaflo Air fed Respirator system with ABE1P filter	CE approved and rated to EN 12941 TH3, EN 166:2:F:3 and EN14594 3A		4, 6*

*some tasks

Table 8. Summary overview of PPE for the tasks covered by WCS 1-8

		Eye protection		Gloves		Protective clothing			Safety footwear	RPE
		Safety glasses	**Face shield**	**Chemical resisitant**	**Technical**	**Work clothing**	**Apron**	**Single use coveralls**	**S3 Shoes/ S5 boots**	**3M® Versaflow Air fed Respirator system (TH3)**
1. Delivery and storage of CrO_3	Taking delivery, transfer to storage area	x			x	x			x	
2. Manual chrome plating operations	Tasks in the plating area for preparation, translation of pieces and rinsing	x	x	x		x			x	
3. Sampling chromate baths	Collect samples from the baths	x	x	x		x			x	
4. Concentration adjustment	Addition of solid CrO_3 to the baths	x		x		x	x	x	x	x
5. Regular maintenance	Different tasks	x	x	x		x		x*	x	
6. Rare maintenance	Different tasks	x	x	x		x	x*	x*	x	x*
7. Waste and wastewater management	Waste handling tasks and waste water treatment related tasks	x	x	x		x			x	
8. Far field exposure		x				x			x	

* For some tasks

Scope and type of assessment:

The scope of the exposure assessment and the type of risk characterisation required for workers are given in Table 9. The exposure estimates (ART 1.5) or measured values refer to the exposure of CrVI and are expressed as an 8-hour Time Weighted Average (TWA) to represent a standard working day of an employee.

Table 9. Type of risk characterisation required for workers

Route	Type of effect	Type of risk characterisation	Hazard conclusion (see RAC/27/2013/06 Rev.)
Inhalation	Systemic Long Term	Not needed	Not relevant
	Local Long Term	Quantitative	Lung cancer ELR = 4.0E−03 per µg CrVI/m³ for 40 years
Dermal	Systemic Long Term	Not needed	Not relevant
	Local Long Term	Not needed	Not relevant

As outlined in Chapter 9.2.1.2, all airborne CrVI particles are assumed to be respirable and the oral route of exposure coming from swallowing non-respirable particles is not considered.

9.1.2.4. Consumers

Exposure assessment is not necessary as there are no consumer-related uses for chromium trioxide.

9.2. Exposure scenario 1: Industrial use of CrO_3 for chrome plating engineering components

Market sector: Use at industrial site

Sector of use: SU 17

Article categories: PC 14: Metal surface treatment products, including galvanic and electroplating products

Environment contributing scenario(s):

ECS 1: Industrial use of CrO_3 in the production of chrome plated engineering components (ERC 6b)

Worker contributing scenario(s):

WCS 1: Delivery and storage of CrO_3 (PROC 1)

WCS 2: Manual chrome plating operations (PROC 13)

WCS 3: Sampling chromate baths (PROC 8b)

WCS 4: Concentration adjustment of baths (PROC 8b)

WCS 5: Regular maintenance (PROC 28)

WCS 6: Rare maintenance (PROC 28)

WCS 7: Waste and wastewater management (PROC 8b)

WCS 8: Far field exposure – tasks done in the same hall (PROC 0)

Subsequent service life exposure scenario(s): none

Exposure scenario(s) of the uses leading to the inclusion of the substance into the article(s): none

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

The applicant APPH is part of Héroux-Devtek, the leading provider of landing gear systems and components to a diverse array of aircraft manufacturers. At APPH, the chrome coating is applied to aircraft components during production as well as repair of worn or damaged components removed from aircraft during overhaul. The chrome plated components include structural parts of landing gear systems as well as items such as hydraulic units (actuators, valves, accumulators) and flight controls. The aircraft components are supplied to all types of aircraft including military helicopters, advanced fighter jets, civil airliners and business jets.

At APPH, chrome plating is applied to many components of the landing gear including all the major ferrous parts of the equipment: sliding pistons, attachment pins, axles, hydraulic cylinders etc. In total, APPH applies chrome plating to #B unique part numbers across the entire legacy product range as well as some of the new landing gear developments. In addition, APHH chrome plates hydraulic components for military vehicles. The chrome plated components must perform under sever loading conditions and in many different environments and have therefore very stringent requirements for performance. Examples of these components are given in Figure 1.

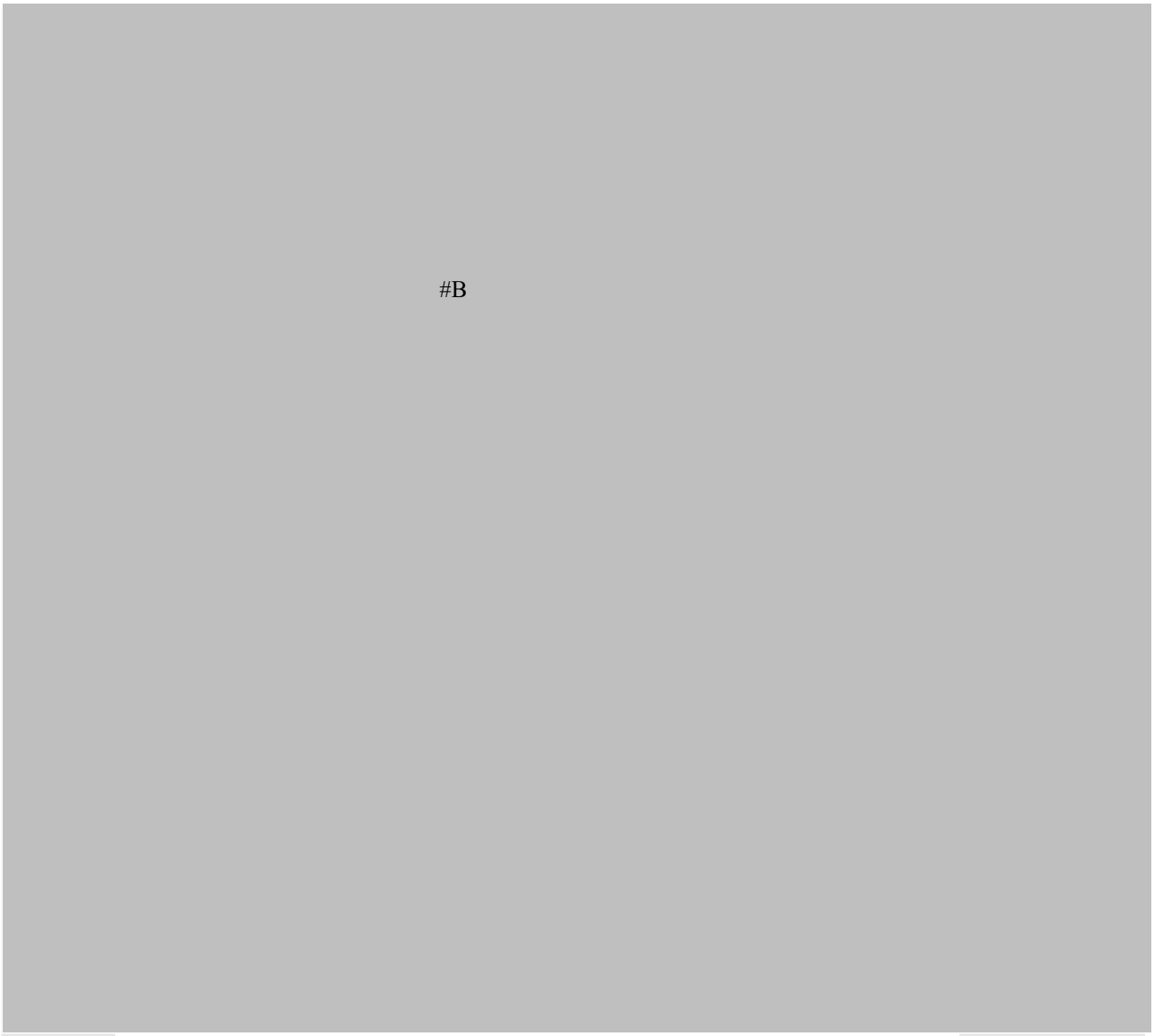


Figure 3. Examples of components chrome plated (the red arrows indicate the chrome plated surfaces)

Chrome plating is a multistep industrial process that involves the sequential modification of the component surface to yield a uniform adherent chrome layer. The steps in the plating process are summarised in Figure 4.

Figure 4. Overview of the chrome plating process – steps 5-14 are done on the line

The process has a pre-treatment, plating and post plating steps. Steps 1-4 are done off the line, step 5 may be done both off the line and on the line, steps 6-14 are done on the line and 15-16 off the line. The line has #B chromic acid etch bath and #B plating baths. There are additionally cleaning baths, #B. The line layout and details of the baths are given in Figure 5. The baths are above ground and accessed via a raised catwalk at bath surface level. The baths are open, fitted with LEV on 2 sides and LEV is on 24/7. Mist suppressants are used in the plating baths to prevent aerosol formation.

In the pre-treatment steps, the parts are loading on jigs after #A The jig is moved to the line #A #A The process method for components loaded to jigs ready for chrome plating is given below:

1. Parts cleaned manually over #A tank with #A pad to achieve a water break finish.
2. Parts immersed in Alkaline clean bath for #A
3. Part removed and rinsed in #A.
4. Either, parts are immersed in #A followed by 5.

   Or

   Parts are immersed in #A followed by 6.

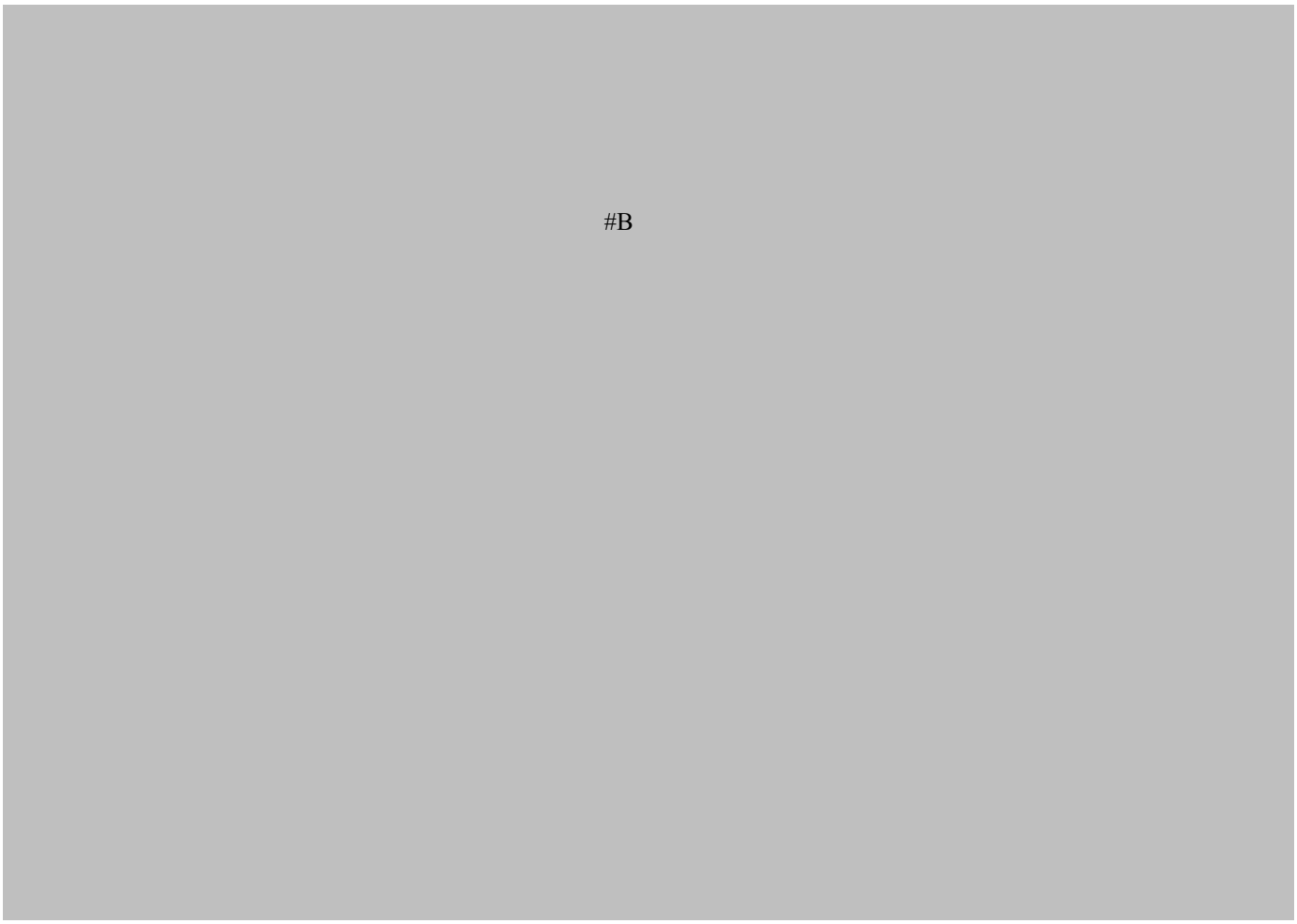
   Or

   Parts are immersed in #A seconds followed by 6.
5. Parts are removed and rinsed in #A
6. Parts immersed in #A
7. Power is applied at #A, then #A for the required plating time. #A
8. When required plating time is achieved, #A. The component is then removed from the bath #A If part is removed by overhead crane, it will be rinsed down over the bath with water using a hose spray. The part is then moved

#A

9. Parts are then moved to the inspection area on the raised gantry for visual and dimensional check.
10. #A
11. Part and jigs are then moved to the degreaser, off the line, for the final cleaning process.

