Exposure Scenarios for Uses of Chromates

Overview Table of Exposure Scenarios

Potassium dichromate (S3)				
Use	ECS (Title)			ES Title
1	Formulation – Formulation of Mixtures for Use 2 except On-site Formulation for Use 2 which is Considered to be Covered by Use 2			S3 - ES on Formulation - Environmental Contributing Scenario (Use 1)
2	Use at Industrial Site - Use of Potassium Dichromate for Surface Treatment of Metals such as Aluminium, Steel, Zinc, Magnesium, Titanium, Alloys, Composites, Sealings of Anodic Films			S3 - ES on Use of Potassium Dichromate for Surface Treatment of Metals - Environmental Contributing Scenario (Use 2)
Use	GPS (#)	WCS (# and title)		ES Title
1	A1	3	Transfer to Mixing Vessel - Aqueous Solution (PROC 8a/8b)	S3 - ES on Formulation - Addition of Liquid Chromates to Mixtures (Use 1)
		5	Mixing by Dilution, Dispersion (Closed or Open Process) (PROC 2 to PROC 5)	
		6	Transfer to Small Containers (Including Filtering) (PROC 9)	
		7	Cleaning of Equipment (PROC 8b)	
		8	Maintenance of Equipment (PROC 8a)	
1	A2	2	Decanting and Weighing of Solids (PROC 8b)	S3 - ES on Formulation - Addition of Solid Chromates to Mixtures (Use 1)
		4	Transfer to Mixing Vessel - Solids (PROC 8b)	
		5	Mixing by Dilution, Dispersion (Closed or Open Process) (PROC 2 to PROC 5)	
		6	Transfer to Small Containers (Including Filtering) (PROC 9)	
		7	Cleaning of Equipment (PROC 8b)	
		8	Maintenance of Equipment (PROC 8a)	
2	C1 / D4 / D5	8	Surface Treatment with Cr(VI) - Loading of Jigs (PROC 4)	S3 - ES on Surface Treatment with Cr(VI) in Baths or Tanks without Electrical Current and Maintenance of Equipment (Use 2)
		9	Surface Treatment with Cr(VI) - Chemical Pre-treatment (PROC 13)	
		10	Surface Treatment with Cr(VI) - By Dipping/Immersion (PROC 2, PROC 13)	
		11	Surface Treatment with Cr(VI) - Rinsing/Drying (PROC 13)	
		12	Surface Treatment with Cr(VI) - Chemical Post-treatment (PROC 13)	
		13	Surface Treatment with Cr(VI) - Cleaning and Unloading of Jigs (PROC 4)	
		14	Surface Treatment with Cr(VI) - Cleaning of Equipment (PROC 8b)	
		15	Maintenance of Equipment (PROC 8a)	

Continued overleaf

 Copyright protected

Overview Table of Exposure Scenarios

Potassium dichromate (S3)				
Use	GPS (#)	WCS (# and title)		ES Title
2	C2	18	Surface Treatment in Automatic Spray Tunnel (PROC 10)	S3 - ES on Surface Treatment with Cr(VI) in an Automatic Spray Tunnel (Use 2)
2	C5	17	Surface Treatment with Cr(VI) - By Pen Application (PROC 10)	S3 - ES on Surface Treatment with Cr(VI) by Pen Application (Use 2)
2	C7 / D4 / D5	8	Surface Treatment with Cr(VI) - Loading of Jigs (PROC 4)	S3 - ES on Surface Treatment with Cr(VI) in Baths or Tanks with Electrical Current and Maintenance of Equipment (Use 2)
		9	Surface Treatment with Cr(VI) - Chemical Pre-treatment (PROC 13)	
		10	Surface Treatment with Cr(VI) - By Dipping/Immersion (PROC 2, PROC 13)	
		11	Surface Treatment with Cr(VI) - Rinsing/Drying (PROC 13)	
		12	Surface Treatment with Cr(VI) - Chemical Post-treatment (PROC 13)	
		13	Surface Treatment with Cr(VI) - Cleaning and Unloading of Jigs (PROC 4)	
		14	Surface treatment with Cr(VI) - Cleaning of Equipment (PROC 8b)	
		15	Maintenance of Equipment (PROC 8a)	
2	C11	16	Surface treatment with Cr(VI) - By Rolling and Brushing (PROC 10)	S3 - ES on Surface Treatment with Cr(VI) by Brushing with Electrical Current (Use 2)
2	C15	2	Decanting of Liquids (PROC 8b)	S3 - ES on Decanting and Mixing of Liquids (Use 2)
		4	Mixing - Liquids (PROC 5)	
2	C16	3	Decanting and Weighing of Solids (PROC 8b)	S3 - ES on Decanting, Weighing and Mixing of Solids (Use 2)
		5	Mixing - Solids (PROC 5)	
2	C17	20	Machining Operations on Small to Medium Sized Parts Containing Cr(VI) on an Extracted Bench/Extraction Booth Including Cleaning (PROC 21, 24)	S3 - ES on Machining Activities (Use 2)
		21	Machining Operations on Small to Medium Sized Surfaces Containing Cr(VI) on an Extracted Bench/Extraction Booth Including Cleaning (PROC 21, 24)	
		22	Machining Operations in Large Work Areas on Parts Containing Cr(VI) Including Cleaning (PROC 21, 24)	
		23	Machining Operations in Large Work Areas on Surfaces Containing Cr(VI) Including Cleaning (PROC 21, 24)	
		24	Machining Operations on Parts Containing Cr(VI) in Small Work Areas Including Cleaning (PROC 21, 24)	
		25	Machining Operations on Surfaces Containing Cr(VI) in Small Work Areas Including Cleaning (PROC 21, 24)	

Continued overleaf

 Copyright protected

Overview Table of Exposure Scenarios

Potassium dichromate (S3)				
Use	GPS (#)	WCS (# and title)		ES Title
1 2	D1	1	Delivery and Storage of Raw Material (PROC 1)	S3 - ES on Delivery and Storage of Raw Material (Use 1 & 2)
2	D2	19	Laboratory Analysis (Sampling, Laboratory Analysis) (PROC 15)	S3 - ES on Sampling (Use 2)
2	D3	6	Re-filling of Baths - Liquids (PROC 8b)	S3 - ES on Re-Filling of Baths - Liquid and Solid Chromates (Use 2)
		7	Re-filling of Baths - Solids (PROC 8b)	
2	D7	27	Waste Management (PROC 8b)	S3 - ES on Wastewater Treatment (Use 2)
2	D8	27	Waste Management (PROC 8b)	S3 - ES on Solid Waste Management (Use 2)

 Copyright protected

S3 - ES on Formulation – Environmental contributing scenario (Use 1)

Introduction

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

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

Amount used, frequency and duration of use (or from service life)
• Daily use at site: <= 0.35 tonnes/day [as Cr(VI)]
• Annual use at a site: <= 35 tonnes/year [as Cr(VI)] – largest formulator
• Percentage of tonnage used at regional scale: = 100 %
Technical and organisational conditions and measures
• Air emission abatement: at least 99% efficiency • Negligible discharge of Cr(VI) in wastewater from the site • All solid and any liquid waste is collected and either the collected waste is directly forwarded to an external waste management company, or Cr(VI) in wastewater is reduced to Cr(III) on-site, and the treated waste is either recycled or forwarded to an external waste management company (licenced contractor) for disposal as hazardous waste
Conditions and measures related to sewage treatment plant
• Not applicable – negligible discharge of Cr(VI) in wastewater from the site
Conditions and measures related to treatment of waste (including article waste)
• Collection of all solid and liquid waste, reduction of Cr(VI) in wastewater to Cr(III), recycling or disposal as hazardous waste by an external waste management company (licenced contractor)
Other conditions affecting environmental exposure
• Exhaust air is passed through filters or wet scrubbers according to best available technique (minimum efficiency 99 %)

Releases

For the formulation of potassium dichromate for surface treatment activities, no air emission data (i.e. measurement of release to the atmosphere) were available.

Significant loss of the substance as a gas or vapour will not occur as potassium dichromate has a high melting point and is of low volatility. Loss of the substance as a particulate is likely to be minimal as it is non-dusty. However, due to the absence of measured emission data, the ERC 2 release factor of 2.5% was selected as initial release factor representing an absolute worst-case and likely unrealistic assumption.

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

Therefore, the final release factor is set to 0.025%.

Gentechnema BV

Table 2: Releases

Release	Release factor estimation method	Explanation / Justification
Air	Release factor	**Initial release factor:** 2.5% **Final release factor:** 0.025% **Local release rate:** 0.15 kg/day

Exposure and risks for the environment and man via the environment

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

Table 3: Exposure concentrations and risks for the environment

Protection target	Exposure concentration	Risk characterisation
Air	**Local PEC:** 6.664E-6 mg/m³	-
Man via Environment – Inhalation	**Local PEC:** 6.664E-6 mg/m³	Based on the dose-response relationship derived by the RAC, considering a 70 year exposure time (24h/day, 7d/week), the following excess lifetime risk for the general population is derived based on the estimated exposure: 0.193 per 1000 exposed.

Conclusion on risk characterisation

The estimated exposure concentration of 6.664E-6 mg/m3 is used as worst-case estimate of $Plocal_{air,ann.}$ and used as the basis for risk characterisation for man via the environment.

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

0.193 per 1000 exposed.

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

Gentochema BV

S3 - ES on Use of Potassium Dichromate for Surface Treatment of Metals - Environmental Contributing Scenario (Use 2)

Introduction

Hexavalent chromium releases to the environment are carefully controlled by industry and monitored by regulators. The volume of hexavalent chromium used depends on the scale of surface treatment operations.

Except in case of very low content of Cr(VI) during occasional release (e.g. infrequent surface treatment using small quantities of Cr(VI) where exposure potential is very low, air emissions relating to local exhaust ventilation (LEV) or extraction systems are filtered or passed through wet scrubbers to remove particulates prior to release to atmosphere. Information from facilities indicates that removal efficiency of at least 99% is typical for industry. Companies regularly monitor and report hexavalent chromium emissions as part of permit conditions. Releases are often beneath detection limits and extended sampling times are necessary to quantify releases. These measured data has therefore been used, in line with the applicable models and guidance, to determine the local concentration of hexavalent chromium in air, and exposure to man via the environment, as set out below.

For the surface treatment applications described here, the production facility is strictly separated from the wastewater stream, i.e. there is only very low release of Cr(VI) to the aquatic environment, if at all. Water in scrubbers or filters is generally recycled and occasionally replaced, with resulting material being treated as a waste.

Facilities may have on-site wastewater treatment facilities that act to reduce the hexavalent chromium to trivalent chromium. The solids are precipitated and the supernatant is discharged from the site. The treatment process is very efficient and concentrations of hexavalent chromium in treated water is below detection limits.

Waste materials containing Cr(VI) are classified and treated as hazardous wastes according to EU and national regulations.

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

Amount used, frequency and duration of use (or from service life)
▪ *See below*
Technical and organisational conditions and measures
• Air emission abatement: at least 99% efficiency. For operations where exposure potential is low [i.e. operations are infrequent using only small quantities of Cr(VI)], air emission abatement may not be required. • Negligible discharge of Cr(VI) in wastewater from the site • All solid waste and any liquid waste is collected and either the collected waste is directly forwarded to an external waste management company, or Cr(VI) in wastewater is reduced to Cr(III) on-site, and the treated waste is forwarded to an external waste management company (licenced contractor) for disposal as hazardous waste
Conditions and measures related to sewage treatment plant
• Not applicable – negligible discharge of Cr(VI) in wastewater from the site
Conditions and measures related to treatment of waste (including article waste)
• Collection of all solid and liquid waste, elimination of Cr(VI) from waste water, disposal as hazardous waste by an external waste management company (licenced contractor)
Other conditions affecting environmental exposure
• When needed, exhaust air is passed through filters or wet scrubbers according to best available technique (minimum efficiency 99 %)

Centrochema BV

Point source emission data were provided for 5 sites. These data were used to estimate $Clocal_{air,ann}$, the estimated annual average concentration in air, 100 m from point source, for the assessment of Man via Environment according to the Technical Guidance document R. 16, 2012.

Where emission was reported in g/h, emission time per day and emission days per year was used to calculate the annual average daily emission (kg/d). Where the measured concentration (g/m^3) was reported, information on mass volume flow (m3/h) was used to determine emission per hour (g/h).

Measured concentrations below the detection limit were used applying a factor of 0.5 to the reported values. If the measurement reported the emission as Cr total, a factor of 0.5 as worst-case assumption was used to estimate Cr(VI) emission. In accordance with standard risk assessment procedures, measured concentration data below elevated detection concentrations (> 0.05 mg Cr(VI)/Nm^3) were not used as they do not allow realistic estimates that support meaningful risk assessment.