The post-treatment steps (heat treatment and polishing if relevant) are done off the line in other areas of the hall.



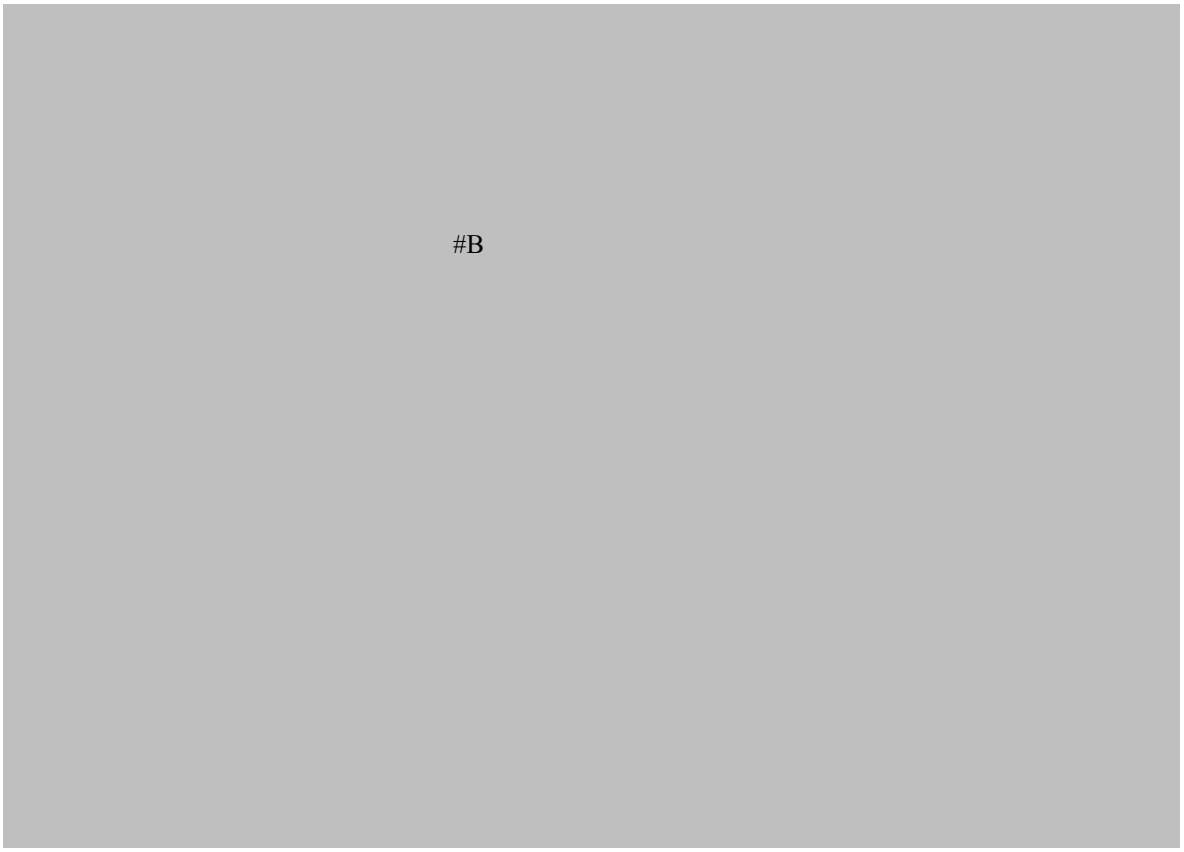


Figure 5. Plating hall layout showing the location of the chrome plating line (a) 2D rendition with baths labelled and (b) 3D rendition of the plating hall

The plant is operational for 353 days per year and runs in a 3 shift pattern Monday to Friday (8 hours per shift) and a weekend shift on Saturday and Sunday (single 12 hour shift on each day). **#B** [5-50] plating operators work in the plating hall and **#B** [2-20] external maintenance contractors have tasks where there is potential for exposure to CrVI. These workers are grouped according to the tasks done as outlined in Table 10. Plating operators spend ca. **#A** mins on the chrome plating line in a typical shift and the rest of their shift doing other tasks in the hall.

Table 10. Summary of worker groups doing tasks with potential for exposure to CrVI

Exposure groups	description	Tasks with potential for exposure to CrVI	Details of what they do	Total number of operators in the group	List of WCSs
Group 1	Hall plating operators	Daily tasks related to operating the chrome plating process and all other tasks done in the same hall	All WCSs	**#B** [5-50]	All WCSs
Group 2	External service providers	Contractors that do specialized maintenance tasks in the hall relating to the plating lines	Repairs to plant, pipework, total preventative maintenance tasks (TPMs), cleaning etc.	**#B** [2-20]	WCS 7 Rare maintenance (sub-scenario)

Explanation on the approach taken for the ES:

Occupational exposure estimates are based on measured data from monitoring campaigns and on modelled data. Inhalation exposure was estimated using the Advanced REACH Tool 1.5 (ART) exposure model. ART is a second-tier model calibrated to assess exposure to inhalable dust, vapours, and mists; this Exposure Scenario is within the scope of ART. The ART print outs are given in Appendix 3. The ART output values give the CrO_3 concentration values and these were corrected to give the CrVI concentration values. The modelled valued are compared with relevant measured exposure data (measured concentrations of particulate residues of CrVI in air), where available. The risk characterisation is based on both exposure modelling and measured values.

APPH regularly performs workplace static, personal and biomonitoring exposure monitoring. Sampling and analysis for static and personal measurements are done according to standard methods (NIOSH 7300 and NIOSH 7600)[1]. The occupational air monitoring is done annually by an external service provider and as per the conditions of the Elementis authorisation decision. Static air monitoring from 2021 and personal air monitoring from 2022 values are used in the assessment.

Static measurements

A summary of the results from the 2021 campaign is given in Table 11. Full details and site maps showing the location of the samplers are given in Appendix 2. The analysis method used (NIOSH 7300) determined total chromium and may overestimate CrVI content of workplace air.

Table 11. Summary of 2021 static air monitoring data

Relevant for WCS	Contextual information	Sample number	8h TWA value (µg/m³)	Relevant value for exposure assessment (µg/m³)
WCS 2, 3	Location: On the line next to the chromic acid baths	N=2	1, 3	3
WCS 2	Location: On the line further from the chromic acid baths	N=2	1, 2	2
WCS 8	Location: Off the line far from the line (grinding area)	N=1	1	1
WCS 8	Location: off the line far from the line – middle of the hall	N=1	1	1

Personal measurements

Values from the 2022 personal monitoring campaigns are summarised in Table 12. Full details are given in Appendix I. 7 measurements monitoring exposure during a typical shift under normal production. The operators do a variety of tasks in the hall and spent ca. 90 mins on tasks on the chrome plating line. The values obtained were 2 for total chromium content (NIOSH 7300) and 1 for CrVI content (NIOSH 7600). Monitoring was also for a specific sub-task for WCS 4 (concentration adjustment of the baths). The amount of CrO_3 to be added to the baths is scooped from the drums to smaller containers at a weighing station in the preparation area. The transfer is done under LEV.

Table 12. Summary of 2022 personal air monitoring data

Relevant for WCS	Contextual information	Sample number	8h TWA value (µg/m³)	Relevant value for exposure assessment (µg/m³)
2 & 8	Device worn plating operators during a typical shift under normal production including ca. 90 mins on the chrome plating line	N=3 N=4	1 CrVI (NIOSH 7600) 2 Total Cr (NISOH 7300)	1
4	Device worn by plating operators during weighing tasks (specific task under WCS 4)	N=2	1, 1* CrVI (NISOH 7600)	1

**short duration sampling*

Biomonitoring program

An annual biomonitoring program for all operators in the plating hall has been in place for more than 25 years. Urine samples are collected post-shift and analysed for total chromium content by an accredited external laboratory. The total urinary chromium value is compared with the BMGV (10 µg chromium/µmol creatinine) by the occupational health care provider and the results are shared with the operator. The occupational health care provider is responsible for the monitoring will propose actions if values are greater than the BMGV. No values have been greater than the BMGV. Aggregated anonymised data available on request.

[1] NISOH 7300 available at https://www.cdc.gov/niosh/docs/2003-154/pdfs/7300.pdf; NISH 7600 available at https://www.cdc.gov/niosh/docs/2014-151/pdfs/methods/7600.pdf

The detailed exposure scenario was developed based on details of the conditions under which each activity is carried out and the duration and frequency of each task. The frequency of a specific activity in the worker contributing scenarios is expressed as daily activity unless otherwise stated.

As outlined in Chapter 9.1, APPH has measures in place to minimise release to the environment. All CrVI containing wastewater is internally recirculated and there is no release from the site. All CrVI containing exhaust gases are treated before release to the atmosphere and the air emission values are below the limit value given in the site environmental permit. Exposure to humans via environmental releases is based on monitoring data using applicable models (EUSES) and guidance.

9.2.1. Environmental contributing scenario 1: Industrial use of CrO_3 in the production of engineering components

9.2.1.1. Introduction

Emission to water

All CrVI containing wastewater is collected and taken for treatment off-site by authorised waste contractors. There is no emission of process wastewater from the chrome plating line to the sewerage or surface water from the site.

Emission to air

APPH has an annual air emissions program and monitors the CrVI content of the treated exhaust gases. Exhaust air from the LEV points on the chrome plating line plant is treated by wet scrubber before release from the stack. The monitoring is performed every year by an accredited external service provider and done in accordance with standard methods for sample collection and analysis (US EPA Method 0061) under normal operating conditions of the plant. Emission values from the past 4 years were used to estimate the release rate. Measured CrVI values (mg/m^3) were converted to grams released per hour using the measured mass flow rate (m^3/h). The emission per day was estimated as the amount of emission for 24 hours emission. The emission per year was estimated using the number of days the site is operational (353 days). The release rate for a given year was estimated by dividing the amount released by amount used. Details are given in Appendix 2. The 90^{th} percentile of values from 2019-2022 was used in the assessment. The highest forecast annual tonnage value was used in the assessment as a worst case. The Excel with the EUSES print out is included with the submission.

9.2.1.2. Conditions of use

Amount used, frequency and duration of use (or from service life)
• Daily use amount at site: ≤ **#B** tonnes/day
• Annual use amount at site: ≤ **#B** tonnes/year
Conditions and measures related to biological sewage treatment plant
• Biological STP: Standard [Effectiveness Water: 0.149 %]
• Discharge rate of STP: ≥ 2E3 m^3/day (default value)
• Application of the STP sludge on agricultural soil: Yes
Conditions and measures related to external treatment of waste (including article waste)
• Particular considerations on the waste treatment operations: No (no waste) *No waste generated.*
Other conditions affecting environmental exposure
• Receiving surface water flow rate: ≥ 1.8E4 m^3/day (default value)

9.2.1.3. Releases

Table 13. Local releases to the environment

Release	Release estimation method	Explanations
Water	Estimated release factor	**Release factor after on site RMM:** 0 %
Air	Estimated release factor	**Release factor after on site RMM:** 8.6E-01 % **Local release rate:** **#B** kg/day
Non-agricultural soil	Estimated release factor	**Release factor after on site RMM:** 0 %

9.2.1.4. Exposure and risks for the environment and human via the environment

The release factors to water and air used in the assessment are given in Table 13. The predicted environmental concentration in the atmospheric compartment (PECair) for both local and regional scales were estimated using EUSES 2.2.0. For waste treatment operations input parameters, “No (no waste)” was chosen as there is no release of waste to the environment. The other parameters are default EUSES values.

Table 14. Exposure concentrations for the environment – on local and regional scales

Protection target	Local scale	Regional scale
Air	**Local PEC:** 4.43E-06 mg/m³	**Regional PEC**: 3.28E-14 mg/m³
Man via environment - Inhalation (systemic effects)	**Concentration in air:** 4.43E-06 mg/m³	**Concentration in air:** 3.28E-14 mg/m³

Table 14 gives the local and regional PEC values estimated with EUSES. The local PEC value was used as the worst-case estimate of $Clocal_{air,ann}$= 4.43E-06 mg/m³. This value was used for the risk characterisation for humans via the environment.

Table 15. Contribution to oral intake for humans via the environment from local contribution

Food item	**Daily dose (local)** mg/kg bw/day	**Daily dose (regional)** mg/kg bw/day
Drinking water	4.59E-07	1.17E-08
Fish	1.59E-10	1.59E-10
Sum	4.59E-07	1.19E-08
Corrected for transformation to CrIII	1.38E-08	3.57E-10

Table 15 gives the estimated daily doses of CrVI through drinking water and fish for local and regional populations from air-emission and water emission values. The values are corrected for the transformation of CrVI to CrIII in the environment according to the European Risk Assessment Report (EU RAR 2005)[2]. The corrected values are used for the risk characterisation for intestinal cancer via the food chain.

Conclusion on risk characterisation:

Using the dose response curves given in Table 6, the excess lifetime cancer risk values for lung and intestinal cancer for local and regional populations can be estimated. The values are given in Table 16.

Table 16. Individual excess life cancer risk values of lung and intestinal cancer for local populations

Individual Excess Lifetime Cancer risk	**Local**	**Regional**
Individual Excess risk of lung cancer for general population 70 years	1.28E-04	9.52E-13
Individual Excess risk of intestinal cancer for general population over 70 years	1.10E-08	2.85E-10

[2] The rationale comes from the "European Union Risk Assessment Report for chromium trioxide, sodium chromate, sodium dichromate, ammonium dichromate and potassium dichromate" report 3rd Priority List Volume 53, European Commission, Joint Research Centre EUR 21508 EN. http://echa.europa.eu/documents/10162/3be377f2-cb05-455f-b620-af3cbe2d570b. As outlined in this report
"*For the risk assessment, it will be assumed that for acidic (or neutral, where high concentrations of reductants for chromium (VI) exist) soils, sediments and waters, chromium (VI) will be rapidly reduced to chromium (III) and that 3% of the chromium (III) formed will be oxidised back to chromium (VI). The net result of this is that of the estimated chromium (VI) release to the environment, 3% will remain as chromium (VI) and 97% will be converted to chromium (III).*"

9.2.2. Worker contributing scenario 1: Delivery and storage of CrO_3 (PROC 1)

Chromium trioxide is delivered in sealed 25 kg drums once or twice a year. Typically 8 drums are delivered on a pallet and the pallet is transferred to the acid storage area. The acid storage area is in a separate room in the plating hall. The task takes about 10 mins and may be done by any one of approx.**#B** [1-5] Group 1 operators. The drums are stored in a separate storage room. The room is locked and access is controlled to authorised personnel. The storage room has spill containment measures in place.

The drums are never opened in the storage area. Drums are taken from storage as needed for concentration adjustment (WCS 4). The drums are mounted on a trolley with secondary containment in case of spills. This is done by 2 Group 1 operators typically once per month and takes 5 mins.

There is no potential for exposure to the operators for deliver and storage of CrO_3 as the drums remain sealed in the storage area. Operators wear work clothing, safety glasses, safety shoes/boots and technical gloves.

Figure 6. Photos of (a) the acid storage area, (b) the sealed CrO_3 drums on shelves in the storage room and (c) labels on the drums

9.2.2.1. Conditions of use

	Method
Product (article) characteristics	Qualitative
• Substance as such /in a mixture • Concentration of CrO_3: 100 %	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 10 mins	
• Frequency: once a month	
Technical and organisational conditions and measures	
• Containment: Closed system (minimal contact during routine operations)	
• Local exhaust ventilation: No	
• Occupational Health and Safety Management System: Advanced*	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No	
Other conditions affecting workers exposure	
• Place of use: separate storage room	
• Process temperature: Room temperature	
* The OHS management systems in place can be considered as "advanced" as they comply with the provisions of the COSHH and control of exposure is adequate as it follows the principles of good practice for the control of substances hazardous to health, the WEL is not exceeded and exposure is reduced to as low a level as is practicably possible. All activities are undertaken with appropriate and well maintained equipment by trained personal operating under supervision; Ensure regular inspection, cleaning and maintenance of equipment and machines; Clear spills immediately and dispose of waste safely; Ensure daily cleaning of the equipment[3]	

9.2.2.2. Exposure and risks for workers

Conclusion on risk characterisation:

There is no potential for exposure. The qualitatively determined exposure estimate of 0 µg CrVI/m³ is used as the basis for risk characterisation giving a value for the excess lifetime cancer risk of 0 per 1000.

[3] Harmonised value as given in the ECHA ENES report "*Mapping of the Conditions of use (input parameters) of the different tools for workers assessment*" December 2020 available at https://echa.europa.eu/documents/10162/22786913/harmnised_conditions_of+use_for_workers_en.pdf/3b327551-19b3-5d56-8b13-a608695d4419

9.2.3. Worker contributing scenario 2: Manual chrome plating operations plating operations (PROC 13)

This scenario covers tasks done by plating operators on the chrome plating line. The chromic acid baths are the primary source of emission to workplace air and the workers are potentially exposed near field when they do tasks on the line. They may also handle contaminated objects (e.g. manual rinsing to remove chromic acid from objects that were in the bath).

The chrome plating process is described in Chapter 9.2. Details of the baths and process conditions are given in Appendix I. The parts to be plated are degreased off the line in a separate machine. Operators then clean, mask and attached to the relevant jigs in an area off the line. The operators then load large parts to the crane off the line and move them to the raised line. The operators move parts from one treatment bath to the next either manually or via the transport system. The parts are moved sequentially through the cleaning baths for cleaning and rinsing steps, to the sulphuric acid or chromic acid etch baths (depending on the part to be plated) for the etch site, to a plating bath (in-situ etch may be done before the plating depending on the part) for chrome plating to the rinse baths. The operators check the plate thickness and visually inspect for flaws. The operators remove the masking from the parts and they are taken off the jigs and taken off the line. The parts leaving the line do not have any residual traces of CrVI.

#B [1-10] plating operators spend up to 1.5 hours doing tasks on the line during a typical shift. Of this 1.5 hours, 1 hour is spent doing tasks that involve handling contaminated objects. Both are considered in the assessment. Other tasks done off the line not relating to chrome plating production by these operators in the same hall is covered under WCS 8. The operators wear work clothing, safety shoes/boots, safety glasses/face shield and chemical resistant gloves. There is static and personal monitoring data covering these tasks and this data is used in the assessment

Figure 7. (a) photo of a component loaded on the jig before plating (b) component immersed in the bath solution (c) plating component lifted from the solution

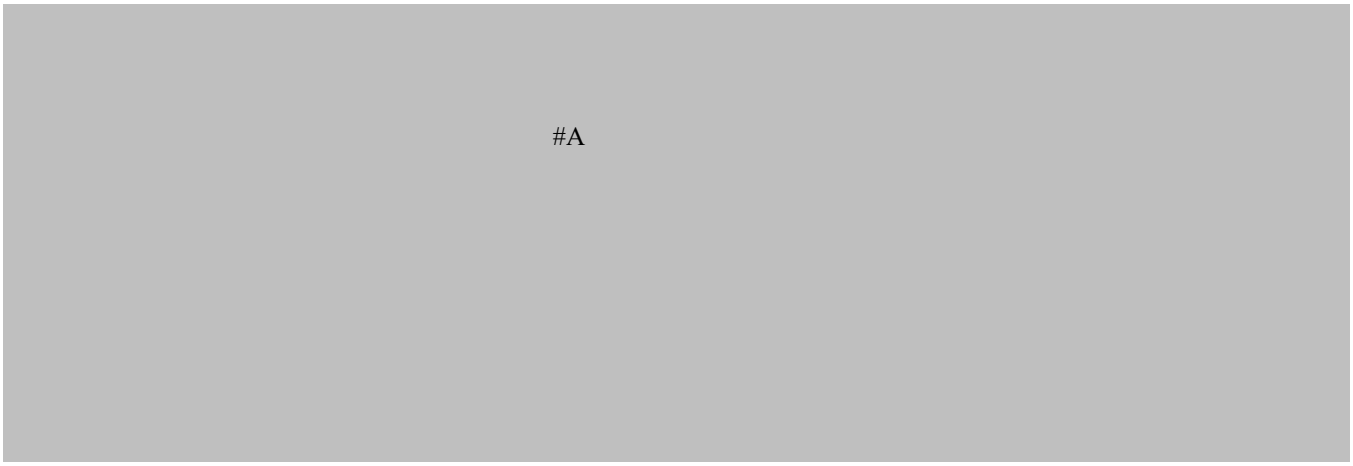


Figure 8. Photos of (a) an operator rinsing the plated part in place above the bath (b) an operator immersing the plated component in the rinse bath (c) the fully rinsed component (d) an operator removing masking

9.2.3.1. Conditions of use

	Method
Product (article) characteristics	Measured data
• Concentration of CrVI in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 90 mins on the line	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH • Containment: open process (mist suppressants used) • Local exhaust ventilation: Fixed capturing hood on all plating baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

9.2.3.2. Exposure and risks for workers

The measured and modelled exposure concentration is reported in Table 17. Personal monitoring data from the 2022 campaign covered tasks done on the line in a typical shift under normal production. The static air monitoring data available from the 2021 campaigns from devices on the line gave corrected for duration gave a value of 5.63E-01 µg/m^3. As the personal monitoring is a more reliable measure of actual exposure, personal monitoring data was used in the assessment.

Table 17. Exposure concentrations for WCS 2

Contributing Scenario	**Route of exposure**	**Method of assessment**	**Exposure value (8h TWA, µg/m^3)**	**Exposure value corrected for duration (µg/m^3)***
WCS 2	Inhalation	Measured (personal)	1	-
		Measured (static)	3	5.63E-01

* 90/480

Conclusion on risk characterisation:

The exposure estimate was based on the measured personal monitoring data. This gave an exposure value of 1 µg/m^3 and an ELR value of 4 per 1000 exposed workers.

9.2.4. Worker contributing scenario 3: Sampling chromate baths (PROC 8b)

This scenario covers collecting samples from the chromic acid baths. The plating baths are regularly sampled to control the electrolyte balance in the solution. The analysis results are used to determine when to top up with CrO_3 to maintain optimal concentrations.

The operator initiates the agitation of each bath by opening the tap located next to the bath to introduce air into the solution via pipes located at the bottom of the bath. The agitation runs for at least 15 minutes minimum prior to taking a sample from the bath. After this time, the operator returns to the line and switches off the agitation. The operator the collects a ca. 200 ml volume of solution to a 250 ml plastic bottle and caps the bottle. The bottle is rinsed in the rinse bath and then rinsed down with rinse water. The sample bottle is then dried, labelled, and packed ready to be sent for analysis by an external company.

#B [1-10] Group 1 operator does this task and spends 30 mins one the line once a month. The conditions of use considered the near field exposure coming from the proximity to the baths. The potential for exposure due from handling contaminated objects does not contribute significantly. There is static monitoring data available next to the baths during normal production and this is used in the assessment.

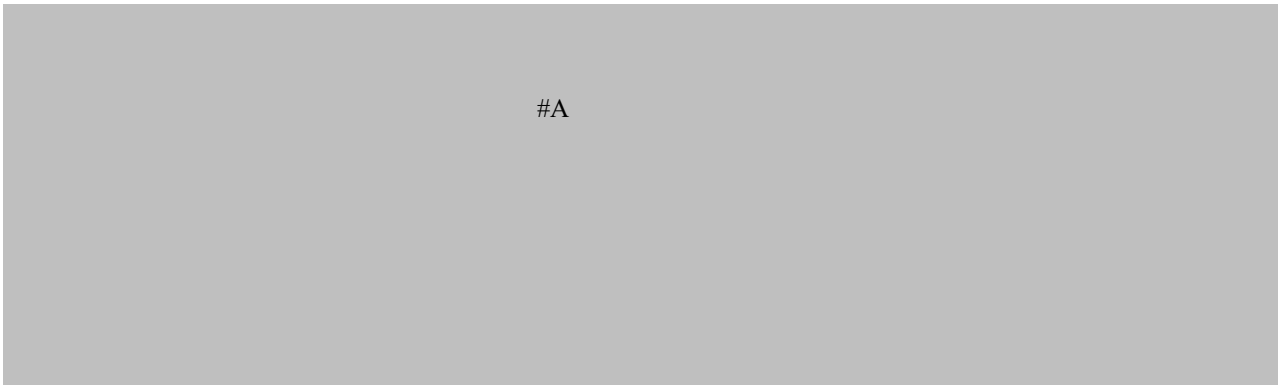


Figure 9. Photos of (a-c) an operator on the line collecting a sample and (d) the filled bottle labelled for transport to the external lab for chemical analysis

9.2.4.1. Conditions of use

	Method
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 30 mins per month	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH • Containment: open process (no aerosol formation - mist suppressants used) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

9.2.4.2. Exposure and risks for workers

The measured static exposure concentrations are reported in Table 18.

Table 18. Exposure concentrations for WCS 3

Contributing Scenario	Route of exposure	Method of assessment	Exposure value (8h TWA, µg/m^3)	Exposure value corrected for duration (µg/m^3)*	Exposure value corrected for duration and frequency** (µg/m^3)
WCS 3	Inhalation	Measured data (Static)	3	1.88E-01	9.38E-03

*30/480 ** 1/20

Conclusion on risk characterisation:

The exposure estimate was based on the measured static data. This gave an exposure value of 9.38E-03 µg/m^3 corrected for task duration and frequency. The corresponding ELR value is 3.751E-02 per 1000 exposed workers.