The $PECregional_{air,ann}$ was estimated in EUSES2.1.2. The following assumptions have been used for estimation:

Table 2: Parameters for estimating $PECregional_{air}$

Tonnage [as Cr(VI)]	Release factor* (%)	Regional fraction** (%)
35	0.001	20

* The release factor was estimated using default from ERC6b (0.1%) and applying efficiency of air abatement of 99%.
** Percentage of tonnage used at regional scale

Exposure and Risks for the Environment and Man via the Environment

The air exposure concentrations are reported in the following table.

Table 3: Cr(VI) exposure concentrations in air, 100 meter from point source

No of Sites	Reporting Year	Range $Clocal_{air,ann}$ (mg/m^3)	Arithmetic Mean (mg/m^3)	Geometric Mean (mg/m^3)	90^{th} Percentile (mg/m^3)
5	2010-2012	2.03E-6 – 6.47E-8	1.02E-6	6.12E-7	1.86E-6

The 90^{th} percentile value of 1.86E-6 mg Cr(VI)/m^3 is used as worst-case estimate of $Clocal_{air,ann}$.

The $PEClocal_{air,ann}$ of 1.86E-6 mg Cr(VI)/m^3 is estimated as sum of $Clocal_{air,ann}$ and $PECregional_{air}$ and used as the basis for risk characterisation for man via the environment.

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

5.39E-02 per 1000 exposed.

As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m^3] might be an over-estimate.

Gentrochema LV

S3 - ES on Formulation - Addition of Liquid Chromates to Mixtures (Use 1)

Introduction

The following Exposure Scenario covers blending of liquid chromate (with or without additives) in solutions by formulators during the manufacturing of proprietary products or by downstream users during preparation of solutions for surface treatment. Solutions are supplied in sealed containers (IBC) or appropriate packaging.

Liquid chromate mixtures are transferred to and filled into the mixing vessel. This might be an open, manual process or an automatic, closed process. The mixing/blending of the preparation is performed within a mixing tank, often a closed or semi-closed system with automated mixing.
After mixing, the formulation is manually or automatically transferred into specified (ADR approved) containers or tanks or appropriate packaging.
If the substance is decanted, the process is not automated. Connecting the receiving vessel to the source vessel is done manually.

Downstream users either add the chromates directly into the mixture in the surface treatment tank or pre-mix it and then add the solution to the tank. The mixing vessel or treatment tank may be fed by automated loading or manually

Equipment Design and Access

Formulation is preferentially carried out in a dedicated mixing vessel.

- The mixing vessel is normally closed with an opening for addition of liquid chromate solution and other raw materials.
- The mixing vessel has local exhaust ventilation (LEV), a manual or automated stirrer and optionally a pump to transfer the product to the containers.
- The water or solvent supply to the mixing tank is designed to prevent splashing of chromates.
- The speed of the mixer is sufficiently low to prevent splashing.
- LEV must be provided at the dosing point.

Chromates Emissions

Chromate containing mist or aerosols might be released from the tanks when the lids are opened. Splashing can occur when adding additional components to chromates or vice versa. Residual chromates on equipment surfaces might be possible in some systems.

Risk Management Measures – Workers

- Flush residues from the drum to the vessel with low pressure water. Carefully add other raw materials / water to prevent splashing.
- LEV must be regularly inspected and maintained to ensure full working order.
- Regularly inspect and rinse equipment to remove residual chromates.
- Implement appropriate measures to prevent cross-contamination between equipment and personal protective equipment (PPE).
- Restrict access to the process area to permitted workers only by appropriate measures.

PPE

To minimize potential exposure to chromates, all persons accessing the formulation process must wear:

- Protective goggles
- Protective gloves
- sufficient resistant clothing / footwear adapted to the chemical risks of the mixture
- Respiratory protection (half or full-face mask with P3 filter) when handling open drums.

CCST Good Practice Sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Centrochema BV

Training and Supervision

All persons with access to the formulation/mixing area must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be provided at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Centrochema BV

Exposure Assessment – Preparation for Mixing, Mixing, Filling into small Containers, Cleaning and Maintenance of Equipment

Adequate measurement data covering all sub-tasks (decanting and weighing, transfer, mixing and cleaning) described in the following worker contributing scenarios (WCS) are available. Exposure estimates based on this measurement data are provided at the end of the Maintenance WCS. Please note that the measurement data used for exposure assessment always included the formulation of solid chromates and therefore likely overestimate exposure for the formulation process only including liquid chromate solutions.
The following WCS set out the operational conditions and risk management measures relevant for the different sub-scenarios.

Worker Contributing Scenario: Transfer to Mixing Vessel – Aqueous Solution (PROC 8a/8b)

Introduction (WCS)

The potassium dichromate solution is transferred to and filled into the mixing vessel. This might be an open, manual process or an automatic, closed process.

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 40%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS.

Centrochem BV

Worker Contributing Scenario: Mixing by Dilution, Dispersion (Closed or Open Process) (PROC 2 to PROC 5)

Introduction

The mixing/blending of the preparation is performed within a mixing tank, often a closed or semi-closed system with automated mixing.

Conditions of Use

Table 2: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C; sometimes above	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS.

Gentochem B.V.

Worker Contributing Scenario: Transfer to Small Containers (Including Filtering) (PROC 9)

Introduction

Manual or automatic filling of formulation into specified containers or tanks.

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS.

Gentrochem B.V.

Worker Contributing Scenario: Cleaning of Equipment (PROC 8b)

Introduction

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

Conditions of Use

Table 4: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *In cases where exposure to dichromates in solid form may occur, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn; [Respirator with APF 30] [Effectiveness Inhal: 96.67%]* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS.

Centrochema B

Worker Contributing Scenario: Regular Maintenance of Equipment (PROC 8a)

Introduction

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

Conditions of Use

Table 5: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 30 min	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *In cases exposure to airborne hexavalent chromium might occur, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquids and solids): Room temperature	Measured data

Exposure and Risks for Workers

See below.

Combined Assessment of Exposure and Risks for Workers

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

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

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

The values reported below includes an estimate of the effectiveness of respiratory protection. Effectiveness of

Genrochem B.V.

respiratory protection was assessed using the company information on type of mask and filter used and the protection factors (APFs) provided by either the *German BG rule "BGR/GUV-R190"* from December 2011 or alternatively, if available, the APF provided by the manufacturer of the respiratory protection equipment. Respiratory protection is always worn during handling of solid dichromates.
The exposure concentrations [Cr(VI)] and risk characterisation ratios (RCR) are reported in the following table.

Table 6: Exposure concentrations and risks for workers – Inhalation, local, long-term

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

* N = number of measurements

Conclusion on Risk Characterisation

The 90th percentile value of the personal sampling data adjusted for respiratory protection of 0.26 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case).
An excess lifetime risk of 1.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[1].

Centrochema BV

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

S3 - ES on Formulation - Addition of Solid Chromates to Mixtures (Use 1)

Introduction

The following Exposure Scenario covers blending of solid (dry) chromates (with or without additives) in solution or dispersion by formulators during the manufacture of proprietary products or by downstream users during preparation of solutions or dispersions prior to surface treatment.
Solid chromates are supplied in drums or bags as crystals, flakes or fine powder.
Formulators blend/dissolve/disperse the chromates in a mixing vessel with water or solvent and other raw materials. After mixing and further process steps (e.g. grinding, sampling, quality control), the formulation is transferred to (ADR approved) containers or other suitable packaging.
Downstream users either dissolve the chromates directly into the mixture in the treatment tank or pre-mix it and then add the solution to the tank. Raw materials may be automatically or manually added to the mixing vessel or treatment tank. For primers and specialty coatings, Downstream Users occasionally add small quantities of other components in a mixing vessel, using a handheld tool to achieve a good consistency.

Equipment Design and Access

Formulation is preferentially carried out in a dedicated mixing vessel.

- The mixing vessel is normally closed with an opening for addition of chromates and other raw materials.
- The mixing vessel has local exhaust ventilation (LEV), a manual or automated stirrer and a pump or other means to transfer the product to the containers.
- LEV is provided at the point at which solid chromates are weighed and added to the mixing vessel.
- The water or solvent or other liquid component supplied to the mixing tank is designed to prevent splashing of chromates.
- The speed of the mixer is sufficiently low to prevent splashing.

Where a dedicated mixing vessel is not available, formulation may be carried out directly in the surface treatment tank or bath.

- Where a separate mixing vessel is not available, the chromates must be dosed into the surface treatment or formulation tank when it is not operational (i.e. in maintenance mode).
- LEV must be provided at the dosing point.

Chromates Emissions

Chromates in solid form can generate dust during handling. Exposure to chromate dust is possible when drums are opened, during weighing and during transfer to the mixing vessel or treatment tank. Splashing can occur when adding water/solvent other liquid component to chromates or vice versa. Residual chromates on equipment surfaces might be possible in some systems.

Risk Management Measures – Workers

- At the mixing vessel, first add a small amount of water or solvent or other liquid component, then slowly invert the container with the chromate close to the LEV, gently releasing the contents to the mixing vessel without splashing.
- When formulating aqueous solutions, flush residues from the drum to the vessel with low pressure water. Carefully add other raw materials/solvent/water to prevent splashing.
- LEV must be regularly inspected and maintained to ensure full working order.
- Regularly inspect and rinse or wipe equipment (as appropriate) to remove residual chromates.
- Implement appropriate measures to prevent cross-contamination between equipment and personal protective equipment (PPE).
- Restrict access to the process area to permitted workers only by appropriate measures.

PPE

To minimize potential exposure to chromates, all persons accessing the formulation process must wear:

- Protective goggles.
- Protective gloves.

Centrochema BV

- Chemical-resistant clothing / footwear, when necessary
- Respiratory protection (half or full-face mask with P3 filter) when handling open drums.

CCST Good Practice Sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to the formulation/mixing area must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be provided at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Gentrochema BV

Exposure Assessment - Preparation for Mixing, Filling into Small Containers, Cleaning and Maintenance of Equipment

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

Worker Contributing Scenario: Decanting and Weighing of Solids (PROC 8b)

Introduction

Solid potassium dichromate may be decanted and weighted before transferred to the mixing vessel.

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics	
• Substance as such / in mixture Concentration of Cr(VI): < 40%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for solids): ambient	Measured data

Exposure and Risks for Workers

See end of Maintenance WCS.

Confidential BV

Worker Contributing Scenario: Transfer to Mixing Vessel – Solids (PROC 8b)

Introduction

The solid potassium dichromate is transferred to and filled into the mixing vessel. This is normally a manual process.

Conditions of Use

Table 2: Conditions of use

	Method
Product (article) characteristics	
• Substance as such / in mixture Concentration of Cr(VI): < 40%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 4 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for solids): ambient	Measured data

Exposure and Risks for Workers

See end of Maintenance WCS.

Certochem B.V.

Worker Contributing Scenario: Mixing by Dilution, Dispersion (Closed or Open Process) (PROC 2 to PROC 5)

Introduction

The mixing/blending of the preparation is performed within a mixing tank, often a closed or semi-closed system with automated mixing.

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C; sometimes above	Measured data

Exposure and Risks for Workers

See end of Maintenance WCS.

Gentochem B.V.

Worker Contributing Scenario: Transfer to Small Containers (Including Filtering) (PROC 9)

Introduction

Manual or automatic filling of formulation into specified containers or tanks.

Conditions of Use

Table 4: Conditions of Use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): <= 40 °C	Measured data

Exposure and Risks for Workers

See end of Maintenance WCS.

Gentro chem B

Worker Contributing Scenario: Cleaning of Equipment (PROC 8b)

Introduction

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

Conditions of Use

Table 5: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *In cases where exposure to dichromates in solid form may occur, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn; [Respirator with APF 30] [Effectiveness Inhal: 96.67%]* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for liquid): <= 40 °C	Measured data

Exposure and Risks for Workers

See end of Maintenance WCS.

Gemrosch en B.V.

Worker Contributing Scenario: Regular Maintenance of Equipment (PROC 8a)

Introduction

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

Conditions of Use

Table 6: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 30 min	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: Yes	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *In cases exposure to airborne hexavalent chromium might occur, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquids and solids): Room temperature	Measured data

Exposure and Risks for Workers

See below.

Combined Assessment of Exposure and Risks for Workers

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

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

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

The values reported below include an estimate of the effectiveness of respiratory protection. Effectiveness of

Genrochem B.V.

respiratory protection was assessed using the company information on type of mask and filter used and the protection factors (APFs) provided by either the *German BG rule "BGR/GUV-R190"* from December 2011 or alternatively, if available, the APF provided by the manufacturer of the respiratory protection equipment. Respiratory protection is always worn during handling of solid dichromates.
The exposure concentrations [Cr(VI)] and risk characterisation ratios (RCR) are reported in the following table.

Table 7: Exposure concentrations and risks for workers – Inhalation, local, long-term

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

* N = number of measurements

Conclusion on Risk Characterisation

The 90th percentile value of the personal sampling data adjusted for respiratory protection of 0.26 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case).
An excess lifetime risk of 1.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[1].

Gentochema BV

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

S3 - ES on Surface Treatment with Cr(VI) in Baths or Tanks without Electrical Current and Maintenance of Equipment (Use 2)

Introduction

This Exposure Scenario covers activities relating to surface treatment by dipping/immersion in sequential process steps within a series of tanks that contain treatment, cleaning and other related solutions. Tasks involved may include the loading of parts onto racks, hangers or jigs, chemical pre-treatment in baths, treatment with Cr(VI) in baths, chemical post-treatment in baths, cleaning, rinsing, drying of the treated parts and finally the unloading of the parts from racks, hangers or jigs. The parts may be moved through the different baths automatically (e.g. the jig is controlled electronically), semi-automatically (e.g. the parts are moved by the operator between the baths using an overhead hoist in a predetermined sequence), or manually (e.g. the worker starts the process and moves the parts manually or using hoists and tracks from tank to tank). The distance between the operators and the baths increases with increasing automation of the processes (decreasing potential for exposure). The size of the baths and the number of treated items also influences exposure potential. All baths containing Cr(VI) or other hazardous substances are equipped with local extract ventilation LEV) during the treatment process. Partially, baths are covered and/or mist suppressants are used.

Worker Contributing Scenario: Surface Treatment with Cr(VI) – Loading and Unloading of Jigs (PROC 4)

Introduction (WCS)

Prior to surface treatment, the articles or parts to be plated are loaded on jigs or hangers. After surface treatment, cleaning and drying, the parts are unloaded from the jigs or hangers. Loading and unloading of jigs are usually conducted by a specific group of workers different to those at the treatment lines, though this might not always be the case.

Equipment Design and Access

Depending on the system, parts may be:

- mounted/demounted to a hoist manually or automatically outside an enclosed chamber
- mounted/demounted to a hoist manually or automatically outside a segregated area
- fixed to / removed from the hoist, racks or grippers manually or automatically at a separate station
- manually mounted on a rack, hoist or crane
- mounted on supports

Chromates Emissions

There is no residual Cr(VI) on the parts during loading or unloading. During this process, exposure to Cr(VI) cannot occur directly but may be possible through secondary sources (e.g. baths in the same room).

Risk Management Measures – Workers

The loading/unloading areas are always located some distance from the plating lines (at least several meters from the treatment baths) or segregated (e.g. by a wall) from the treatment area or even located in another room/hall. Therefore, potential for any exposure from secondary sources is very low.

PPE

No specific PPE apart from safety shoes and gloves are usually required during loading and unloading.

Centrochema BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: No	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): Room temperature	Measured data

Exposure and Risks for Workers

Workplace monitoring data relating to the loading and unloading areas are not currently available. The monitoring results at the plating lines (1.26 µg Cr(VI)/m³ as 90th percentile value).can be used to develop exposure estimates, considering the loading and unloading area is several meters in distance to the chromium baths.

In the ART 1.5 model[1], far-field exposure (more than 1 meter in distance to the exposure source) is determined by applying a reduction factor of 0.1 to exposure measured in the near-field[2]. The ART 1.5 model assumes a room size of > 1000 m[3] and an hourly air exchange rate (ACH) of 1 for this far-field exposure assessment. As a worst-case approach for this Exposure Scenario, a room size of 1000m³ and ACH of 1 is assumed for the room/hall where loading and unloading is carried out and the plating lines are located has been used in the exposure assessment. However, the room volume is typically much larger, and the ACH higher than this and, as noted above, loading/unloading activity is often segregated from the plating line.

Applying the factor 0.1 according to the ART 1.5 model to measured data at the chromium baths, the estimated exposure for the loading and unloading areas would be 0.126 µg Cr(VI)/m³.

Conclusion on Risk Characterisation

The exposure estimate is based on measured data at the plating baths and adjusted using worst case assumptions to account for distance to the source of exposure of 0.126 µg Cr(VI)/m³. This is used as the basis for risk characterisation.

An excess lifetime lung cancer risk of 0.50 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality[3].

[1] Development of a mechanistic model for the Advanced REACH Tool (ART) - Version 1.5 – TNO report V9009, January 2013

[2] As described in Table 3.9.4. "Indoor Far-Field Multipliers for dusts, mists (low-volatile liquids), powders in liquids, paste/slurry, solid objects and fibres (long-term; 8-hour tasks)", page 160 of the TNO report V9009.

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

Gemnoclenia B.V.

Worker Contributing Scenario: Surface Treatment with Chromates in Open Tanks or Baths (e.g. Passivation, Conversion Coating, Anodize Seal) without Electric Current (PROC 13)

Introduction (WCS)

This worker contributing scenario covers the industrial surface treatment of articles in one or more treatment tanks. These processes (e.g. passivation, conversion coating, anodize seal) involve no electric current at the tank ('electroless'). The treatment line comprises a series of baths or tanks. The article is immersed in an aqueous solution containing chromates. The treated parts are rinsed in separate tanks.

Equipment Design and Access

The treatment tanks are open. Articles or parts with varying dimensions are fixed to and removed from hoists, racks or added to baskets at a separate station and fed manually or by a conveyor system through the surface treatment system. Parts are typically treated over short cycles. The process is normally carried out at temperatures up to 35°C and occasionally up to 95°C. The treatment system must have all of the following features:

- Articles are prepared for the treatment process at a dedicated station in an adjacent/separate area.
- No electric current is applied at the chromate tank.
- Following surface treatment, the parts are rinsed in water in separate tanks.
- LEV designed, dimensioned, located and maintained to capture and remove chromates is provided.

Chromates Emissions

Residual chromate solution on equipment surfaces and articles/parts might be possible after surface treatment. Residual chromate solution typically drains from the treated part and is captured in the surface treatment or rinse tank.

Risk Management Measures – Workers

- Process equipment must be regularly inspected and rinsed to remove residual chromates, which appears as colored traces on the equipment.
- Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination from equipment and PPE.

PPE

To minimize potential exposure to chromates, all persons accessing the treatment line must wear:

- Protective eye goggles.
- Protective gloves.
- Safety clothing / footwear.

See CCST Good Practice Sheet E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to the treatment process must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

Cenrochema BV

Exposure Assessment

Conditions of Use

Table 2: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes, if Cr(VI) or other dangerous substances are used in the pre-treatment	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): Above room temperature	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS

Genroc-hema B.V.

Worker Contributing Scenario: Maintenance of Equipment (PROC 8a)

For the regular maintenance of the baths and related equipment (e.g. LEV, rectifier, pumps, panels etc.), it is conservatively assumed that it will happen 60 minutes every day. Regular maintenance is conducted when the bath solutions are at ambient temperature and no aerosol formation can be expected. Therefore, the results of the air measurements provided below, which have been conducted during the surface treatment process, represent a worst-case estimate for the regular maintenance activities. If maintenance is needed during the process, often RPE is used. This scenario also covers infrequent maintenance activities with longer duration.

Introduction (WCS) (Regular Maintenance)

Regular maintenance activities are conducted when the bath solutions are at ambient temperature and no aerosol formation can be expected.
Plant and equipment must be checked periodically according to a maintenance plan to ensure it is operating optimally.
This worker contributing scenario describes minor maintenance and cleaning activities that can be carried out when the plant is nonoperational, but chromates solution or electrolyte remains in the bath, vessel or equipment.
These activities should be subject to a permit-to-work system in most cases. Management of risks relating to exposure to chemicals including chromates should be accounted for as part of the permit-to-work system.

Equipment Design and Access (Regular Maintenance)

Full access to all components of the plant/equipment is required for maintenance, repair and installation. A specific risk assessment and permit to work system must be in place for all scheduled maintenance activities.

Chromates Emissions (Regular Maintenance)

Chromate residues on equipment surfaces such as plating tanks, lids, extraction lips and racks might be possible. Released residual material in pumps or pipes could splash. While the process is nonoperational, low levels of airborne aerosols or dusts relating to residual chromate cannot be discounted.

Risk Management Measures – Workers[4] (Regular Maintenance)

- A permit-to-work system that takes into account specific chemical exposure must be in place for all maintenance, repair and installation works. Approval for such works must be gained according to the permit-to-work system.
- Prior to commencing work, surfaces should be thoroughly cleaned by rinsing with low pressure water. Pipework, pumps and other closed equipment with potential residual chromate solution must be gently flushed with water. Reducing agents should be used.
- Replaced parts and components may or may not be cleaned to remove residual chromates prior to disposal in accordance with relevant legislation.
- Effective access control must be in place.

PPE (Regular Maintenance)

To minimize potential exposure to chromates, all persons conducting maintenance work wear:

- Protective eye goggles.
- Protective work gloves.
- Safety clothing / anti-static protective boots
- Air-fed masks/full-face masks with P3 filter for higher risk operations with an increased potential for exposure (e.g. exchange of HEPA filters on air extraction equipment)
- Half-face respirator with P3 filter at all other times

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision (Regular Maintenance)

All maintenance persons with access to the equipment must be instructed in the risks from working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

[4] RMM and OC outlined below relate to management of chromate exposure only.

Centrochema BV

Monitoring (Regular Maintenance)

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Introduction (WCS) (Infrequent maintenance)

Plant and equipment must be checked periodically according to a maintenance plan to ensure it is operating optimally. From time to time, the plant will be completely refurbished.
Unscheduled access to the equipment may also be required to perform maintenance and repair in case of a malfunction.

This worker contributing scenario also describes activities when the plant is non-operational and all chromates solution, electrolyte or product has been removed.

These activities should be subject to a permit-to-work system in most cases. Management of risks relating to exposure to chemicals including chromates should be accounted for as part of the permit-to-work system.

Equipment Design and Access (Infrequent Maintenance)

Full access to all components of the plant/equipment is required for maintenance, repair and installation. A specific risk assessment and permit to work system must be in place for all scheduled and maintenance activities.

Chromates Emissions (Infrequent Maintenance)

Chromate residues on equipment surfaces such as plating tanks, lids, extraction lips and racks might be possible. Released residual material in pumps or pipes could splash. While the process is nonoperational, low levels of airborne aerosols or dusts relating to residual chromates cannot be discounted.

Risk Management Measures – Workers[5] (Infrequent Maintenance)

- Prior to commencing work, surfaces should be thoroughly cleaned by rinsing with low pressure water. Pipework, pumps and other closed equipment must be gently flushed with water to remove residual chromate solution. Reducing agents may be used.
- A permit-to-work system that takes into account specific chemical exposure must be in place for all maintenance, repair and installation works. Approval for such works must be gained according to the permit-to-work system.
- Replaced parts and components may or may not be cleaned to remove residual chromate prior to disposal in accordance with relevant legislation.
- When the intervention requires access to a “confined space” (e.g. tank), take additional precautions as required by current national legislation. Any parts that are removed from the installation to be discarded or refurbished should be decontaminated on-site using a suitable reducing agent.

PPE (Infrequent Maintenance)

To minimize potential exposure to chromates, all persons conducting maintenance work must wear:

- Protective eye goggles.
- Face mask/visor in case of splashing risk.
- Protective work gloves.
- Safety clothing / anti-static protective boots
- P3 filter mandatory for encapsulated open tank process lines.
- P3 filter recommended for other process lines.

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

5 RMM and OC outlined below relate to management of chromate exposure only.

Certiscrema BV

Training and Supervision (Infrequent Maintenance)

All maintenance persons with access to the equipment must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring (Infrequent Maintenance)

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Exposure Assessment

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: No	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquids and solids): Room temperature	Measured data

Exposure and Risks for Workers

See below.

Gentscheff BV

Combined Assessment of Exposure and Risks for Workers for WCS Surface Treatment with Chromates in Open Tanks or Baths (e.g. Passivation, Conversion Coating, Anodize Seal) without electric current and WCS Maintenance

Exposure and Risks for Workers

More than 400 personal sampling and static measurement data from 2000-2013 in six EU countries are available. Because sufficient (>80) data from personal sampling is available, the exposure assessment is based on these data (as suggested in the Technical Guidance document R.14).