9.2.5. Worker contributing scenario 4: Concentration adjustment of baths with solid CrO_3 (PROC 8b)

This scenario covers the addition of solid chromium trioxide flakes to the plating baths. Chromium trioxide is the source of CrVI ions in the plating bath and is constantly depleted as CrVI is consumed. The bath solution must regularly be analysed for the CrVI content and the concentration adjusted with chromium trioxide to replenish the CrVI as necessary.

The CrVI concentration of the baths is adjusted by the addition of solid chromium trioxide flakes and is typically done once per month. #B[1-10] plating operators do this task and spend 30 mins on the line transferring the flakes to the bath and rinsing empty drums/containers. During the addition, access to the line is restricted to the operators doing the additions. Operator lifts the unopened drum onto the stainless-steel table located close up to the front of the bath, the seal and the lid are then removed from the drum. The contents of the bath are then transferred from the drum to the bath using a scoop/trowel. The drum is located close to the bath so any spills will go into the bath and not onto the floor.

If less than a full drum is required for dosing an individual bath, they may spend an additional 5 mins per bath to be dosed opening and measuring out the amount to be dosed at the weighing station. As a worst case, it is assumed that the weighing step is done for all dosing events giving a total of 25 mins per month. At the weighing station, the operator opens drums under LEV and the required quantity of chrome is measured out into a container using a scoop and electronic scales. This is done off the line by the chemical stores in the plating hall, with the area cordoned off using local extraction LEV. The container is then taken to the chrome plating line on a trolley and the contents transferred to the bath. It takes ca. 15 mins to transfer the contents to the bath. When the drum is empty, the operator then rinses the empty drum and lid using clean water from a hose pipe. The empty clean drum is then transferred to the waste acid area. It takes about 2 mins per drum to rinse the empty drums.

The operators wears coveralls, an apron and RPE (3M Versaflo Air fed Respirator system (TH3), chemical resistant gloves, and safety footwear.

4 sub-scenarios are considered in the assessment; 4a the activity of transferring flakes from the drum to smaller containers at a weighing station, 4b the activity of transferring the flakes to the bath, 4c rinsing the empty drum/container next to the bath and 4d the time spent on the line next to the open baths. There is personal and static monitoring data covering these task and these are used in the assessment. The measured data is compared with ART modelled values.

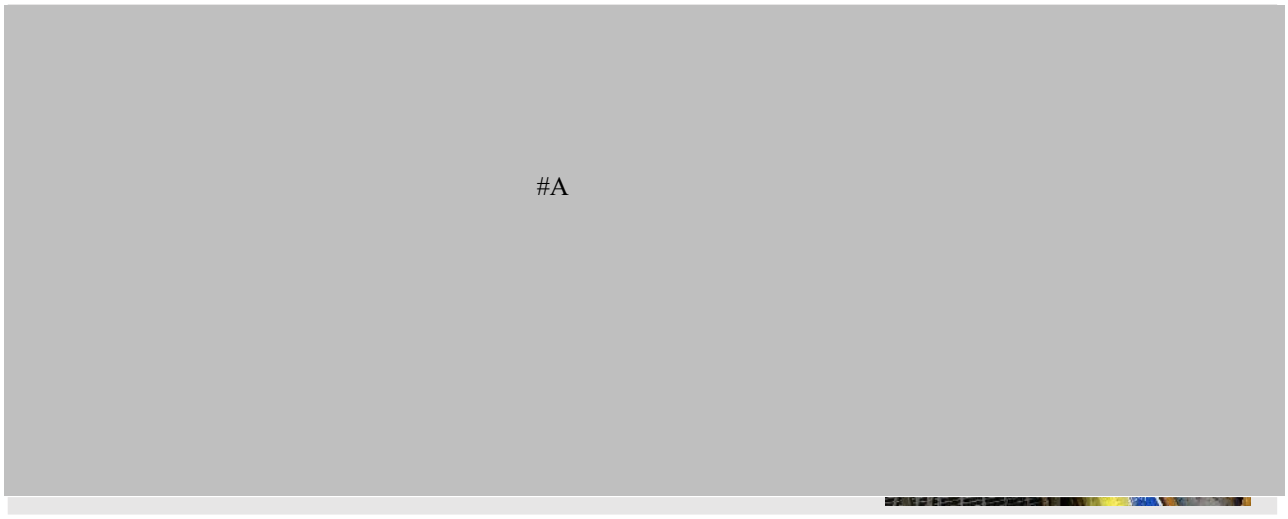


Figure 10. Photos of (a) transport of the closed drum from the storage area to the weighing station/line (b) weighing station with LEV arm over the open drum (c) transfer of the flakes to the bath

9.2.5.1. Conditions of use

4a. Transferring CrO_3 to smaller containers	**Method**
Product (article) characteristics/substance emission potential	ART/ Personal monitoring data
• Substance product type: Powders, granules or pelletised material	

4a. Transferring CrO_3 to smaller containers	Method
• Dustiness: firm granules, flakes or pellets	
• Moisture content: dry product	
• Powder weight fraction: Pure material	
Activity emission potential	
• Duration of activity: < 25 mins per month	
• Primary emission source located in the breathing zone of the worker: Yes	
• Activity class: Falling of powders, granules or pelletised material	
• Situation: Transferring 1-10 kg/min	
• Type of handling: Careful transfer involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner e.g. careful weighing in laboratory	
• Drop height: < 0.5 m	
• Level of containment: Open process	
Technical and organisational conditions and measures	
• Primary: Movable capturing hood (50.00 % reduction – ART input parameter)	
• Secondary: No	
• Process fully enclosed: no	
• Effective housekeeping practices in place: Yes	
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoor	
• Room size: small	
• Room ventilation: 5-10 ACH (10 ART input parameter)	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: 3M Versaflo Air fed Respirator (TH3) – APF 40[4]	

4b. Adding CrO_3 flakes into the bath	Method
Product (article) characteristics/substance emission potential	ART 1.5
• Substance product type: Powders, granules or pelletised material	
• Dustiness: firm granules, flakes or pellets	
• Moisture content: dry product	
• Powder weight fraction: Pure material	
Activity emission potential	
• Duration of activity: < 15 mins per month	
• Primary emission source located in the breathing zone of the worker: Yes	
• Activity class: Falling of powders, granules or pelletised material	
• Situation: Transferring 1-10 kg/min	
• Type of handling: Careful transfer involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner e.g. careful weighing in laboratory	
• Drop height: < 0.5 m	
• Level of containment: Open process	
Technical and organisational conditions and measures	
• Primary: Fixed capturing hood (90.00 % reduction – ART input parameter)	
• Secondary: No	
• Process fully enclosed: no	
• Effective housekeeping practices in place: Yes	

[4] https://multimedia.3m.com/mws/media/1937480O/key-considerations-regarding-respiratory-protection-assigned-protection-factors-apf-dvc-letter.pdf and https://www.hse.gov.uk/pubns/priced/hsg53.pdf

4b. Adding CrO_3 flakes into the bath	Method
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoor	
• Room size: > 3000 m^3	
• Room ventilation: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: 3M Versaflo Air fed Respirator (TH3) – APF 40	

4c. Rinsing drums/containers	Method
Substance emission potential	ART 1.5
• Substance product type: liquids	
• Concentration of CrVI in mixture: main component	
• Process temperature: < #A [30-70] ºC	
• Vapour pressure: 0.01 Pa	
• Viscosity: low	
Activity emission potential	
• Duration of activity: ≤ 20 min per month	
• Activity class: Handling of contaminated objects	
• Activities with treated/contaminated objects (surface 0.3-1 m^2)	
• Level of contamination: Contamination 10-90 % of surface	
Surface contamination	
• Process fully enclosed: No	
• Effective housekeeping practices in place: Yes	
Dispersion	
• Work area: Indoors	
• Room size: > 3000 m^3	
Risk management measures: localised controls	
• Primary: no	
• Secondary: no	
• Ventilation rate: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: Yes	
• Respiratory protection: 3M Versaflo Air fed Respirator (TH3) – APF 40	

4d. Activity next to an open bath	Method
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 30 mins per month	
Technical and organisational conditions and measures	
• General ventilation: 5-10ACH • Containment: open process (mist suppressants used) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: 3M Versaflo Air fed Respirator (TH3) – APF 40	
Other conditions affecting workers exposure	
• Place of use: Indoor	

• Process temperature: ≤#A [30-70] ºC	

9.2.5.2. Exposure and risks for workers

The modelled and measured exposure concentrations are reported in Table 19. The 2022 campaign included 2 personal measurements covering transfer to smaller containers at the weighing station. Both gave values of 1 µg/m^3 and this value is used for 4a. Exposure was also modelled with ART for comparison. There is no specific monitoring data for the transfer of the contents to the bath or the rinsing task. ART was used to estimate the exposure for these tasks. Static monitoring data was used to estimate exposure coming from the activity next to the baths (4d). The combined exposure is the sum of the values for 4a-4d.

Table 19. Exposure concentrations for WCS 4

Contributing Scenario	Route of exposure	Method of assessment	Exposure value (8h TWA, µg/m^3)	Exposure value corrected for RPE (µg/m^3)*	Exposure value corrected for RPE & duration (µg/m^3)**	Exposure value corrected for RPE, duration & frequency (µg/m^3)***
WCS 4a	Inhalation	Measured data (personal data)	1.00E+00	2.50E-02		1.25E-03
4a		ART	3.90E+00	9.75E-02		4.88E-03
4b		ART	2.60E-01	6.50E-03		3.25E-04
4c		ART	1.20E-01	2.99E-03		1.50E-04
4d		Measured data Static data)	3.00E+00	7.50E-02	4.69E-03	2.34E-04

*1/40 ** 30/480 frequency correction ***1/20

Conclusion on risk characterisation:

The exposure estimate was based on combined monitoring & modelled data and taking into account RPE worn and the frequency of the task. Taking the higher value for 4a, the combined exposure value is 5.58E-03 µg/m^3 giving an ELR value of 2.23E-02 per 1000 exposed workers.

9.2.6. Worker contributing scenario 5: Regular maintenance (PROC 28)

This covers any maintenance task where there is potential for exposure to CrVI. Regular maintenance activities are done by the plating operators and typically**#B** [1-10] operators do these tasks. The duration and frequency depends on the task. Maintenance tasks can be done on the line or off the line for example changing the scrubber filter.

Daily maintenance tasks include topping up the solution levels in the baths. An operator enters the line and turns on the controller to add water via a hosepipe to the bath for 5 mins. The operator leaves the line and returns to check the level and then repeats this until the required level is achieved. This is done by one operator per shift and the total time spent on the line next to the baths is 15 mins. The temperature of the baths is also checked daily. The task takes 5 mins per day and is done by one operator. The low level temperature probe is checked weekly. The probe is lifted out of solution, checked and returned to the bath. This task is done by one operator and takes ca. 15 mins per week. The electrical contact points for the busbars are cleaned every 2 months. The task is done by one operator and takes ca. 1 hour. The scrubber filter is also cleaned every 2 months and the sump waters replaced. During this task, plating is off on all baths and the line is not in use. cleaning of the extraction scrubber filters and renewal of the rinse waters in the scrubber sump takes place. The filters are cleaned by removing the top hatch on the scrubber unit and using the overhead crane, the filters are lifted out of the scrubber. The filters are then lowered to the ground using the crane and lifted by 2 operators to the bunded area by the effluent sump. They are then rinsed down with clean water until the contamination is removed and left to dry in place. The filters are then carried back to the scrubber, lifted up using the crane, and located back in the scrubber unit, the cover is then replaced and secured with bolts. The chrome line is then put back into use. This task is done by 2 operators and takes ca. 3 hours per operator.

As a worst case, it is assumed that the same operators do all maintenance tasks meaning that one operator may spent ca. 30 mins per shift doing maintenance tasks on the line. Exposure due to proximity to the baths (5a: 30 mins per day) and handling contaminated objects (5b1: 5 mins per day) is considered in the assessment. Additional tasks done off the line are included (5b2: 5 mins per day per operator).

LEV is on 24/7 in the plating baths and chemical anti-misting agents prevent aerosol formation. Operators wear safety shoes/boots, safety glasses/face shield, chemical resistant gloves and work clothing.

Available personal monitoring data covers daily maintenance tasks but not tasks done less frequently. Available static monitoring data gives an estimate of exposure near field to the baths. Exposure coming from handling contaminated objects was modelled with ART as there is no monitoring data covering these specific tasks.

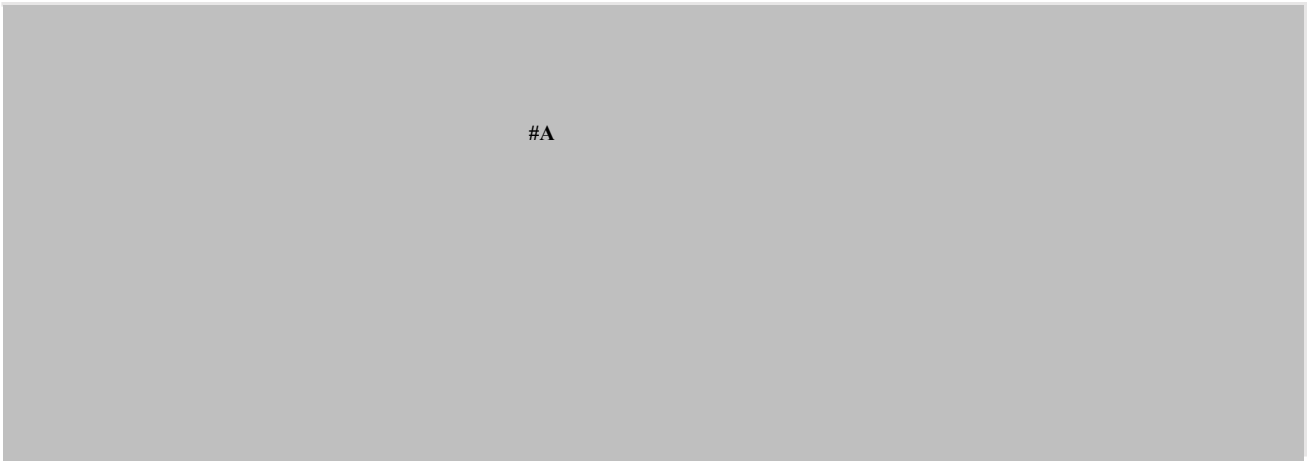


Figure 11. Photos of (a) a bath being topped up with water from the hosepipe, (b-c) an operator checking the low level probe and washing the scrubber filter

9.2.6.1. Conditions of use

5a. Activity next to the baths	**Method**
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 30 mins per day (worst case)	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH	

• Containment: open process (no aerosol formation as mist suppressants used in all plating baths) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

5b1. Handling contaminated objects (cleaning the busbars)	**Method**
Substance emission potential	ART 1.5
• Substance product type: liquids	
• Process temperature: <#A [30-70] ºC	
• Vapour pressure: 0.01 Pa	
• Concentration of CrO_3 in mixture: main component	
• Viscosity: low	
Activity emission potential	
• Duration of activity: 5 mins (worst case)	
• Frequency: daily	
• Primary emission source located in the breathing zone of the worker: Yes	
• Activity class: Handling of contaminated objects	
• Activities with treated/contaminated objects surface > 3 m^2	
• Level of contamination: Contamination > 90 % of surface	
Technical and organisational conditions and measures	
• Local exhaust ventilation: Fixed capturing hood (ART parameter: 90 % reduction)	
• Process fully enclosed: No	
• Effective housekeeping practices in place: Yes	
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoors	
• Room size: > 3000 m^3	
• Room ventilation: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: no	

5b2. handling contaminated objects (rinsing the scrubber filter)	**Method**
Substance emission potential	ART 1.5
• Substance product type: liquids	
• Process temperature: room temperature	
• Vapour pressure: 0.01 Pa	
• Concentration of CrO_3 in mixture: substantial	
• Viscosity: low	
Activity emission potential	
• Duration of activity: 5 mins (worst case)	
• Frequency: daily	
• Primary emission source located in the breathing zone of the worker: Yes	
• Activity class: Handling of contaminated objects	
• Activities with treated/contaminated objects surface 1- 3 m^2	

• Level of contamination: Contamination > 90 % of surface	
Technical and organisational conditions and measures	
• Localised controls: no	
• Process fully enclosed: No	
• Effective housekeeping practices in place: Yes	
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoors	
• Room size: > 3000 m^3	
• Room ventilation: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: no	

9.2.6.2. Exposure and risks for workers

The measured and modelled exposure concentrations are reported in Table 20. The combined exposure values for 5a (static monitoring next to the bath under normal production) 5b1 and 5b2 (ART modelled values) were used in the assessment.

Table 20. Exposure concentration for WCS 5

Contributing Scenario	**Route of exposure**	**Method of assessment**	**Exposure value (8h TWA, µg/m^3)**	**Exposure value corrected for duration (µg/m^3)***
WCS 5a	Inhalation	Measured (static)	3	1,88E-01
5b1		ART 1.5	9.88E-03	-
5b2		ART 1.5	4.21E-02	-

*30/480

Conclusion on risk characterisation:

The combined exposure estimate was based on the measured static (5a) and modelled data (5b1+5b2) corrected for duration (static). This gave a combined exposure value for operators of 2.40E-01 µg/m^3 and a corresponding ELR value of 9.58E-01 per 1000 exposed workers.

9.2.7. Worker contributing scenario 6: Rare maintenance (PROC 28)

This covers rare maintenance tasks where there is potential for exposure to CrVI. Rare maintenance activities relating to the chrome plating plant are done by the Group 1 plant operators and Group 2 external maintenance service providers (ca. #B [2-20] different providers for specialist services) according to a scheduled maintenance plan and documented procedures. The contractors are trained on the work and safety procedures as per company policy and permit to work scheme (details given in Appendix 1). Unscheduled maintenance is done as needed to take action as needed for faults noted during regular checks. Typical rare maintenance tasks are given in Table 21.

Plating operators do most rare maintenance tasks. An example of a maintenance task done infrequently is the anode check. The anodes are checked, cleaned and replaced as needed once a year (during the end of year production shutdown period). The contact busbars are also cleaned at the same time. The task takes ca. 12 hours and is done by one operator. All power to the chrome plating baths and the heaters will be turned off. The anodes are removed from all chrome plating baths using the overhead cranes, the operator will lift the anodes one at a time from each bath, rinse the anode with clean water from a hose pipe, then move the anode to the water rinse bath where they are stored over the shutdown period. All busbars are also cleaned by rinsing any chrome from the bars with the water hose pipe, the operator will then scrub the bars with an abrasive pad until any staining is removed. On return after the shutdown period, the anodes are replaced using the overhead crane to lift the anodes from the water rinse to the chrome plating baths. Other tasks include emptying the bath, cleaning, sludge removal and replacing the bath installation (see Table 21).

External contractor do specialist maintenance tasks, typically replacement of heating and probe level units. The replacement of the bath heating units may be done ca. every 6 months and takes ca. 30 mins. The power is turned off to the plating bath heaters. The contractor unscrews the clamp located at the rear of the plating bath holding the heater in place, removes the heater to the side of the bath after rinsing it down with the hose pipe and unscrews the wiring so the heater can be completely removed. A new heater is connected to the existing wiring and reconnected to the bath using the clamp. The old heater is disposed of through the hazardous waste stream. A low level probe unit may be replaced every 6 months and takes ca. 30 mins. Faulty low level probe units are removed and replaced by either operators or outside contractors. The faulty probe located at the front of the bath, is lifted out of the housing, the cover and the wiring unscrewed, and the probe removed from the bath. The replacement probe is attached to the existing wiring, the cover replaced, and the unit positioned in the housing with the probe in the solution. The old probe is disposed of through the hazardous waste stream. Other tasks done by external contractors are given in Table 21.

Table 21. Details of scheduled rare maintenance tasks

Task description	Duration	Frequency	Number of workers
Check of anodes and replacement of anodes	12 h	Yearly	#B (Group 1)
Emptying chrome baths of solution for removal/ replacement bath installation	3 h	5 years	#B (Group 1)
Emptying chrome baths of chrome salts/sludge for removal/ replacement bath installation	8 h	5 years	#B(Group 1)
Rinsing down and cleaning any chrome contamination from a bath prior to removal/replacement of the bath	4 h	5 years	#B(Group 1
Replacement of heating units	30 mins	Every 6 months	#B(Group 2)
Replacement of level probe units	30 mins	Every 6 months	#B (Group 2)
Removal of plating bath	12 h	5 years	#B (Group 2)
Repairs to rectifier control panel	1 h	Every 6 months	#B (Group 2)

The estimated time spent on scheduled rare maintenance tasks in a typical year is given in the table below.

Type of worker	Total number of workers	Total person-time/year	Per operator
Plating operators (Group 1)	#B [1-10]	15 h /year	2.5 -12 h / year
Service provider (Group 2)	#B [2-20]	160 h /year	Ca. 12 h/ year

The rare maintenance tasks involve the handling of contaminated objects. Since many of the tasks are also done on the plating line, it was assumed as a worst-case scenario that all tasks were done close to the baths. The combined exposure from the bath as emission source (6a) and handling contaminated objects (6b) was considered in the assessment.

In total, #B [2-20] external contractors from different specialised service providers may perform rare maintenance tasks. Therefore, the maximal duration per worker (12 hrs per year) is used as a worst-case scenario for the exposure assessment of Group 2 workers. For Group 1 plating operators, as a worst case, it was assumed that one operator may do up to 4 days per year including both scheduled and unscheduled maintenance.

There is no specific occupational air monitoring data for rare maintenance tasks. Exposure from handling contaminated objects was modelled with ART (6b). There is static air monitoring data available relevant for exposure during tasks done close to the baths (6a).

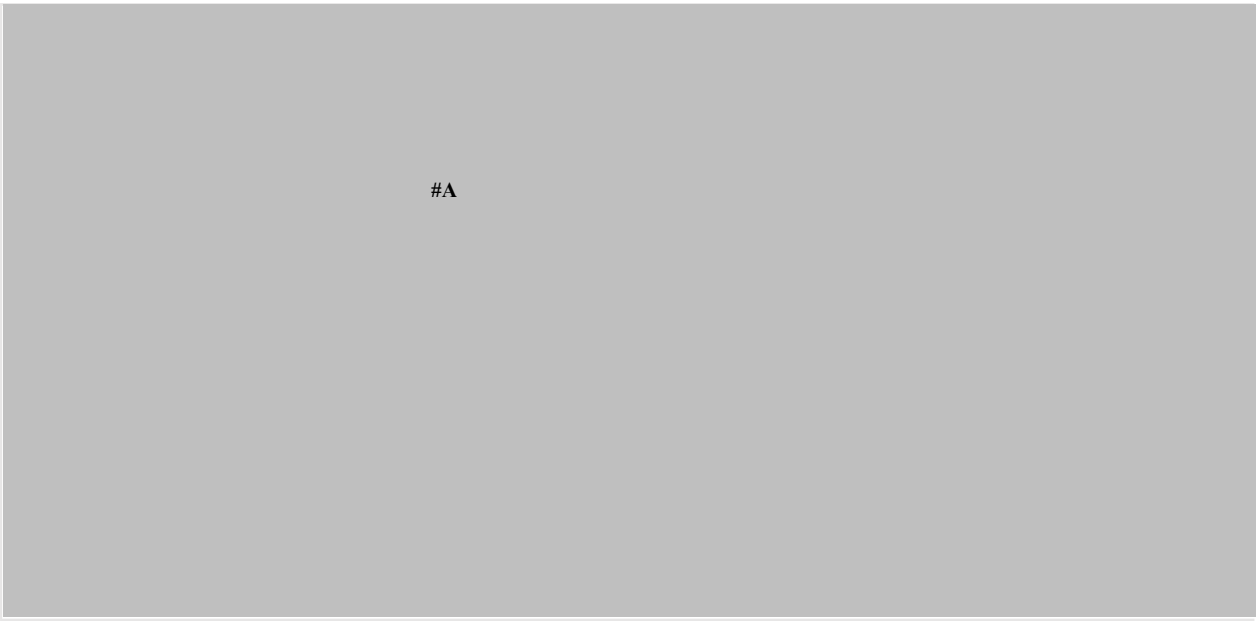


Figure 12. Photos of an operator lifting the anodes

9.2.7.1. Conditions of use

6a. Activity next to the baths	Method
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 4 days per year (worst case) (Group 1) < 1.5 day per year (Group 2)	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH • Containment: open process (no aerosol formation as mist suppressants used in all plating baths) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

6b1. Handling contaminated objects	Method
Substance emission potential	ART 1.5
• Substance product type: liquids	
• Process temperature: <#A [30-70] ºC	
• Vapour pressure: 0.01 Pa	

• Concentration of CrO_3 in mixture: substantial	
• Viscosity: low	
Activity emission potential	
• Duration of activity: < 4 days per year (worst case) (Group 1) < 1.5 day per year (Group 2)	
• Primary emission source located in the breathing zone of the worker: Yes	
• Activity class: Handling of contaminated objects	
• Activities with treated/contaminated objects surface > 3 m^2 (Group 1) 1-3 m^2 (Group 2)	
• Level of contamination: Contamination > 90 % of surface	
Technical and organisational conditions and measures	
• Local exhaust ventilation: Fixed capturing hood (ART parameter: 90 % reduction)	
• Process fully enclosed: No	
• Effective housekeeping practices in place: Yes	
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoors	
• Room size: > 3000 m^3	
• Room ventilation: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: no	

9.2.7.2. Exposure and risks for workers

The measured and modelled exposure concentrations are reported in Table 22 for both plating operators (Group 1) and external contractors (Group 2). The combined exposure (6a + 6b) estimated for both groups was used in the assessment.