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

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

The values reported below include an estimate of the effectiveness of respiratory protection.

In general, however, respiratory protection is not worn during surface treatment activities and the data therefore rather represent external, measured exposure results.

In the few cases in which respiratory protection was used, the effectiveness of respiratory protection was assessed using the company information on type of mask and filter used and the protection factors (APFs) provided by the *German BG rule "BGR/GUV-R190"* from December 2011 or alternatively, if available, the APF provided by the manufacturer of the respiratory protection equipment. Respiratory protection is always worn in situations in which exposure to potassium dichromate in solid state could occur. Partially, however, respiratory protection is also used when work is conducted close to the chromate emission source (chromate containing baths). In a minority of cases, depending on the level of reporting provided with the data, the duration for which respiratory protection had been used clearly could be assigned to the measurement results and the measured values then have been adjusted accordingly. In most of the cases, however, this was not possible and the values used for exposure estimation provide an overestimate of inhaled dose (i.e. the measured values were not adjusted to account for use of respiratory protection in these cases).

It is important to mention that the exposure data do not represent exposure to potassium dichromate alone but, in most cases, include also exposure to other chromates, and to chromium trioxide as the main emission source. However, because it was not possible to separate the respective contribution of each emission source, the values below provide Cr(VI) exposure estimates from all emission sources as worst case estimate for potassium dichromate) exposure.

Gentrochem BV

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

Table 4: Exposure concentrations and risks for workers – Inhalation, local, long-term

Worker contributing scenario	PROC	Description	N*	Arithmetic Mean	Geometric Mean	90th Percentile	RCR
WCS	PROC 13	Surface treatment with chromates in open tanks or baths	**87**	**0.69 µg/m³**	**0.45 µg/m³**	**1.26 µg/m³**	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 5.04 per 1000 exposed workers
WCS	PROC8a	Maintenance of equipment					

* N = number of measurements

Conclusion on Risk Characterisation

The 90th percentile value of the personal sampling data partially adjusted for respiratory protection of 1.26 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case).
An excess lifetime risk of 5.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Gentrochema BV

S3 - ES on Surface Treatment with Cr(VI) in an Automatic Spray Tunnel (Use 2)

Introduction

This Exposure Scenario covers the industrial surface treatment of articles by spraying (with no or low pressure compressed air) in spraying tunnels. The metal article is automatically transported through the spray line in the tunnel. Typically, the article is suspended from a fitting at the top of the tunnel which is conveyed along the tunnel at a steady speed. The aqueous treatment solution is transferred to the processing line via pipes and discharged as a spray. The bottom, the top, and the sides of the tunnel are generally contained with the exception of a long narrow slot for the suspension fitting. The sides of the tunnel may have maintenance access panels, but these are closed during spraying. Enclosures at the entrance and outlet of the tunnel are not opened during the activity but have openings wide enough for the component parts. A negative pressure is maintained within the enclosure. Washing areas to deposit remaining aqueous spray are situated between the entrance and the exit of the spraying tunnel. The article exits the tunnel and is subsequently dried in an oven outside the spraying line.

Effective housekeeping practices include regularly cleaning as well as preventive maintenance of machinery and control measures to repel spill and reduce personal cloud.

Equipment Design and Access

The cabin/tunnel comprises a spraying chamber that is closed during operations. The process is automated and workers are outside the cabin during spraying. The parts are mounted to a conveyor system at a dedicated station and transported by a conveyor into the cabin. Spray nozzles in the cabin apply the coating. Ooverspray is returned and reused. The parts are then conveyed to curing or drying chambers. The system must have all the following features:

- Spray operations are enclosed within a closed spray chamber/tunnel.
- Access to the spray chamber/tunnel is not possible during spray operations.
- LEV is provided to efficiently remove chromates from the chamber/tunnel.
- The spray chamber is maintained under negative pressure when the system is operating.
- Articles are prepared for the treatment process at a dedicated station in an adjacent/separate area.
- Masking materials may be used to protect equipment during operations such as spraying or maintenance where there is increased potential for release. The masking material is periodically removed and replaced.

Chromates Emissions

Material containing chromates is released during spray operations. Residual chromates on equipment surfaces might be possible.

Risk Management Measures – Workers

- Controls are in place to ensure access to the spray chamber/tunnel is restricted when the plant is operational, including adequate clearance time after completion of a production cycle. Clearance time should be determined via an appropriate test.
- The LEV system must be hard-wired so that the spraying process stops immediately in case of a ventilation malfunction/ breakdown.
- The LEV system must be tested regularly and comprehensively to ensure it is operating efficiently.
- Process equipment must be regularly inspected and rinsed to remove residual chromates.
- Implement appropriate measures e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination from equipment and PPE to adjacent areas.

PPE

There should be no access to the spray cabin/tunnel during spray operations. To minimize potential exposure to chromates, all persons accessing the spray cabin must wear:

- Protective eye goggles.
- Protective gloves
- Safety clothing / footwear.
- Plastic coverall

Centrochema BV

- Full-face mask with P3 filter

See CCST Good Practice Sheet E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to the spray cabin/tunnel must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Gentrochema BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: Extremely small (0.1 – 0.5%)	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 480 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: No	ART 1.5
• Activity class: Surface spraying of liquids	ART 1.5
• Situation: High application rate (> 3 l/minute)	ART 1.5
• Spray direction: In any direction (including upwards)	ART 1.5
• Spray technique: Spraying with no or low compressed air use	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: 300m3	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Medium level containment (99.00 % reduction)[1]	ART 1.5
• Secondary: Other enclosing hoods (90.00 % reduction)	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

[1] Medium level containment can, e.g., be described as "Enclosed material transfer with the receiving vessel being docked or sealed to the source vessel" [Advanced REACH Tool (ART) version 1.5].

Cermochem B.V.

Exposure and Risks for Workers

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

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.4 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime mortality risk up to age 89 is derived based on the estimated exposure: 1.6 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.4 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[2].

An excess lifetime risk of 1.6 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[3].

Gentrochema B.V.

[2] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Surface Treatment with Cr(VI) by Pen Application (Use 2)

Introduction

This Exposure Scenario covers the industrial surface treatment of articles by touching up small areas using a pen-stick, typically during quality control, maintenance or repair.
An even thickness of a surface treatment containing chromates is applied to the article using a pen-stick or a small brush. The pen-stick is designed specifically to minimize worker exposure during small maintenance activities.
Very small areas may be treated using a pen stick containing small amounts of potassium dichromate (chromate).

Equipment Design and Access

Purpose-designed pen-sticks (pre-filled with the chromate mixture) and small brushes are supplied with the surface treatments formulations.

Workers use the pen-stick or small brushes to apply the proprietary surface treatment containing chromates to small areas

Chromates Emissions

Residual chromate solution on equipment surfaces and articles/parts might be possible after treatment. Pen-sticks are specifically designed to minimize exposure and release during use.

Risk Management Measures – Workers

- Pen-sticks/small brushes and small cups must be cleaned or disposed after use (see CCST Good Practice Sheet D8 at this Link).
- Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination from equipment and PPE to adjacent areas.

PPE

All persons carrying out touch up operations must wear:

- Protective eye goggles.
- Protective gloves.
- Safety clothing.

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons carrying out these operations must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties and to safely cease such duties as needed. Adequate supervision must be available at all times

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Centrochema BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: very small (0.5 - 1%)	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Medium	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Spreading of liquid products	ART 1.5
• Situation: Spreading of liquids at surfaces or work pieces < 0.1 m² / hour	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors/outdoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: No localized controls (0.0 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

Centrochem B.V.

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.017 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.07 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5) of 0.017 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime risk of 0.07 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[2].

Centrochema BV

[1] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Surface Treatment with Cr(VI) in Baths or Tanks with Electrical Current and Maintenance of Equipment (Use 2)

Introduction

This Exposure Scenario covers activities relating to surface treatment by dipping/immersion is conducted in sequential process steps within a series of tanks that contain treatment, cleaning and other related solutions. Tasks involved may include the loading of racks, hangers or jigs with the parts, chemical pre-treatment in baths, treatment with Cr(VI) in baths, chemical post-treatment in baths, cleaning, rinsing, drying of the treated parts and finally the unloading of the parts from racks, hangers or jigs. The movement of parts through the different baths may be an automatic process in which the movement of the jigs is controlled electronically, a semi-automatic process in which the parts are moved by the operator between the baths using an overhead hoist in a predetermined sequence, or a manual process, in which the worker starts himself the process and moves the parts manually or using hoists and tracks from tank to tank. The distance between the operators and the baths increases with increasing automation of the processes, so the exposure potential might decrease. On the other hand, the size of the baths of the automatic lines and the number of treated items might be larger compared to the manual systems, which may lead to an opposite effect on exposure potential. All baths containing hexavalent chromium or other hazardous substances are equipped with extract ventilation during the treatment process. Partially, baths are covered and/or mist suppressants are used.

Worker Contributing Scenario: Surface Treatment with Cr(VI) – Loading and Unloading of Jigs (PROC 4)

Introduction (WCS)

Prior to surface the articles or parts to be plated are loaded on jigs or hangers. After surface treatment, cleaning and drying, the parts are unloaded from the jigs or hangers. Loading and unloading of jigs are usually conducted by a specific group of workers different to those at the surface treatment lines, though this might not always be the case.

Equipment Design and Access

Depending on the system, parts may be:

- mounted/demounted to a hoist manually or automatically outside an enclosed chamber
- mounted/demounted to a hoist manually or automatically outside a segregated area
- fixed to / removed from the hoist, racks or grippers manually or automatically at a separate station
- manually mounted on a rack, hoist or crane
- mounted on supports

Chromates Emissions

There is no residual Cr(VI) on the parts during loading or unloading. During this process, exposure to Cr(VI) cannot occur directly but may be possible through secondary sources (e.g. baths in the same room).

Risk Management Measures – Workers

The loading/unloading areas are always located some distance from the surface treatment lines (at least several meters from the plating baths) or segregated (e.g. by a wall) from the surface treatment area or even located in another room/hall. Therefore, potential for any exposure from secondary sources is very low.

PPE

No specific PPE apart from safety shoes and gloves are usually required during loading and unloading.

Centrochema B.V.

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: No	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): Room temperature	Measured data

Exposure and Risks for Workers

Workplace monitoring data relating to the loading and unloading areas are not currently available. Instead, the monitoring results directly at the plating lines (1.26 µg Cr(VI)/m³ as 90th percentile value).can be used as a worst case data, considering the loading and unloading area is several meters in distance to the chromium baths.

In the ART 1.5 model[1], far-field exposure (more than 1 meter in distance to the exposure source) is determined by applying a reduction factor of 0.1 to exposure measured in the near-field[2]. The ART 1.5 model assumes a room size of > 1000 m3 and an hourly air exchange rate (ACH) of 1 for this far-field exposure assessment. As a worst-case approach for this Exposure Scenario, a room size of 1000m³ and ACH of 1 is assumed for the room/hall where loading and unloading is carried out and the plating lines are located has been used in the exposure assessment. However, the room volume is typically much larger, and the ACH higher than this and, as noted above, loading/unloading activity is often segregated from the plating line.

Applying the factor 0.1 according to the ART 1.5 model to measured data at the chromium baths, the estimated exposure for the loading and unloading areas would be 0.126 µg Cr(VI)/m³.

Conclusion on Risk Characterisation

The exposure estimate is based on measured data at the plating baths and adjusted using worst case assumptions to account for distance to the source of exposure of 0.126 µg Cr(VI)/m³. This is used as the basis for risk characterisation.

An excess lifetime lung cancer risk of 0.50 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality. As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m³] might be an over-estimate.

[1] Development of a mechanistic model for the Advanced REACH Tool (ART) - Version 1.5 – TNO report V9009, January 2013

[2] As described in Table 3.9.4. "Indoor Far-Field Multipliers for dusts, mists (low-volatile liquids), powders in liquids, paste/slurry, solid objects and fibres (long-term; 8-hour tasks)", page 160 of the TNO report V9009.

Centrochem BV

Worker Contributing Scenario: Anodizing Operations in an Open Tank with Manual Loading to Bath with Electric Current (PROC 13)

Introduction (WCS)

This worker contributing scenario covers the industrial, anodizing of articles in one or more open tanks. This process is realized by immersion in aqueous solutions containing chromates with application of an electric current.