Table 22. Exposure concentrations for WCS 6

Contributing Scenario	Route of exposure	Method of assessment	Exposure value (8h TWA, µg/m^3)	Exposure value Corrected for frequency (µg/m^3)
WCS 6a (Group 1)	Inhalation	Static	3	5.00E-02*****
WCS 6b (Group 1)		ART	0.4004	6.67E-03*****
WCS 6a (Group 2)		Static	3	1.88E-02**
WCS 6b (Group 2)		ART	0.2028	2.54E-03**

correction for frequency *4/240 **1.5/240

Conclusion on risk characterisation:

The exposure estimate was based on the combined modelled and measured data corrected for duration and frequency as relevant. For Group 1 operators, this gave a combined exposure value of 5.67E-02 µg/m^3 and a corresponding ELR value of 2.27E-01 per 1000 exposed workers. For Group 2 operators, this gave a combined exposure value of 2.13E-02 µg/m^3 and a corresponding ELR value of 8.51E-02 per 1000 exposed workers

9.2.8. Worker contributing scenario 7: Waste and wastewater management (PROC 8b)

This scenario covers tasks relating to waste and wastewater management specifically relating to potential for exposure to CrVI. All waste handling and wastewater management tasks are done by the plating operators.

All rinse water containing CrVI from the rinsing step is recirculated back to the effluent to be treated, before returning to the rinse baths & are finally disposed as contaminated effluent. Any solution that requires disposal from the plating baths is collected in IBCs for treatment off-site by authorised waste contractors. There is no on-site CrVI wastewater treatment, only treatment of rinse waters. The IBCs are located in a dedicated area with secondary containment.

All waste streams are collected and taken for disposal according to their waste classification by authorised waste contractor. Chrome contaminated waste is placed into bags located in hazardous waste wheelie bins. The bins are emptied daily by an operator lifting the bag out of the wheelie bin, securing the top of the bag with a cable tie, or tying a knot in the top of the bag, then carrying the bags to the hazardous waste skip located outside and placing the bags in the skip. This takes about 10 mins and is done by #B[1-10] operator per shift.

Waste produced during the concentration adjustments (empty clean CrO_3 containers and lids) are taken to the waste acid area for collection by authorised waste contractors. Waste produced during rare maintenance (anodes, spent acid, etc.) is collected by authorised waste contractors.

The potential for exposure comes from proximity to the baths during normal operation and handling contaminated objects. There is no specific occupational air monitoring data for these tasks. There is static and personal monitoring data available covering tasks done next to the baths under normal plant operation. The available static monitoring data is representative of tasks done near the baths on a typical day with plating in normal production. This data is used in the assessment. Exposure from handling of contaminated objects was modelled with ART 1.5. Worst case conditions of use were used (i.e. assuming that the task is done on the line and next to the baths).

9.2.8.1. Conditions of use

7a. Activity next to the baths	**Method**
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 10 mins per day	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH • Containment: open process (no aerosol formation as mist suppressants used in all plating baths) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

7b. Handling contaminated objects	**Method**
Substance emission potential	ART 1.5
• Substance product type: liquids	
• Process temperature: room temperature	
• Vapour pressure: 0.01 Pa	
• Concentration of CrO_3 in mixture: minor	
• Viscosity: low	
Activity emission potential	
• Duration of activity: 10 mins	
• Frequency: daily	
• Primary emission source located in the breathing zone of the worker: Yes	

• Activity class: Handling of contaminated objects	
• Activities with treated/contaminated objects surface > 3 m^2	
• Level of contamination: Contamination > 90 % of surface	
Technical and organisational conditions and measures	
• Local exhaust ventilation: Fixed capturing hood (ART parameter: 90 % reduction)	
• Process fully enclosed: No	
• Effective housekeeping practices in place: Yes	
• Occupational Health and Safety Management System: Advanced	
Other conditions affecting workers exposure	
• Place of use: Indoors	
• Room size: > 3000 m^3	
• Room ventilation: 5-10 ACH	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Face/eye protection: yes	
• Respiratory protection: no	

9.2.8.2. Exposure and risks for workers

The measured and modelled exposure concentrations are reported in Table 23. The combined exposure (7a + 7b) estimated for both groups was used in the assessment.

Table 23. Exposure concentrations for WCS 7

Contributing Scenario	Route of exposure	Method of assessment	Exposure value (8h TWA, µg/m^3)	Exposure value corrected for duration (µg/m^3)*
7a	Inhalation	Measured (static)	3	6.25E-02
7b		ART 1.5	2.08E-03	-

*10/480

Conclusion on risk characterisation:

The exposure estimate was based on the combined measured and modelled data corrected for duration (static). The combined exposure estimate 6.46E-02 is µg/m^3 giving an ELR of 2.58E-01 per 1000 exposed workers.

9.2.9. Worker contributing scenario 8: Far field activities (PROC 0)

This scenario covers time spent in the plating hall on tasks not related to the activities under WCS 1-7. There are #B [5-50] operators (Group 1) who generally spend their full shift in the hall. They may spend on average ca. 90 mins on the line and the rest on tasks off the line. As the chromic acid baths are open and the plating line is not physically segregated, there is potential for far field exposure with the baths as the emission source. The workers wear work clothing, safety shoes/boots, safety glasses, and technical gloves. For some tasks like grinding, the workers wear RPE (half-face mask with RPE filter).
There is occupational air monitoring data covering far field exposure. This data is used in the assessment.

7. Far field	Method
Product (article) characteristics	Measured data
• Concentration of CrO_3 in mixture: Substantial	
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 390 mins	
Technical and organisational conditions and measures	
• General ventilation: 5-10 ACH • Containment: open process (no aerosol formation as mist suppressants used in all plating baths) • Local exhaust ventilation: Fixed capturing hood on all baths • Occupational Health and Safety Management System: Advanced	
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: no	
Other conditions affecting workers exposure	
• Place of use: Indoor • Process temperature: <#A [30-70] ºC	

9.2.9.1. Exposure and risks for workers

The available occupational monitoring measurements (2021, N=2 static) cover far-field situations. The value from these measurements was used in the assessment.

Table 24. Exposure concentrations for WCS 8

Contributing Scenario	Route of exposure	Method of assessment	Exposure value (8h TWA, µg/m^3)	Exposure value corrected for duration (µg/m^3)*
8	Inhalation	Measured (static)	1	8.13E-01

*390/480

Conclusion on risk characterisation:

The exposure estimate was based on the combined measured and modelled data corrected for duration (static). The combined exposure estimate 8.13E-01is µg/m^3 giving an ELR of 3.25E-01 per 1000 exposed workers.

9.3. Summary

The exposure estimates and risk characterisations for workers and humans via the environment discussed in Chapter 9.2 are summarized. Table 25 compiles the exposure values taken forward for assessment for each of the WCSs.

Table 25. Summary of exposure concentrations per WCS and the excess lifetime lung cancer risk including information on duration, frequency and RPE usage workers

WCS	# workers	Method of assessment	Duration & frequency	8h TWA exposure value	Exposure value corrected for RPE (µg/m³)	Exposure value corrected for duration (µg/m³)	Exposure value corrected for RPE, duration & frequency (µg/m³)	Exposure value used in the assessment (µg/m³)	Excess risk value
2	G1 (#B) [5-50]	personal	90 mins, daily	1.00E+00				1.00E+00	4.00E-03
		static		3.00E+00		5.63E-01		5.63E-01	2.25E-03
3	G1 #B [1-10]	2 static	30 mins /month	3.00E+00		1.88E-01	9.38E-03	9.38E-03	3.75E-05
4a	G1 #B [1-10]	personal	25 mins /month	1.00E+00	2.50E-02		1.25E-03	1.25E-03	5.00E-06
4a		ART		3,90E+00	9,75E-02		4,88E-03	4,88E-03	1,95E-05
4b		ART	15 mins /month	2.70E-01	6.50E-03		3.25E-04	3.25E-04	1.30E-06
4c		ART	20 mins /month	1.20E-01	2.99E-03		1.50E-04	1.50E-04	5.98E-07
4d		static	30 mins /month	3.00E+00	7.50E-02.	4.69E-03	2.34E-04	2.34E-04	9.38E-07
5a	G1 #B [1-10]	static	30 mins daily	3.00E+00		1.88E-01		1.88E-01	7.50E-04
5b1		ART	5 mins daily	9.88E-03				9.88E-03	3.95E-05
5b2		ART	5 mins daily	4.21E-02				4.21E-02	1.68E-04
6a	G1 (#B) [1-10]	static	4 days /year	3.00E+00			5.00E-02	5.00E-02	2.00E-04
6b		ART		4.00E-01			6.67E-03	6.67E-03	2.67E-05
6a	G2 #B [2-20]	static	1.5 days /year	3.00E+00			1.88E-02	1.88E-02	7.50E-05
6b		ART		4.06E-01			2.54E-03	2.54E-03	1.01E-05
7a	G1 (#B [1-10]	static	10 mins per day	3.00E+00		6.25E-02		6.25E-02	2.50E-04
7b		ART		2.08E-03				2.08E-03	8.32E-06
8	G1 #B [5-50]	static	ca. 390 mins /day	1		8.13E-01		8.13E-01	3.25E-03

Table 26 compiles the exposure concentrations by the 2 routes considered in the assessment of exposure to humans via the environment for local populations.

Table 26. Summary of the exposure from the environmental contributing scenario local populations

Humans vis the environment – route of exposure	Exposure concentration	Adjusted exposure concentration	Cancer risk type	Excess lifetime cancer risk**
Inhalation	4.43E-06 mg/m³		Lung	1.28E-04
Oral intake	4.59E-07 mg/kg bw/day	1.38E-05 mg/kg bw/day	Intestinal	1.10E-08

*97 % reduction due to transformation of CrVI to CrIII (EU RAR 2005) ** 70 years

10. RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

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

10.1.1. Workers

The operators doing the tasks described in the WCSs can be grouped into the 2 groups given in Table 27. Group 1 includes the#B [5-50] operators who work daily in the plating hall over 3 shifts. Group 2 includes external contractors who do specific tasks under rare maintenance in the hall. The highest combined exposure value for an operator in Group 1 is 2.19 μg/m^3. This value is below the WEL value (10 μg/m^3) for CrVI showing that exposure control is adequate.

Table 27. Summary of combined exposure by different groups of workers

Worker groups	Number of workers	WCS	Aggregated exposure value over 8h corrected for duration, frequency, RPE as relevant (μg/m^3)	Excess risk
Group 1	#B [5-50]	1-8	2.19E+00	8.74E-03
Group 2	#B [2-20]	6a, 6b	2.13E-02	8.51E-05

10.1.2. Consumers

Not relevant as there is no consumer use.

10.2. Environment (combined for all emission sources)

As chromium trioxide is not listed in REACH Annex XIV due to environmental effects, no environmental exposure assessment is performed here

<u>Man via environment</u>

Exposure of humans via the environment and associated risks are discussed and presented in Chapter 9.1.1. above (local and regional scale) and summarised in Table 26 and Table 28 respectively.

Table 28. Summary of the exposure from the environmental contributing scenario regional populations

Humans vis the environment – route of exposure	Exposure concentration	Adjusted exposure concentration	Cancer risk type	Excess lifetime cancer risk**
Inhalation	3.28E-14		Lung	9.52E-13
Oral intake	1.19E-08 mg/kg bw/day	3.57E-10 mg/kg bw/day	Intestinal	2.85E-10

*97 % reduction due to transformation of CrVI to CrIII (EU RAR 2005) ** 70 years

10.2.1. All uses (regional scale)

Not relevant as no environmental assessment is performed

11. REFERENCES

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UK HSE 2013, Respiratory protective equipment at work, A Practical Guide Health and Safety Executive, HSG53 (Fourth edition, published 2013) available online at https://www.hse.gov.uk/pUbns/priced/hsg53.pdf

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APPENDICES

Appendix 1. Process and site details

Details of the chromic acid containing baths on the chrome plating line in the plating hall are given in Table 29. The baths have LEV on 2 sides (front & back push/pull) and is on 24/7. The LEV flowrate is monitored and there is a visual alarm if it decreases or stops. The alarm triggers a manual shutdown of plating on the line. Mist suppressant (Fumetrol 2) is used in the plating baths to prevent aerosol formation on the solution surface.