Equipment Design and Access

The treatment system involves one or more open tanks and is designed to support parts or articles with varying dimensions. Workers have access to the treatment tank(s). Articles or parts are mounted on supports and transported through the treatment system manually.
During the oxidation process, the operator may have access to the tank.
The electrolyte remains in the tank throughout operations and the electric current to the tank is switched on when parts are lowered into the treatment tanks, and switched off when the parts are lifted from the tanks.
An open treatment system has the following features:

- Continuous fixed LEV removes chromates mist or aerosols, which are generated during the anodizing operation, from above the tank(s).
- After immersion, rinsing takes place in separate rinsing tanks. The rinse water is treated in a waste water treatment plant or recycled.

Chromates Emissions

Chromates mist or aerosols can be released from the tanks. Residual chromates on equipment surfaces is possible.

Risk Management Measures – Workers

- Electrically interlocked control systems ensure the electric current to the treatment process can only be switched on when the extraction unit (LEV) is operating. If the exhaust system malfunctions/fails, the electric current to the process automatically switches off immediately.
- Electric current to the treatment tank is switched off when parts are lowered into or lifted from the tank.
- Use of a mist suppressant/foam layer is recommended to minimize chromates aerosols.
- The oxidation solutions are working above room temperature (between 35°C and 60°C), which prevent avoidable misting or aerosol formation. A temperature control system should be used on the bath to maintain temperature in this range.
- The LEV system must be tested regularly and comprehensively to ensure it is operating efficiently.
- Process equipment must be regularly inspected and rinsed to remove residual chromates.
- Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination from equipment and PPE to adjacent areas.

PPE

All persons accessing the treatment line must wear:

- Respiratory equipment, the efficiency level of which to be determined based on risk assessment and monitoring results.
- Protective eye goggles or face shield.
- Protective gloves.
- Safety clothing / footwear.

See CCST Good Practice Sheet E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to the treatment line must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Centrochema BV

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Expert input is advisable. Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

Exposure Assessment

Conditions of Use

Table 2: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Containment: No	Measured data
• Local exhaust ventilation: Yes, if Cr(VI) or other dangerous substances are used in the pre-treatment	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquid): Above room temperature	Measured data

Exposure and Risks for Workers

See end of the Maintenance WCS.

Confidential

Worker Contributing Scenario: Maintenance of Equipment (PROC 8a)

For the regular maintenance of the baths and related equipment (e.g. LEV, rectifier, pumps, panels etc.), it is conservatively assumed that it will happen 60 minutes every day. Regular maintenance is conducted when the bath solutions are at ambient temperature and no aerosol formation can be expected. Therefore, the results of the air measurements provided below, which have been conducted during the surface treatment process, represent a worst-case estimate for the regular maintenance activities. If maintenance is needed during the process, often RPE is used. This scenario also covers infrequent maintenance activities with longer duration.

Introduction (WCS) (Regular Maintenance)

Regular maintenance activities are conducted when the bath solutions are at ambient temperature and no aerosol formation can be expected.
Plant and equipment must be checked periodically according to a maintenance plan to ensure it is operating optimally.
This worker contributing scenario describes minor maintenance and cleaning activities that can be carried out when the plant is nonoperational, but chromates solution or electrolyte remains in the bath, vessel or equipment.
These activities should be subject to a permit-to-work system in most cases. Management of risks relating to exposure to chemicals including chromates should be accounted for as part of the permit-to-work system.

Equipment Design and Access (Regular Maintenance)

Full access to all components of the plant/equipment is required for maintenance, repair and installation. A specific risk assessment and permit to work system must be in place for all scheduled maintenance activities.

Chromates Emissions (Regular Maintenance)

Chromate residues on equipment surfaces such as plating tanks, lids, extraction lips and racksmight be possible. Released residual material in pumps or pipes could splash. While the process is nonoperational, low levels of airborne aerosols or dusts relating to residual chromate cannot be discounted.

Risk Management Measures – Workers[3] (Regular Maintenance)

- A permit-to-work system that takes into account specific chemical exposure must be in place for all maintenance, repair and installation works. Approval for such works must be gained according to the permit-to-work system.
- Prior to commencing work, surfaces should be thoroughly cleaned by rinsing with low pressure water. Pipework, pumps and other closed equipment with potential residual chromate solution must be gently flushed with water. Reducing agents should be used.
- Replaced parts and components may or may not be cleaned to remove residual chromates prior to disposal in accordance with relevant legislation.
- Effective access control must be in place.

PPE (Regular Maintenance)

To minimize potential exposure to chromates, all persons conducting maintenance work wear:

- Protective eye goggles.
- Protective work gloves.
- Safety clothing / anti-static protective boots
- Air-fed masks/full-face masks with P3 filter for higher risk operations with an increased potential for exposure (e.g. exchange of HEPA filters on air extraction equipment)
- Half-face respirator with P3 filter at all other times

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision (Regular Maintenance)

All maintenance persons with access to the equipment must be instructed in the risks from working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

[3] RMM and OC outlined below relate to management of chromate exposure only.

Centrochema BV

Monitoring (Regular Maintenance)

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Introduction (WCS) (Infrequent Maintenance)

Plant and equipment must be checked periodically according to a maintenance plan to ensure it is operating optimally. From time to time, the plant will be completely refurbished.
Unscheduled access to the equipment may also be required to perform maintenance and repair in case of a malfunction.
This worker contributing scenario also describes activities when the plant is non-operational and all chromates solution, electrolyte or product has been removed.
These activities should be subject to a permit-to-work system in most cases. Management of risks relating to exposure to chemicals including chromates should be accounted for as part of the permit-to-work system.

Equipment Design and Access (Infrequent Maintenance)

Full access to all components of the plant/equipment is required for maintenance, repair and installation. A specific risk assessment and permit to work system must be in place for all scheduled and maintenance activities.

Chromates Emissions (Infrequent Maintenance)

Chromate residues on equipment surfaces such as plating tanks, lids, extraction lips andracks might be possible. Released residual material in pumps or pipes could splash. While the process is nonoperational, low levels of airborne aerosols or dusts relating to residual chromates cannot be discounted.

Risk Management Measures – Workers[4] (Infrequent Maintenance)

- Prior to commencing work, surfaces should be thoroughly cleaned by rinsing with low pressure water. Pipework, pumps and other closed equipment must be gently flushed with water to remove residual chromate solution. Reducing agents may be used.
- A permit-to-work system that takes into account specific chemical exposure must be in place for all maintenance, repair and installation works. Approval for such works must be gained according to the permit-to-work system.
- Replaced parts and components may or may not be cleaned to remove residual chromate prior to disposal in accordance with relevant legislation.
- When the intervention requires access to a “confined space” (e.g. tank), take additional precautions as required by current national legislation. Any parts that are removed from the installation to be discarded or refurbished should be decontaminated on-site using a suitable reducing agent.

PPE (Infrequent Maintenance)

To minimize potential exposure to chromates, all persons conducting maintenance work must wear:

- Protective eye goggles.
- Face mask/visor in case of splashing risk.
- Protective work gloves.
- Safety clothing / anti-static protective boots
- P3 filter mandatory for encapsulated open tank process lines.
- P3 filter recommended for other process lines.

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision (Infrequent Maintenance)

All maintenance persons with access to the equipment must be instructed about the risks of working with

[4] RMM and OC outlined below relate to management of chromate exposure only.

Gentrochema BV

chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring (Infrequent Maintenance)

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Exposure Assessment

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 20%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
• Local exhaust ventilation: No	Measured data
• Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
• Place of use: Indoor	Measured data
• Process temperature (for liquids and solids): Room temperature	Measured data

Exposure and Risks for Workers

See below.

Centrochem BV

Combined Assessment of Exposure and Risks for Workers for WCS Anodizing operations in an Open Tank with Manual Loading to Bath with Electric Current and WCS Maintenance

Exposure and Risks for Workers

More than 400 personal sampling and static measurement data from 2000-2013 in six EU countries are available. Because a sufficient number (>80) of data from personal sampling is available, the exposure assessment is based on these data (as suggested in the Technical Guidance document R.14).

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

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

The values reported below include an estimate of the effectiveness of respiratory protection.

In general, however, respiratory protection is not worn during surface treatment activities and the data therefore rather represent external, measured exposure results.

In the few cases in which respiratory protection was used, the effectiveness of respiratory protection was assessed using the company information on type of mask and filter used and the protection factors (APFs) provided by the *German BG rule "BGR/GUV-R190"* from December 2011 or alternatively, if available, the APF provided by the manufacturer of the respiratory protection equipment. Respiratory protection is always worn in situations in which exposure to potassium dichromate (chromate) in solid state could occur. Partially, however, respiratory protection is also used when work is conducted close to the chromate emission source (chromate containing baths). In a minority of cases, depending on the level of reporting provided with the data, the duration for which respiratory protection had been used clearly could be assigned to the measurement results and the measured values then have been adjusted accordingly. In most of the cases, however, this was not possible and the values used for exposure estimation provide an overestimate of inhaled dose (i.e. the measured values were not adjusted to account for use of respiratory protection in these cases).

It is important to mention that the exposure data do not represent exposure to potassium dichromate (chromate) alone but, in most cases, include also exposure to other chromates, and to chromium trioxide as the main emission source. However, because it was not possible to separate the respective contribution of each emission source, the values below provide Cr(VI) exposure estimates from all emission sources as worst case estimate potassium dichromate (chromate) exposure.
The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Gentrochema BV

Table 4: Exposure concentrations and risks for workers – Inhalation, local, long-term

Worker contributing scenario	PROC	Description	N*	Arithmetic Mean	Geometric Mean	90th Percentile	RCR
WCS	PROC 13	Anodizing operations in an open tank with manual loading to bath with electric current	**87**	**0.69 µg/m³**	**0.45 µg/m³**	**1.26 µg/m³**	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 5.04 per 1000 exposed workers
WCS	PROC8a	Maintenance of equipment					

* N = number of measurements

Conclusion on Risk Characterisation

The 90th percentile value of the personal sampling data partially adjusted for respiratory protection of 1.26 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case).
An excess lifetime risk of 5.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Gentrochema BV

S3 - Surface Treatment with Cr(VI) by Brushing with Electrical Current (Use 2)

Introduction

This Exposure Scenario covers the industrial surface treatment of articles by brushing small areas (e.g. scratches and minor damages) with a chromate-based electrolyte. The brush is connected to a power pack. When contact to the part is made, the electric current is completed, and the coating is deposited at the surface of the part. The process, also named selective electrolysis brush, is typically portable and manually operated to allow repair of stationary parts that are either difficult to move or disassemble.
Small areas may be treated with potassium dichromate (chromate) using a brush.

Equipment Design and Access

Workers use a small brush (as supplied by the formulator) to apply a surface treatment containing chromates to small areas, typically during quality control, maintenance or repair.
A power pack deliver direct and reverse current (0-50V) to the brush.
The selective electrolysis brush plating process can be practiced in a closed glove box or not.
The process is typically carried out at room temperature. The process temperature is always <60°C.

Chromates Emissions

Equipment is designed to minimise exposure and release during use. There is potential for chromate electrolyte to spill during brush operations. Residual chromates on equipment surfaces might be possible.

Risk Management Measures – Workers

- Process equipment must be regularly inspected.
- Implement appropriate measures e.g. provision of local cleaning facilities and hazardous waste management bins to prevent cross-contamination from equipment and PPE to adjacent areas.

PPE

To minimize potential exposure to chromates, all persons carrying out touch up operations must wear:

- Protective eye goggles.
- Protective gloves.
- Safety clothing.

See CCST Good Practice Sheet E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons carrying out these operations must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.
Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide provide further information on monitoring, including reference to relevant standards.

Centrochema BV

Centrochema BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: small (1 - 5%)	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Spreading of liquid products	ART 1.5
• Situation: Spreading of liquids at surfaces or work pieces < 0.1 m² / hour	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: No localized controls (0.0 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

Centrochem B.V.

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.23 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.92 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.23 Cr(VI)µg/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime risk of 0.92 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[2].

Centrochema BV

[1] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Decanting and Mixing of Liquids (Use 2)

Introduction

This Exposure Scenario covers activities relating to decanting and mixing of liquids (aqueous/solvent solutions) containing chromates.
The aqueous/solvent solution may be decanted from a drum or other container to (smaller) containers or mixing vessels for re-filling of baths or for (pre)mixing.

Equipment Design and Access

- Use appropriate equipment to ensure a high level of control of flow of chromate from containers.
- Chromates should be dispensed close to the neck of the receiving container to limit potential for splashing.
- All equipment should be provided with appropriate secondary containment.

Chromates Emissions

Splashes containing chromates can be released from open containers when chromates are decanted to containers or mixing vessels prior to re-filling of baths or for further pre-mixing. Residual chromates on equipment surfaces might be possible in some systems.

Risk Management Measures – Workers

- Carefully add other chromate and other raw materials / water to the receiving container to prevent splashing.
- Implement appropriate measures e.g. provision of local cleaning facilities and hazardous waste management bins to prevent cross-contamination from equipment and personal protective equipment (PPE) to adjacent areas.
- Once empty, gently flush residues from the drum to the vessel with low pressure water.
- Regularly inspect and rinse equipment to remove residual chromates.
- Restrict access to the process area to permitted workers only by appropriate measures, such as signage or procedural measures.

PPE

To minimize potential exposure to chromates, all persons conducting decanting or mixing of chromates must wear:

- Protective goggles.
- Protective gloves.
- Safety clothing / footwear.

See CCST Good practice sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons performing decanting/mixing activities must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.
CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Centrochema BV

A. Exposure Assessment - Decanting of liquids (PROC 8b)

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: < 20%	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Falling liquids	ART 1.5
• Situation: Transfer of liquid product with flow of 10–100 l/min	ART 1.5
• Containment level: Open process.	ART 1.5
• Loading type: Splash loading, where the liquid dispenser remains at the top of the reservoir and the liquid splashes freely	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Medium level containment (99.00 % reduction)[1]	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

[1] Medium level containment can, e.g., be described as "Enclosed material transfer with the receiving vessel being docked or sealed to the source vessel" [Advanced REACH Tool (ART) version 1.5].

Gentochema bv

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.42 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 1.68 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.42 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[2].
An excess lifetime risk of 1.68 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[3].

Centrochema BV

[2] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

B. Exposure Assessment – Mixing of liquids (PROC 5)

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: < 20%	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 15 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Activities with Agitated Surfaces	ART 1.5
• Situation: Open surface < 0.1 m²	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Low level containment (90.00 % reduction)[4]	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

[4] Low level containment can, e.g., be described as "Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity" [Advanced REACH Tool (ART) version 1.5].

Genrochem B.V.

Exposure and Risks for Workers

Table 4: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.11 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.44 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.11 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[5].
An excess lifetime risk of 0.44 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[6].

Centrochema BV

[5] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3- ES on Decanting, Weighing and Mixing of Solids (Use 2)

Introduction

This Exposure Scenario covers weighing and decanting/mixing of solids containing chromates. The solid potassium dichromate (chromate) may be decanted and weighed for re-filling of baths or for (pre)mixing and/or dilution.

Equipment Design and Access

- Equipment should be configured to limit the potential for dust generation. For example, containers and equipment should be covered where possible.
- Gentle mixing should only be possible when covers are fully in place.
- Equipment should be provided with appropriate secondary containment.

Chromates Emissions

Chromates in solid form can generate dust. Exposure to chromate dust is possible when drums are opened, during weighing and during transfer to the mixing vessel or plating tank. Splashing or dust can occur when adding liquids to chromates or vice versa. Residual chromates on equipment surfaces might be possible in some systems.

Risk Management Measures – Workers

- When formulating aqueous solutions, flush residues from the drum to the vessel with low pressure water. Carefully add other raw materials / water to prevent splashing.
- LEV must be in place.
- LEV must be regularly inspected and maintained to ensure full working order.
- Implement appropriate measures to prevent cross-contamination from equipment and personal protective equipment (PPE) to adjacent areas.
- Regularly inspect and rinse or wipe equipment (as appropriate) to remove residual chromates.
- Restrict access to the process area to permitted workers only by appropriate measures, such as signage or procedural measures.

PPE

To minimize potential exposure to chromates, all persons conducting decanting or mixing of chromates must wear:

- Protective goggles.
- Protective gloves.
- Safety clothing / footwear.
- Disposable coveralls
- Full-face mask with P3 filter when handling open drums.

See CCST Good practice sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE..

Training and Supervision

All persons performing weighing/decanting/mixing activities must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

Gentrochema BV

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Gentrochema BV

A. Exposure Assessment – Decanting and Weighing of Solids (PROC 8b)

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Powders, granules or pelletised material	ART 1.5
• Powder weight fraction (Cr(VI): < 40%	ART 1.5
• Dustiness: Low (inhalable fraction: ≤ 100 mg/kg)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 15 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Movement and agitation of powders, granules or pelletised material	ART 1.5
• Situation: Movement and agitation of 10 - 100 kg	ART 1.5
• Level of agitation: Low	ART 1.5
• Containment level: Handling that reduces contact between product and adjacent air.	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
Primary: No localized controls (0.0 % reduction) *In most cases, this activity is conducted under LEV. However, this has not been considered in this exposure assessment.*	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Genuchem BV

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.5 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 2.0 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5) of 0.5 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime risk of 2.0 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[2].

Centrochema BV

[1] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

B. EXPOSURE ASSESSMENT – Mixing of Solids (PROC 5)

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Powders, granules or pelletised material	ART 1.5
• Dustiness: Low (inhalable fraction: ≤ 100 mg/kg)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
• Powder weight fraction (Cr(VI): < 40%	ART 1.5
Activity emission potential	
• Duration of activity: < 15 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Movement and agitation of powders, granules or pelletised material	ART 1.5
• Situation: Movement and agitation of 10 - 100 kg	ART 1.5
• Level of agitation: Low	ART 1.5
• Containment level: Handling that reduces contact between product and adjacent air.	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Low level containment (90.00 % reduction)[3]	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

[3] Low level containment can, e.g., be described as "Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity" [Advanced REACH Tool (ART) version 1.5].

Chemochema B.V.

Exposure and Risks for Workers

Table 4: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.17 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.68 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5) of 0.17 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[4].
An excess lifetime risk of 0.68 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[5].

Centrochema BV

[4] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Machining Activities (Use 2)

Introduction

Machining operations, such as abrading, grinding or drilling of parts may be carried out on articles/ parts that have been surface treated with mixtures containing chromates.
Drilling is generally either fully automated (e.g. robotic) or semi-automated with on-tool extraction and lubricants. Some manual drilling may still be conducted occasionally. Manual drilling is conducted wet or with extraction or both.
Abrading (as surface preparation before painting) is generally carried out in grinding booths which are fully contained booths with laminar down-flow, or on a portable semi-open booth. Abrading tools are equipped with on-tool extraction and a decontamination area is present at the exit of the cabin.
For some repairs, when abrading is done directly on the aircraft with no possibility to move it to a dedicated booth, wet method or on-tool extraction are used.
Light abrading of small localised areas is typically carried out manually by means of glass fibre brush and/or dry abrasive paper for the purpose of bonding or for localised re-coating (repair and touch up).
These machining activities may be carried out in fully contained cabins with laminar down-flow. For small parts activities are typically carried out in a contained dry-stripping cabin, with LEV or a vacuum hose applied adjacent to the abrading activity. Manual light sanding equipped with on-tool extraction is used directly on the aircraft (not in a dedicated booth).

This Exposure Scenario covers the following specific machining operations:

1. Drilling or cutting on small to medium sized parts containing Cr(VI) on an extracted bench/extraction booth including cleaning (PROC 21, 24)
2. Abrasion, fettling or sanding on small to medium sized surfaces containing Cr(VI) on an extracted bench/extraction booth including cleaning (PROC 21, 24)
3. Drilling, riveting or cutting in large work areas on parts containing Cr(VI) including cleaning (PROC 21, 24)
4. Abrasion, fettling or sanding in large work areas on surfaces containing Cr(VI) including cleaning (PROC 21, 24)
5. Drilling, riveting or cutting on parts containing Cr(VI) in small work areas including cleaning (PROC 21, 24)
6. Abrasion, fettling, edging or sanding of surfaces containing Cr(VI) in small work areas including cleaning (PROC 21, 24)

Equipment Design and Access

Parts with varying dimensions are typically operated on. The process is normally carried out at room temperature.
Metal fitting is generally (but not only) done at the work station using:

- Extracted workbench
- On-tool extraction or wet abrading when the component to be fitted cannot be moved
- In confined work area (e.g. wing tank) forced ventilation may be used as this also benefits thermal comfort

Chromates Emissions

Materials containing chromates may be released as dust during machining operations. Residual chromates on equipment surfaces and articles/parts might be possible after machining.

Risk Management Measures – Workers

Extraction units must be equipped with HEPA filters.
Cleaning to remove dusts generated during the machining process is conducted under the same operational conditions and risk management measures as the machining activities.

PPE

To minimize potential exposure to chromates, all persons performing machining activities wear:

- Half-face or full face mask with P3 filter for operations with a longer duration of activity
- Full-face mask with P3 filter with or without air supply in small work areas without any localised control

Genrochema BV

CCST Good Practice Sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE..

Training and Supervision

All persons with access to the machining process must be instructed about the risks of generating chromate dusts, the safe way of managing dusts and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Annual programs of inhalation exposure monitoring for chromium (VI) through personal sampling must be implemented in combination with post-shift biomonitoring for chromium.
Expert input is advisable.

Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.
CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Gentrochema BV

Worker Contributing Scenario: Drilling or Cutting on Small to Medium Sized Parts Containing Cr(VI) on an Extracted Bench/Extraction Booth Including Cleaning (PROC 21, 24)

Introduction (WCS)

During assembly, maintenance and/or repair, small to medium sized solid parts are drilled or cut on a dedicated work bench fitted with air extraction. Cleaning due to contamination during the machining process is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.

This scenario covers also machining operations with a longer duration of activity but with a higher level of respiratory protection, e.g. by using a half-face mask with P3 filter (APF 30) or a full face mask with P3 filter (APF 400).

The Cr(VI) weight fraction of the part is assumed to be < 0.1 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way[1] (i.e. 0.5 % concentration in the product would lead to an increase of the exposure estimate by a factor of 5). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 0.1 %	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 180 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Equipment level: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Fixed capturing hood /Vacuum cleaner (HEPA filter with at least 99.00 % reduction)	ART 1.5 (extended)
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

[1] The exposure model ART applies a linear relationship

Centrochem BV

	Method
• Respiratory Protection: Yes [Respirator with APF 10] [Effectiveness Inhal: 90%] • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *At least half or quarter mask with P2 filter (APF 10 according to German BG rule 190) is worn if workplace monitoring data do not confirm negligible exposure clearly below 1 µg/m³ (e.g. < 0.1 µg/m³)* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.11 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.44 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.11 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[2].
An excess lifetime risk of 0.44 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[3].

Centrochema BV

[2] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

Worker Contributing Scenario: Abrasion, Fettling or Sanding on Small to Medium Sized Surfaces Containing Cr(VI) on an Extracted Bench/Extraction Booth Including Cleaning (PROC 21, 24)

Introduction (WCS)

During assembly, maintenance and/or repair, small to medium sized surfaces are fettled, abraded, or sanded on a dedicated work bench fitted with air extraction. Cleaning due to contamination during the machining process is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.

This scenario covers also machining operations with a longer duration of activity but with a higher level of respiratory protection e.g. by using a full face mask with P3 filter (APF 400).

The Cr(VI) content of the surface is assumed to be < 3 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way (i.e. a 10% concentration on the surface would lead to an increase of the exposure estimate by a factor of more than 3). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 3 %	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 180 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Equipment level: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Fixed capturing hood /Vacuum cleaner (HEPA filter with at least 99.00 % reduction)	ART 1.5 (extended)
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

Controlled BV

	Method
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67 %] *At least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn if workplace monitoring data do not confirm negligible exposure clearly below 1 µg/m³ (e.g. < 0.1 µg/m³)* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 4: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**1.13 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 4.52 per 1000 exposed workers

Measured Data for the WCS:
Personal sampling data are available. The activities represent slightly different situations, due to the size of the parts machined and the type of tools used, as described below. Some variation can be expected from facility to facility, and the situations described below are considered typical of such activities.

1. Situation: Mechanical treatment of very small parts. The small sample size (n = 3) a does not allow for using the measured data as the basis for exposure estimation. However, the measured value is presented as supportive evidence for the appropriateness of model estimates:
   Measured exposure (personal sampling, arithmetic mean): **0.05 µg Cr(VI)/m³**, (90th percentile 0.05 µg/m³), all measurement results below the detection limit (0.1 µg Cr(VI)/m³). This value does not account for respiratory protection.
   The measured values indicate that the estimated exposure from the ART model (based on the solid material *stone* as metal is currently not an available option in ART*),* which resulted in an exposure estimate of 1.13 µg Cr(VI)/m³ and which accounted for respiratory protection overestimated exposure for this situation by a factor of around 500.
2. Situation: Mechanical treatment of small to medium sized parts. The small sample size (n = 3) does not allow for using the measured data as the basis for exposure estimation. However, the measured value is presented as supportive evidence for the appropriateness of model estimates:
   Measured exposure (personal sampling, taking respiratory protection but with a lower APF into account, arithmetic mean): **0.27 µg Cr(VI)/m³** (90th percentile 0.28 µg/m³).
   The measured values indicate that the estimated exposure from the ART model (based on the solid material *stone* as metal is currently not an available option in ART), which resulted in an exposure estimate of 1.13 µg Cr(VI)/m³ likely produced a considerable overestimation of exposure.