Table 29. Details of the chromic acid baths on the chrome plating line

	#A & #B

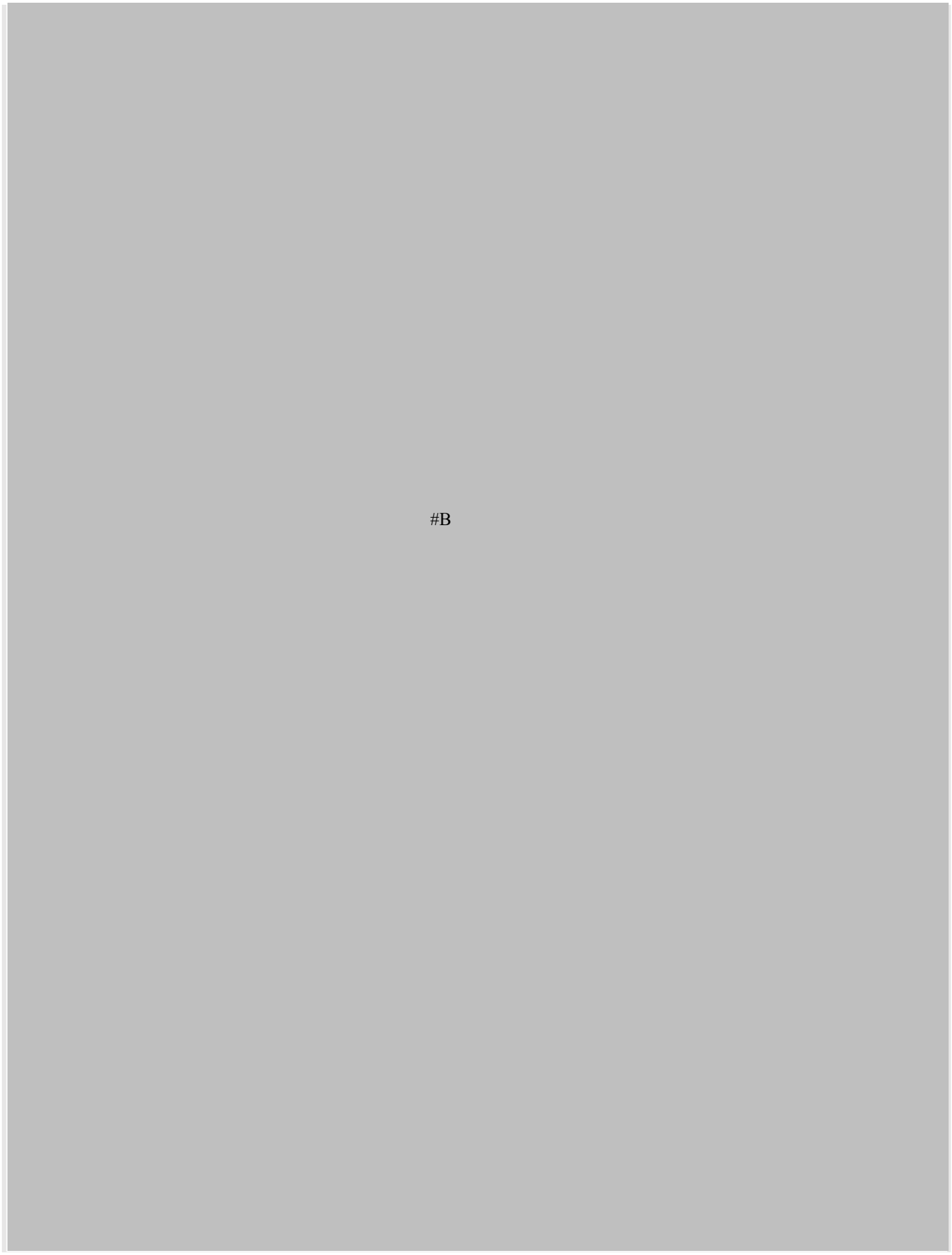


Figure 13. Plating hall layout with the chrome line shown in the red inset; the location of static monitoring devices Cr1-Cr4 are shown in the inset

Table 30. Training program overview

Training for bath additions	• Only IOSH trained technicians to be approved to lead on bath additions • For initial approval, a minimum of six months on the job training with a qualified technician plus a sufficient number of addition forms (per process) required before approval can be reviewed • Internal approval will be carried out by cycle 2 manufacturing engineer, who will observe & assess the technician before submitting the relevant documentation to the quality dept. Secondary sign off required to attain approval by Quality Manager (or designated representative), as per form F2002-1 (first time stamp), then use F2002-26C training passport. • Skill matrix to be updated by training manager when scope approval document - form F2002-1 / F2002-26C signed off by cycle 2 manufacturing engineer & Quality Manager (or designated representative). • When any bath addition standard operating procedure (SOP) changes, all approved technicians will require refresher training prior to performing the relevant addition
General training	• Chemical / Cyanide awareness training presentation to be carried out on all cycle 2 technicians annually & training attendance record – form F2039-1 to be completed. • Any procedure changes to EMS (environmental management system) documents will require training attendance record – form F2039-1 to be completed. • Spill Training to be carried every 3 years by external trainer for designated spill team members in cycle's 1, 2 & 3, however all technicians within cycle 2 require spill simulation refresher training annually - training attendance record – form F2039-1 to be completed • Chemical splash simulation training to be carried out annually for all technicians within cycle 2 - training attendance record – form F2039-1 to be completed • Toolbox talks relating to health & safety require training attendance record • All staff to be trained in low level, site specific chemical awareness as part of the induction process (general awareness / high risk areas etc.)
Type of trainings	Face to face training internal for spill kit simulation & awareness / chemical awareness Inductions. Outside supplier used for oxygen training / Spill kit training / first aid Reviews carried out for on-the job training from manufacturing engineer / supervision / quality / training manager.

Checklist for external contractors as per the company policy "Control of Facilities Contractors Policy and Procedure"

CP12020-1 Appendix B

Facilities Contractor Pre-Work Checklist

Contractor Name:		**Contractor Company:**	
Working on HD UK Site:	Bolton/Nottingham/Runcorn*	**Working in Site Area:**	
Work Order Number:		**Similar Work Orders:**	
Site Co-ordinator Name:		**Date:**	

* Delete as appropriate

Note on Personal Protective Equipment (PPE):

- Minimum PPE that shall be provided for each contractor is safety glasses and safety shoes
- Hearing, head, hand, repertory and chemical handling protection shall be provided as necessary.

Scope of Work *Check as many items as necessary*

Yes	No	Type of Work	Yes	No	Type of Work
X		Section 1 General			Section 6 Mechanical/HVAC
		Section 2 Service work			Section 7 Overhead work
		Section 3 Material/Machine/Office moves			Section 8 Construction/ Demolition
		Section 4 Plumbing/Piping			Section 9 Confined Space/Excavation
		Section 5 Welding/Cutting			Section 10 Electrical

Checklist

Yes	No	n/a	**Section 1: General** *A check in a red box = notify your Site Co-ordinator*
			Have you received Safety or Awareness training regarding the assigned task?
			Do you have any safety issues or job related questions prior to work?
			Do you have medical restrictions that the task will exceed?
			Is lighting adequate?
			Slip or trip hazards eliminated prior to work?
			Other housekeeping issues resolved prior to work?
			People in area notified if aisles and/or doorways would need to be blocked?
			Do you have applicable permits for task? Welding, Confined Space, Asbestos
			If you will need help, have you informed your supervisor?
			Will working alone in an isolated area require emergency communication?
			Will by-products of work (dust, fumes, noise, debris) be contained or minimized?
			Could gas powered tools or equipment create dangerous carbon monoxide levels?
			Are you trained in the use of atmospheric monitoring equipment?
			Will Hazardous Material be used, produced, or possibly spilled?
			Have you been made aware this is an EA permitted site?
			Have you read CP12020-1 appendix A Visitors & Contractors HS&E Briefing leaflet?
			Do you understand CP12020-1 appedix A Visitors & Contractors HS&E Briefing leaflet?

Yes	No	n/a	**Section 2: Service Work**
			Are hand tools, power tools, extension cords in good order?
			Do items exceed a safe lifting limit?

Yes	No	n/a	**Section 3: Material Handling** *A check in a red box = notify your Site Co-ordinator*
			Do you have a current fork truck license?
			Fork trucks, hoist, chains, slings or other lifting devices inspected prior to use?
			Do fork trucks, hoist, chains, slings or other lifting devices meet loads required?
			Are floors, dock levelers, elevators or other surfaces rated for loads?
			Do loads need to be secured?

Yes	No	n/a	**Section 4: Plumbing/Piping** *A check in a red box = notify your Site Co-ordinator*
			Have affected areas been informed of impairment and estimated duration?
			Will asbestos abatement permit be required?
			Has fire protection impairment notifications been made through EH&S?
			Are required lockout devices in place?
			F&ES notified of piping installations, changes, or removal?

Yes	No	n/a	**Section 5: Welding / Cutting /Grinding** *A check in a red box = notify your Site Co-ordinator*
			Are welders, cables and hoses, cords, PPE and welding helmets in good order?
			Do you have completed permit for any work not performed in welding shop?
			Do you have face shield and hearing protection for grinding operations?

Yes	No	n/a	**Section 6: HVAC/Mechanical** *A check in a red box = notify your Site Co-ordinator*
			Are required lockout devices in place?
			Do ladder safety or fall protection rules apply?
			Gloves, face shield, apron used while handling chemicals?
			Area notified of impairment to HVAC or exhaust systems if necessary?

Yes	No	n/a	**Section 7: Overhead Work** *A check in a red box = notify your Site Co-ordinator*
			Ladders, lifts, scaffolds and fall protection devices visually inspected prior to use?
			Are caution tape and/or barricade devices in place?
			If there is potential for head injury are helmets properly fitted and secure?

Yes	No	n/a	**Section 8: Construction /Demolition**
			Are hand tools, power tools, extension cords and required RCDs in good order?
			Head, Eye, Hearing protection, Respiratory PPE being used?
			Ladders, lifts and fall protection devices visually inspected prior to use?
			Are caution tape and/or barricade devices in place?
			Material handling Section III requirements met?
			Fire protection sprinklers, extinguishers, and emergency exits clear & accessible?

Yes	No	n/a	**Section 9: Confined Space/ Excavation** *A check in a red box = notify your Site Co-ordinator*
			Do you have completed Confined space permit?
			Does task require work in soil dug to a depth of more than 3FT?
			Have utilities been located prior to digging?

Yes	No	n/a	**Section 9: Electrical** *A check in a red box = notify your Site Co-ordinator*
			Are energized parts exposed? (other than troubleshooting / diagnostic requires permit)
			Are required lockout devices in place and ZERO energy verified?
			Can necessary trouble shooting requiring "live" conditions be done safely?
			Is appropriate PPE available and being used?
			Are insulated tools available and being used?

Contractor Signature:		**Date:**	
Site Co-ordinator Signature:		**Date:**	

Day	8:00am	10:00am	12:00pm	2:00pm	4:00pm	6:00pm	8:00pm
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

Visitors and Contractors HS&E Briefing leaflet as per the company policy “Control of Facilities Contractors Policy and Procedure”

CP12020-1 Appendix A

Visitors and Contractors must:

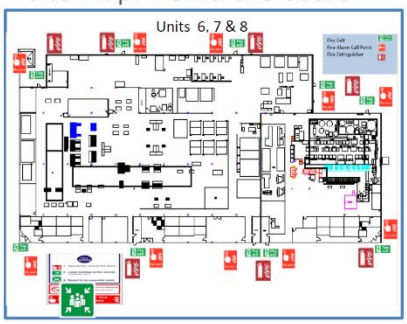
- Sign in and out of Reception when entering or leaving site at anytime.
- Always wear visitor badge visibly at all times.
- Be aware of the fire escape routes and assembly points.
- Have contact details of your host.
- Wear appropriate footwear. Open Toe shoes are prohibited on the shop floor.
- Only use electrical equipment with valid PAT test .
- Follow company rules, procedures and guidelines documented in this briefing.

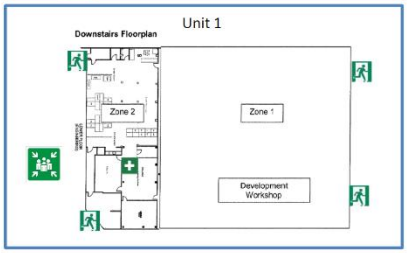
Facilities Contractors must also:

- Leave a mobile phone contact number with their host and follow permit to work procedure.
- Be subject to Health, Safety and Environmental regulations whilst on site.
- Read the visitor & contractors Health, Safety & Environmental briefing document.
- This is a regulated EPR site. Follow any instructions given to you by your host in the event of an incident occurring.
- Wait for your host to arrive.
- Fill out the Pre work assessment form with your host.
- Dispose of any waste generated in the correct bins; hazardous waste must be reported to your host
- Have an available written Risk Assessment and Method Statement for the work to be carried out.
- Not deviate from the Risk Assessment and Method Statement without prior agreement with the Permit issuer
- Have a valid work authorisation issued prior to any work being carried out.
- Never use any plant or equipment that they are not trained and authorised to use.

Heroux Devtek is a proactive, safety conscious company. We encourage any comments to further improve our business.
Thank you for visiting and have a safe trip home.

Site Map: Pembroke Court





Fire Assembly point is situated along the front of the building clearly marked in the car park.

Fire exits can be seen in various locations.

The First Aid rooms are situated on the ground floor.

HEROUX DEVTEK

Visitors and Contractors Health, Safety and Environmental Briefing

8 Pembroke Court
Manor Park
Runcorn
WA7 1TG

Thinking SAFE Aim ZERO
Safe Accident free Environment

Please read this briefing and take it with you.

Issue 4

Arrival/Departure

- ✓ All visitors/contractors must sign in and out at Reception.
- ✓ All visitors/contractors must have an agreed appointment and be security cleared.
- ✓ All visitors/contractors must ensure their visitor badge is worn visibly at all times whilst on the premises.
- ✓ All facilities contractors will abide by CP12018 Control of Facilities Contractors Policy and Procedure.

Emergency Response

Fire

- ✓ In the event of fire alarm being activated, evacuate quickly and safely by the most direct route.
- ✓ If you discover a fire, inform those in the immediate danger area and activate the fire alarm

Injury Control

In the event of injury:

- ✓ Inform the nearest First Aider or your host.
- ✓ Complete the Accident Book.