Cefrochema BV

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 1.13 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[4].

An excess lifetime risk of 4.52 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Centrochema BV

[4] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90$_{th}$ percentile value as representative for the exposure situation.

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

Worker Contributing Scenario: Drilling, Riveting or Cutting Operations in Large Work Areas on Parts Containing Cr(VI) Including Cleaning (PROC 21, 24)

Introduction (WCS)

Solid parts are manually drilled, riveted, or cut outside a booth in large work areas. Cleaning after machining is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.

This scenario covers also machining operations with a longer duration of activity but with a higher level of respiratory protection, e.g. by using a half-face mask with P3 filter (APF 30) or a full face mask with P3 filter (APF 400).

The Cr(VI) weight fraction of the part is assumed to be < 0.1 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way (i.e. 0.5 % concentration in the product would lead to an increase of the exposure estimate by a factor of 5). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 5: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 0.1 %	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (< 5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Large workrooms only	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Wetting at the point of release/on-tool extraction/vacuum cleaning (90.00 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

Chemroom BV

	Method
• Respiratory Protection: Yes [Respirator with APF 10] [Effectiveness Inhal: 90%] *At least half or quarter mask with P2 filter (APF 10 according to German BG rule 190) is worn if workplace monitoring data do not confirm negligible exposure clearly below 1 µg/m³ (e.g. < 0.1 µg/m³)* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 6: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.20 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.8 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.20 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[5].
An excess lifetime risk of 0.8 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[6].

Centrochema BV

[5] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

Worker Contributing Scenario: Abrasion, Fettling or Sanding Operations in Large Work Areas on Surfaces Containing Cr(VI) Including Cleaning (PROC 21, 24)

Introduction (WCS)

Surfaces are manually fettled, abraded or sanded outside a booth in large work areas. Cleaning after machining is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.
This scenario covers also of machining operations which a longer duration of activity but with a higher level of respiratory protection.
The Cr(VI) content of the surface is assumed to be < 3 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way (i.e. a 10% concentration on the surface would lead to an increase of the exposure estimate by a factor of more than 3). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 7: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 3 %)	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (< 5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Large workrooms only	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Wetting at the point of release/on-tool extraction/vacuum cleaning (90.00 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

Eurofoma BV

	Method
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *At least half-face mask with P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 8: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**2.03 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 8.12 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 2.03 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[7].
An excess lifetime risk of 8.12 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Measured Data for the Drilling, riveting or cutting operations in large work areas on parts containing Cr(VI) including cleaning WCS and the Abrasion, fettling or sanding operations in large work areas on surfaces containing Cr(VI) including cleaning WCS:
Personal sampling data are available representing a mixture of activities described in both WCSs. The small sample size (n = 7) does not allow for using the measured data as the basis for exposure estimation. However, the measured value is presented as supportive evidence for the appropriateness of model estimates:
Measured exposure (personal sampling, taking respiratory protection into account, arithmetic mean): **0.39 µg Cr(VI)/m³**, (90th percentile 0.5 µg/m³).
The measured values indicate that the ART model (based on the solid material *stone* as metal currently is not an available option in ART), which resulted in an exposure estimate of 0.20 and 2.03 µg Cr(VI)/m³ respectively,

[7] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

Gentrochema BV

likely produced an overestimation of exposure for machining activities on the surface of parts.

Worker Contributing Scenario: Drilling, Riveting or Cutting Operations on Parts Containing Cr(VI) in Small Work Areas Including Cleaning (PROC 21, 24)

Introduction (WCS)

Parts are drilled, riveted or cut in comparable small work areas (e.g. inside wing tanks). Cleaning after machining is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.
In small work areas, no air extraction or other localised controls (e.g. wetting, vacuum cleaning) may be available. This scenario assumes the absence of any localised control.
The Cr(VI) weight fraction of the part is assumed to be < 0.1 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way (i.e. 0.5 % concentration in the product would lead to an increase of the exposure estimate by a factor of 5). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 9: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 0.1 %	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (< 5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Small workrooms only	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: No localized controls (0.0 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

Certochem BV

	Method
• Respiratory Protection: Yes [Respirator with APF 400] [Effectiveness Inhal: 99.75%] *Full face mask with P3 filter (APF 400 according to German BG rule 190) is worn if workplace monitoring data do not confirm negligible exposure clearly below 1 µg/m³ (e.g. < 0.1 µg/m³)* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 10: Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.16 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.64 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.16 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[8].
An excess lifetime risk of 0.64 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[9].

Centrochema BV

[8] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

Worker Contributing Scenario: Abrasion, Fettling, Edging or Sanding of Surfaces Containing Cr(VI) in Small Work Areas Including Cleaning (PROC 21, 24)

Introduction (WCS)

Small surfaces are fettled, edged, abraded or sanded in comparable small work areas (e.g. inside wing tanks). Cleaning after machining is included in this scenario because it is conducted under the same operational conditions and risk management measures as the machining activities.
In small work areas, no air extraction or other localised controls (e.g. wetting, vacuum cleaning) may be available. This scenario assumes the absence of any localised control.
The Cr(VI) content of the surface is assumed to be < 3 %. In case of lower or higher Cr(VI) content, estimated exposure would be reduced or increased in a linear way (i.e. a 10 % concentration on the surface would lead to an increase of the exposure estimate by a factor of more than 3). If needed, OCs and RMMs could be adjusted for that different situation.

Exposure Assessment

Conditions of Use

Table 11: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Solid object	ART 1.5
• Solid weight fraction: < 3%	ART 1.5
• Solid material: Stone (as worst-case for metal)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
Activity emission potential	
• Duration of activity: < 60 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Fracturing and abrasion of solid objects	ART 1.5
• Situation: Mechanical treatment / abrasion of small sized surfaces	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Small workrooms only	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: No localized controls (0.0 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	

Eurofoma BV

	Method
• Respiratory Protection: Yes [Respirator with APF 1000] [Effectiveness Inhal: 99.9%] *Full-face mask with P3 filter and air supply (APF 1000 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Exposure and Risks for Workers

Table 12: Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**1.9 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 7.6 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 1.9 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[10].
An excess lifetime risk of 7.6 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Measured Data for the Drilling, riveting or cutting operations on parts containing Cr(VI) in small work areas including cleaning WCS and the Abrasion, fettling, edging or sanding of surfaces containing Cr(VI) in small work areas including cleaning WCS:
Personal sampling data representing a mixture of activities described in the both WCSs are available. The small sample size (n = 11) does not allow for using the measured data as the basis for exposure estimation. However, the measured value is presented as supportive evidence for the appropriateness of model estimates:
Measured exposure (personal sampling, taking respiratory protection into account, arithmetic mean): **0.28 µg Cr(VI)/m³**, (90th percentile 0.18 µg/m³).
The measured values indicate that the ART model (based on the solid material *stone* as metal currently is not an available option in ART), which resulted in an exposure estimate of 0.475 and 1.9 µg Cr(VI)/m³ respectively,

[10] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

Centrochema BV

likely produced an overestimation of exposure in both WCS.

Centrochema BV

S3 - ES on Delivery and Storage of Raw Material (Uses 1 & 2)

Introduction

This Exposure Scenario covers activities relating to handling during storage, delivery, dispatch and transportation of chromates during formulation, surface treatment or plating.
Chromates are supplied as such (i.e. as a substance) or in formulations.
Solid chromates are supplied in drums or bags as crystals or flakes. When solid chromate is delivered in bags (rather than in drums), open bags must be "overpacked" in a well labelled, appropriately sized UN approved container to avoid loss or product degradation.
Liquid chromate solution is delivered in tanks or IBC containers.
The chromate is delivered to the site. It is stored in a designated storage area. It may be removed from the storage area for transfer to the production plant or dispatch to the downstream user.

Equipment Design and Access

Chromates are very hazardous to human health and the environment. Chromates are strong oxidizers and may cause fire or explosion depending on the concrete product characteristic. They should be handled and stored according to the relevant regulatory requirements and the information provided on the Safety Data Sheet (SDS). Adequate facilities and equipment should be provided to ensure the worker is not exposed to chromates and to avoid spillages or releases to the environment during transfer to and from storage and at the point of storage.

- A dedicated, dry, covered, cool and secure storage area must be provided. Access to the storage area should be restricted to suitably qualified personnel.
- Keep in the original container. Open bags need to be "overpacked". Containers should be clearly and adequately labelled according to CLP Regulations.
- Keep containers tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers.
- Empty containers retain product residue and can be hazardous.

Chromate Emissions

Chromates are completely contained when stored and transferred correctly. Chromate release may occur on damaged containers. Residue could occur on previously opened containers/bags.

PPE

PPE for normal storage operations, including safeguarding against accidental releases, should be available. This typically includes:

- Protective eye goggles.
- Protective gloves.
- Safety shoes.
- Safety clothing.

See CCST Good Practice Sheet E1 (see Link) and other sections of this SDS provide relevant information on PPE.

Risk Management Measures – Workers

- In case of accidently damaged drums, bags or containers, the spills or releases must be cleaned. See CCST GPS D6 (see Link) and SDS for details on accidental release measures
- Restrict access to the storage area to permitted workers only by appropriate measures.

Training and Supervision

All persons with access to the storage areas must be instructed about the risks of working with chromates, the safe way of handling chromate containers and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Not relevant as no exposure expected.

Gentrochema BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

Not relevant as no exposure expected.	**Method**
Product (article) characteristics	
• Substance as such / in mixture • Concentration of Cr(VI): < 40%	Qualitative
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Qualitative
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Qualitative
• Containment: Closed system (minimal contact during routine operations)	Qualitative
• Local exhaust ventilation: No	Qualitative
• Occupational Health and Safety Management System: Advanced	Qualitative
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No	Qualitative
Other conditions affecting workers exposure	
• Place of use: Indoor	Qualitative
• Process temperature (for liquids and solids): Room temperature	Qualitative

Exposure and Risks for Workers

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

Table 2: Exposure concentration and risks for worker

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

Conclusion on Risk Characterisation

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

An excess lifetime risk of 0 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[1].

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

Centrochem B.V.

S3 - ES on Sampling (Use 2)

Introduction

This Exposure Scenario covers activities relating to quality control of chromate solutions used for surface treatment. This scenario covers regular sampling of chromate solutions in treatment tanks to allow adjustments, as necessary, to control the quality of the surface treatment. It also covers sampling of chromate solutions during formulation activities to check conformity against the specification.

Equipment Design and Access

Typically, samples are manually obtained by a trained person directly from the treatment tank (or a connected reservoir or storage tank) or, in the case of formulation, from the mixing tank. Access to the treatment or mixing tank is necessary to obtain the sample.

- Some different possible tank configurations are described in CCST Good Practice Sheets (GPS) series A and C (see Link).
- Typically, the trained operator will obtain a sample from the tank using an appropriate scoop or beaker, or similar specialist tool.
- During sampling the production line is typically operational (i.e. in production mode). Consequently, the solution can be hot and/or highly concentrated.
- The samples are transferred to suitable containers, securely closed and transferred in a bucket, trolley or box to the laboratory for analysis.

Chromate Emissions

Chromate mist or aerosols can be released from the tanks when the lids are opened. Leakage may occur. Residual chromate on equipment surfaces (plating cells) might be possible in some systems.

Risk Management Measures

- For surface treatment processes, adequately designed and functioning LEV must be provided. LEV must be regularly inspected and maintained to ensure full working order. The LEV must be switched on during sampling involving manual access to the tank.
- For electroplating processes, the electric current must be switched off during sampling involving manual access to the tank.
- Appropriate sampling equipment must be used. The samples must be transferred directly to appropriate containers and transported to the laboratory with adequate secondary containment.
- All persons with access to the production line must be instructed in dealing with chromates and be equipped with PPE.
- Sampling equipment must be regularly inspected and rinsed to remove residual chromates, which appears as colored traces on the equipment.

PPE

To minimize potential exposure to chromates, all persons accessing metal surface treatment line for sampling must wear:

- Chemical resistant eye protection.
- Protective gloves.
- Safety clothing / footwear.

See CCST GPS E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to operations for sampling must be instructed in the risks from working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Centrochema BV

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2–E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Exposure Assessment

Conditions of Use

One or more samples are drawn at the bath(s) and then transferred in a closed flask to the laboratory.

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: < 20%	ART 1.5
• Process temperature: Above room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 30 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Activities with relatively undisturbed surfaces (no aerosol formation)	ART 1.5
• Situation: Open surface 1 - 3 m²	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

Certochem BV

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.65 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 2.6 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.65 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime risk of 2.6 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[2].

Centrochema BV

[1] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Re-Filling of Baths - Liquid and Solid Chromates (Use 2)

Introduction

This Exposure Scenario covers the (re)adjustment of tanks containing chromates solution or electrolyte by addition of chromates.
Chromates in solid (dry) or liquid (aqueous) form are used as such (i.e. as a substance) or in formulations to maintain treatment baths.
Solid chromates are supplied in drums or bags as crystals or flakes. The solid chromates are dissolved either directly into the mixture in the treatment tank or prepared into an aqueous solution (e.g. in a freestanding vessel) and then added to the tank.
Alternatively, a pre-prepared aqueous chromate solution delivered in, e.g., tanks or IBC containers is added to the tank via pipework (continuously or as needed) or manual dosing.
Preparatory steps for the re-adjustment of the chromate solution including decanting, weighing and (pre-) mixing of either solid or aqueous solutions of chromates in a manual process are conducted only when the amounts of chromates in use are relatively small.

Equipment Design and Access

Pre-Mixing of Solid Chromate Solution:

- The mixing vessel has local exhaust ventilation system (LEV) and a manual or automated stirrer.
- The water supply to the mixing vessel is designed to prevent splashing of chromates.
- The speed of the mixer is sufficiently low to prevent splashing.
- A small amount of water or electrolyte is first added to the vessel. The dry chromates are then carefully added to the mixing vessel close to the LEV system.
- The empty container is flushed with low pressure water to remove residual chromates, and the rinsate is returned to the mixture. Other materials are then added, avoiding splashing.

Addition of Solid Chromates to Treatment Tank:

- LEV must be provided at the dosing point.
- The process should be automated as far as possible to minimize worker exposure.
- When chromates are dosed direct to the plating tank, the plating tank must be in maintenance mode.

Addition of Liquid (Aqueous) Chromates to Treatment Tank:

- When chromates are delivered in IBCs, prior to use the IBC should be fitted with a (suction) lance that is secured against unauthorized removal and a splash guard. Please note that this is especially valid for high-concentrated chromate solutions. IBCs containing lower-concentrated chromate solutions might have bottom outlets.

Chromates Emissions

Chromates in solid (dry) form can generate dust. Exposure to chromate dust is possible when drums or bags are opened and during transfer from the packaging to the mixing vessel or plating tank.
Splashing can occur when adding chromates to the solution.

Risk Management Measures – Workers

- LEV must be provided when exposure to dust and/or aerosols is possible. LEV must be regularly inspected and maintained to ensure full working order.
- Equipment must be regularly inspected and rinsed to remove residual chromates, which appears as colored traces on the equipment.
- Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination between equipment and PPE.
- Restrict access to the process area to permitted workers only.

PPE

To minimize potential exposure to chromates, all persons conducting adjustment work at the plating or treatment line must wear:

Gentrochema BV

- Chemical resistant eye protection.
- Face mask in case of splashing risk.
- In case of handling solid (dry) chromates: Air-fed respirator /full-face filter mask with P3 filter
- Protective gloves.
- Safety clothing / footwear.

See CCST Good practice sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons with access to the plating or treatment line must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other control equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level. Expert input is advisable.
Monitoring should be carried out at least annually. Downstream users may reduce the frequency of measurements once it is demonstrated that exposure of humans and releases to the environment has been reduced to as low a level as technically and practically possible and that the risk management measures and operational conditions correspond to the exposure scenarios and function appropriately.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Gentrochema BV

A. Exposure Assessment - Re-filling of Baths – Liquids (PROC 8b)

Introduction

This scenario covers as worst-case similar activities in which the adjustment is done automatically; or in which a complete emptying and re-filling of a bath is conducted - only rarely needed and not a manual process.

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: < 20%	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: <10 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Falling liquids	ART 1.5
• Situation: Transfer of liquid product with flow of 10 –100 l/min	ART 1.5
• Containment level: Open process	ART 1.5
• Loading type: Splash loading, where the liquid dispenser remains at the top of the reservoir and the liquid splashes freely	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

Controlled BV

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.76 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 3.04 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.76 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime risk of 3.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[2].

Centrochema BV

[1] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

B. Exposure Assessment – Re-filling of Baths – Solids (PROC 8b)

Conditions of Use

Table 3: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Powders, granules or pelletised material	ART 1.5
• Dustiness: Low (inhalable fraction: ≤ 100 mg/kg)	ART 1.5
• Moisture content: Dry product (<5 % moisture content)	ART 1.5
• Powder weight fraction [(Cr(VI)]: < 40%	ART 1.5
Activity emission potential	
• Duration of activity: < 10 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Falling powders	ART 1.5
• Situation: Transferring 10 – 100 kg/minute	ART 1.5
• 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 e.g. careful weighing in laboratory	ART 1.5
• Drop height: Drop height < 0.5 m	ART 1.5
• Containment level: Open process	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* ▪ Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

Genthochema BV

Exposure and Risks for Workers

Table 4: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.066 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.26 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.066 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[3].
An excess lifetime risk of 0.26 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[4].

Centrochema BV

[3] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Wastewater Treatment (Use 2)

Introduction

This Exposure Scenario covers activities relating to wastewater treatment.
Different options for management of wastewater containing chromates are available. These include on-site wastewater treatment and/or disposal as a hazardous waste by a licensed contractor according to applicable regulations.
On-site wastewater treatment involves treating the wastewater within a dedicated plant to remove chromates prior to discharge to sewer or surface water. In the most common system, the wastewater is dosed with a chemical known as a reducing agent. The resulting salt is separated from the wastewater (under alkaline conditions), dewatered (e.g. in a filter press) and disposed as a solid waste. The tanks are closed. The wastewater treatment process is entirely automated (controlled on redox and pH). It must be possible to safely sample treated wastewater for analysis.
Other wastewater treatment systems (e.g. activated carbon, ion exchange and adsorption followed by filtration) are less common.

Equipment Design and Access

As a minimum wastewater treatment systems should be:

- Restricted in access to prevent worker exposure to chromates.
- Contained to prevent release of chromates to the environment.
- Automated controlled to ensure reliable and effective treatment of chromates in wastewater.
- Monitored to ensure the chromates concentration in wastewater is minimised prior to discharge. Wastewater from the process (e.g. filter press) or treated wastewater containing chromates above the permitted limit is returned to the start of the wastewater treatment process.

Chromates Emissions

When operating normally, wastewater treatment should minimise emissions to the environment.

Risk Management Measures – Workers

- Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination between equipment and PPE to adjacent areas.
- Restrict access to permitted workers only.

PPE

Exposure to chromates are unlikely during process supervision. To minimize potential exposure to chromates, all persons working on parts of the system where chromates may be must wear:

- Protective eye goggles.
- Protective gloves.
- Safety clothing / footwear.

CCST Good Practice Sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE..

Training and Supervision

All persons with access to the wastewater treatment plant must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be provided at all times.

Monitoring

Adequate monitoring data must be available to evidence that potential exposure of workers and potential environmental release are maintained to as low as reasonably practicable level.

CCST GPS E2-E3 (see Link) provide further information on monitoring, including reference to relevant standards.

Centrochem BV

Exposure Assessment

Conditions of Use

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Liquid	ART 1.5
• Concentration of Cr(VI) in mixture: minute	ART 1.5
• Process temperature: Room temperature	ART 1.5
• Vapour pressure of substance: < 0.01 Pa	ART 1.5
• Viscosity: Low	ART 1.5
Activity emission potential	
• Duration of activity: < 10 min	ART 1.5
• Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
• Activity class: Falling liquids	ART 1.5
• Situation: Transfer of liquid product with flow of 0.1 - 1 l/min	ART 1.5
• Loading type: Splash loading, where the liquid dispenser remains at the top of the reservoir and the liquid splashes freely	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: No localized controls (0.0 % reduction)	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

Getrouw Chemie BV

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		
ART model output	0.0023 µg/m³ (90th percentile value)	Based on the dose-response relationship for lung cancer mortality derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime lung cancer mortality risk up to age 89 is derived based on the estimated exposure: 0.009 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.0023 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[1].
An excess lifetime lung cancer risk of 0.009 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality[2].

Centrochema BV

1 These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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

S3 - ES on Solid Waste Management (Use 2)

Introduction

This Exposure Scenario covers activities relating to handling of waste contaminated with chromates.
Waste containing residual chromates may result from normal operations, cleaning activities, decontamination activities and measures to prevent contamination, such as use of PPE. It also includes contaminated process waste (e.g. empty bags, containers, filters, waste from cleaning activities).
Waste contaminated with chromates must be managed and disposed according to relevant waste management regulations. Wastes containing chromate must be stored in closed containers and collected under consignment by licensed waste management companies for treatment, incineration and disposal of incineration residues to contaminated landfill.

Equipment Design and Access

Waste contaminated with chromates (empty bags, containers, filters, waste from cleaning activities) must be transferred to and stored in closed containers. These wastes must be stored in a designated and secure hazardous waste storage area. These containers are collected under consignment by licensed waste management companies for treatment, incineration and disposal of incineration residues to contaminated landfill.
Once empty, bags used to supply chromate are placed in a large bag or other hazardous waste container. A bag-press may be used to compact the bags within the container.
Containers will be cleaned, re-used if possible, or alternatively sealed, marked as hazardous waste and sent for disposal by certified disposal companies.

Chromates Emissions

Residual chromates on solid waste could be released as dust during handling.

Risk Management Measures – Workers

Implement appropriate measures (e.g. provision of local cleaning facilities and hazardous waste management bins) to prevent cross-contamination between equipment and PPE to adjacent areas.

PPE

To minimize potential exposure to chromates, all persons handling solid waste must wear:

- Protective eye goggles.
- Protective gloves.
- Safety clothing / footwear.
- Respiratory Protective Equipment, if assessed necessary based on specific task and workplace measurement results

CCST Good Practice Sheet (GPS) E1 (see Link) and other sections of this Safety Data Sheet (SDS) provide relevant information on PPE.

Training and Supervision

All persons handling solid waste containing hexavalent chromium must be instructed about the risks of working with chromates, the safe way of handling chromates and use of PPE and other equipment. Workers must be properly trained and equipped to carry out their duties, and to safely cease such duties as needed. Adequate supervision must be available at all times.

Monitoring

It is expected that disposal of contaminated waste to take place at the time of the chromate use activity or shortly after (during clean-up). Any monitoring of the chromate use should therefore also capture disposal.

Centrochema BV

Exposure Assessment

Conditions of Use

The scenario below describes the transfer of such type of waste (e.g. empty bags) to the storage area.

Table 1: Conditions of use

	Method
Product (article) characteristics/substance emission potential	
• Substance product type: Powders, granules or pelletised material	ART 1.5
• Dustiness: Fine Dust	ART 1.5
• Moisture content: Dry product (< 5 % moisture content)	ART 1.5
• Powder weight fraction [Cr(VI)]: < 40%	ART 1.5
Activity emission potential	
• Duration of activity: 30 min	ART 1.5
• Activity class: Handling of contaminated solid objects or paste	ART 1.5
• Situation: Handling of objects with visible contamination (object covered with fugitive dust from surrounding dusty activities)	ART 1.5
• Handling type: Careful handling, involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner.	ART 1.5
Surface contamination	
• Process fully enclosed? No	ART 1.5
• Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
• Work area: Indoors	ART 1.5
• Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
• Primary: Low level containment (90.00 % reduction)[1].	ART 1.5
• Secondary: No localized controls (0.0 % reduction)	ART 1.5
• Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *During waste transfer activities with potential to exposure to airborne hexavalent chromium at least half-mask with A2P3 filter (APF 30 according to German BG rule 190) is worn* • Dermal Protection: Yes [Protective clothing, chemical-resistant, impermeable gloves (e.g. nitrile rubber gloves with a minimum layer thickness of 0.11 mm and a break through time of at least 480 min), goggles] *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

[1] Low level containment can, e.g., be described as "Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity" [Advanced REACH Tool (ART) version 1.5].

Gentochem B.V.

Exposure and Risks for Workers

Table 2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.22 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.88 per 1000 exposed workers

Conclusion on Risk Characterisation

The modelled exposure estimate (ART 1.5) of 0.22 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure[2].
An excess lifetime risk of 0.88 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship[3].

Centrochema BV

[2] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation) to reduce exposure
- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

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

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