Spillage Incident

- ✓ Do not put yourself in danger
- ✓ Report spillage to your host or nearest point of contact

Safety Rules

Smoking is not permitted on site except in the designated smoking area. If no designated area, you must smoke off-site. Ask your host.

Please do not use any mobile devices (phone, tablet, etc) whilst walking or driving around the site

Do not touch any machines or equipment unless competent and authorised to do so.

Visitors are to walk along the pedestrian walkways unless authorised by the host.

Fork Lift Trucks and motor vehicles operate around the site, care must be taken when on share vehicle and pedestrian routes

If you have a pacemaker or other medical condition which could be adversely affected by strong magnetic fields, please let your host know immediately as this may restrict access to the Non-destructive-testing area.

NOTICE LINE HANDRAIL — Please use the handrails when using the stairs.

Fire Alarm

The alarm is a continuous siren. There are no audible alarm tests, so if you hear the alarm, exit the building immediately.

Personal Protective Equipment (PPE)

Safety glasses/goggles must be worn where indicated, and safety glasses always in Treatments.

Safety shoes must be worn when off the marked pedestrian walkways. No open-toe shoes.

Hearing protection (ear muffs or plugs) must be worn where indicated.

Hand protection may be required for contractors depending on their tasks and risk assessments.

Accidents & Incidents

- ✓ There are sufficient fully qualified first aiders on site, identified in each area by a poster on the wall. Should you require any first aid assistance, please request this from your host or nearest point of contact.
- ✓ All accidents, incidents or ‘close calls’ (near misses) must be reported immediately to your host or nearest point of contact.

Appendix 2. Compiled monitoring data

Table 31 compiles the air emission monitoring data from 2019-2022 from the A3 stack from the ventilation system for the chrome plating line. The sample is taken from the flow after abatement and is analysed for CrVI according standard methodologies (US EPA Method 0061[5]). The monitoring is performed by an accredited external service provider and done in accordance with the method under normal operating conditions of the chrome plating line. The values are generally below the emission values given in the BREF[6] (< 0.01-0.2) and in line with the current state of the art for abatement measures (< 0.01 mg/Nm^3))[7].

Table 31. Summary of measured air emission monitoring data from 2018-2022

Date	Measurement value (CrVI) (mg/m^3)	Exhaust air flow (m^3 N/h)	Limit of detection of analysis method (mg/m^3)
15/12/22	0.0002	15461	0.0001
18/11/21	0.011	15708	0.0018
17/11/20	0.0045	9360	0.0017
05/12/19	0.0045	14851	0.0003
11/01/19	0.0019	15647	0.0012

[5] METHOD 0061 DETERMINATION OF HEXAVALENT CHROMIUM EMISSIONS FROM STATIONARY SOURCES available at https://www.epa.gov/sites/default/files/2015-12/documents/0061.pdf

[6] Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the Surface Treatment of Metals and Plastics August 2006 available at https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/stm_bref_0806.pdf

[7] Table 27 in State of the Art for Surface Treatment of Metals and Plastics by an Electrolytic or Chemical Process (Galvanic Industry); a report prepared by the Federal Ministry of Austria in 2021 available at https://info.bml.gv.at/dam/jcr:a5cef0ef-024e-4153-bf7e-f26e2614f600/Stand_der_Technik_Oberfl%C3%A4chenbehandlung_von_Metallen_und_Kunststoffen.pdf

Occupational air monitoring data from 2021-2022 are summarized in Table 32 and Table 33. The sampling and analysis was done by an accredited external service provider according to standard methods.

Method NIOSH 7300 was used for the static air monitoring and total Cr analysed. The working range of the method is 0.005 to 2 mg/m3 in a 500 l air sample.[8] The samples were collected during normal production in the hall meaning that plating was on in the bath (Cr1, Cr2) or in baths on the line (Cr3-Cr6). The location of the devices is indicated in the site map in Figure 13.

Table 32. Summary of static monitoring data from 2021

Data label	Date	TWA value (mg/m^3) total Cr	Duration (min)	Sample volume (liters)	Location of the device	On the line	Relevant for WCS
Cr1	10.10.2022	0.001	180	360	Static sample adjacent to plating bath 11 control panel	Yes	WCS 2-7
Cr2	20.10.2021	0.003	180	360	Static sample adjacent to plating bath control panel	Yes	WCS 2-7
Cr3	04.05.2021	0.002	360	720	Static sample adjacent to the control panel	Yes	WCS 2-7
CR4	04.05.2021	0.001	360	720	Static adjacent to the compressed air blowers at the rear of the plating gantry	Yes	WCS 2-7
CR5	04.05.2021	0.001	360	720	Static sample undertaken at the center of the prep area	NO	WCS 8
CR6	04.05.2021	0.001	360	720	Static sample undertaken at the center of the machining area	NO	WCS 8

[8] https://www.cdc.gov/niosh/docs/2003-154/pdfs/7300.pdf

P1-P7 personal monitoring devices were worn by Group 1 operators doing normal duties on a typical shift during normal production. P8 and P9 devices were worn by Group 1 operators doing the transfer of CrO_3 from the drums to smaller containers at the weighing station. Monitoring was done according to methods NIOSH 7300 and NIOSH 7600[9]. The latter method is for CrVI and the working range is 0.001 to 5 mg/m^3 for a 200 l air sample.

Table 33. Summary of personal monitoring data from 2022

Label	Date	TWA value (mg/m^3)	Duration (min)	Sample volume (liters)	Method	Tasks done during the monitoring period	Time spent on the line during the monitoring period	Relevant for WCS
P1	01.08.2022	0.001 (CrVI)	180	360	NIOSH 7600	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P2	01.08.2022	0.002 (total Cr)	180	360	NIOSH 7300	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P3	01.08.2022	0.001 (CrVI)	180	360	NIOSH 7600	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P4	01.08.2022	0.001 (CrVI)	180	360	NIOSH 7600	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P5	01.08.2022	0.002 (CrVI)	180	360	NIOSH 7300	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P6	01.08.2022	0.002 (total Cr)	180	360	NIOSH 7300	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P7	01.08.2022	0.002 (total Cr)	180	360	NIOSH7300	Moving parts, loading/ unloading, demasking, inspecting.	Ca. 90 min	WCS 2 & 8
P8	21.02.2022	0.001 (CrVI)	44	132	NIOSH7600	Weighing CrVI additions for plating baths	0 min test carried out at preparation area	WCS 4
P9	21.02.2022	0.001 (CrVI)	180	360	NIOSH7600	Weighing CrVI additions for plating baths	0 min test carried out at preparation area	WCS 4

[9] https://www.cdc.gov/niosh/docs/2003-154/pdfs/7600.pdf

Appendix 3. ART reports

ART REPORT – **WCS 4a -** Transfer of solid CrO3 – 23-Feb-23

Transfer to smaller containers at the weighing station

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	455

Metadata	
ART version	1.5
Creator	
Date created	19-Oct-21
Date last edited	21-Feb-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 25

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Powders, granules or pelletised material
Dustiness	Firm granules, flakes or pellets
Moisture content	Dry product (< 5 % moisture content)
Powder weight fraction	Pure material

Activity emission potential	
Activity class	Falling powders
Situation	Transferring 1 – 10 kg/minute
Handling type	Careful transfer involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner.
Drop height	Drop height < 0.5 m
Containment level	Open process

Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes

Dispersion	
Work area	Indoors
Room size	Small workrooms only

Risk Management Measures

Localised controls	
Primary	Movable capturing hood (50.00 % reduction)
Secondary	No localized controls (0.00 % reduction)

Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.0075 mg/m³.

The inter-quartile confidence interval is 0.0037 mg/m³ to 0.016 mg/m³.

ART REPORT – **WCS 4b** Transfer of solid CrO3– 14-Mar-23

Transferring flakes to the baths

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	465

Metadata	
ART version	1.5
Creator	
Date created	19-Oct-21
Date last edited	21-Feb-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 15

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Powders, granules or pelletised material
Dustiness	Firm granules, flakes or pellets
Moisture content	Dry product (< 5 % moisture content)
Powder weight fraction	Pure material

Activity emission potential	
Activity class	Falling powders
Situation	Transferring 1 – 10 kg/minute
Handling type	Careful transfer involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner.
Drop height	Drop height < 0.5 m
Containment level	Open process

Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes

Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	Fixed capturing hood (90.00 % reduction)
Secondary	No localized controls (0.00 % reduction)

Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.00052 mg/m³.

The inter-quartile confidence interval is 0.00026 mg/m³ to 0.0011 mg/m³.

ART REPORT – **WCS 4c-** washing contaminated objects – 21-Feb-23

Rinsing empty drums

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	460

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	09-May-22

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 20

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	Room temperature
Vapour pressure	0.01 Pa
Liquid weight fraction	Main component
Viscosity	Low
Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface 0.3-1 m^2)
Contamination level	Contamination 10-90 % of surface
Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes
Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	No localized controls (0.00 % reduction)
Secondary	No localized controls (0.00 % reduction)
Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.00023 mg/m³.

The inter-quartile confidence interval is 0.0001 mg/m³ to 0.00052 mg/m³.

ART REPORT – **WCS 5b1 -** handling contaminated objects – 23-Feb-23

Regular maintenance

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	475

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	20-Jan-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 5

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	Room temperature
Vapour pressure	0.01 Pa
Liquid weight fraction	Substantial
Viscosity	Low
Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface 1-3 m^2)
Contamination level	Contamination > 90 % of surface
Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes
Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	No localized controls (0.00 % reduction)
Secondary	No localized controls (0.00 % reduction)
Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.000081 mg/m^3.

The inter-quartile confidence interval is 0.000036 mg/m^3 to 0.00019 mg/m^3.

ART REPORT – **WCS 5b1 -** handling contaminated objects – 22-Feb-23

Regular maintenance

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	475

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	20-Jan-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 5

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	#A K
Vapour pressure	0.01 Pa
Liquid weight fraction	Main component
Viscosity	Low
Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface > 3 m^2)
Contamination level	Contamination > 90 % of surface
Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes
Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	Fixed capturing hood (90.00 % reduction)
Secondary	No localized controls (0.00 % reduction)
Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.000019 mg/m³.

The inter-quartile confidence interval is 0.0000085 mg/m³ to 0.000043 mg/m³.

ART REPORT – **WCS 6b (Group 1)** handling contaminated objects – 23-Feb-23

Rare maintenance

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	0

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	20-Jan-23

Details for Activity (untitled)

Emission sources: Near field ✓

Far field

Duration (mins): 480

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	#A K
Vapour pressure	0.01 Pa
Liquid weight fraction	Substantial
Viscosity	Low
Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface > 3 m^2)
Contamination level	Contamination > 90 % of surface
Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes
Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	Fixed capturing hood (90.00 % reduction)
Secondary	No localized controls (0.00 % reduction)
Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.00077 mg/m^3.

The inter-quartile confidence interval is 0.00035 mg/m^3 to 0.0018 mg/m^3.

ART REPORT – **WCS 6b (Group 2)** handling contaminated objects – 21-Mar-23

Rare maintenance

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	0

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	20-Jan-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 480

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	#A K
Vapour pressure	0.01 Pa
Liquid weight fraction	Substantial
Viscosity	Low
Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface 1-3 m^2)
Contamination level	Contamination > 90 % of surface
Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes
Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	Fixed capturing hood (90.00 % reduction)
Secondary	No localized controls (0.00 % reduction)
Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.00078 mg/m³.

The inter-quartile confidence interval is 0.00035 mg/m³ to 0.0018 mg/m³.

ART REPORT – **WCS 7b -** handling contaminated objects – 23-Feb-23

Waste handling

Chemical details	
Chemical	Chromium trioxide
CAS No.	1333-82-0

Scenario details	
Number of activities	1
Total duration (mins)	480
Nonexposure period (mins)	470

Metadata	
ART version	1.5
Creator	
Date created	08-Sep-21
Date last edited	20-Jan-23

Details for Activity (untitled)

Emission sources: Near field ✓ Duration (mins): 10

Far field

Near-field exposure

Operational Conditions

Substance emission potential	
Substance product type	Liquids
Process temperature	Room temperature
Vapour pressure	0.01 Pa
Liquid weight fraction	Minor
Viscosity	Low

Activity emission potential	
Activity class	Handling of contaminated objects
Situation	Activities with treated/contaminated objects (surface 0.3-1 m^2)
Contamination level	Contamination < 10 % surface

Surface contamination	
Process fully enclosed?	No
Effective housekeeping practices in place?	Yes

Dispersion	
Work area	Indoors
Room size	3000 m^3

Risk Management Measures

Localised controls	
Primary	No localized controls (0.00 % reduction)
Secondary	No localized controls (0.00 % reduction)

Dispersion	
Ventilation rate	10 air changes per hour (ACH)

Predicted exposure levels

ART predicts air concentrations in a worker's personal breathing zone outside of any Respiratory Protection Equipment (RPE). The use of RPE must be considered separately.

Mechanistic model results

The predicted 90th percentile full-shift exposure is 0.000004 mg/m³.

The inter-quartile confidence interval is 0.0000018 mg/m³ to 0.0000093 mg/m³.