CHEMICAL SAFETY REPORT

Non-confidential Report

Surface treatment for the manufacture of grain-oriented electrical steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers

Legal name of applicant(s):: *thyssenkrupp* Electrical Steel GmbH
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Submitted by: *thyssenkrupp* Electrical Steel GmbH

Substance Name: Chromium trioxide

EC Number: 215-607-8

CAS Number: 1333-82-0

9. EXPOSURE ASSESSMENT (and related risk characterisation)

9.0. Introduction

This exposure assessment aims to provide reliable estimates of current work place exposure level at the applicant's facilities in Gelsenkirchen, Germany and Isbergues, France for the following uses of chromium trioxide: Surface treatment for the manufacture of Grain Oriented Electrical Steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers.

For details of the processes, see section 9.1.

Occupational work place exposure to hexavalent chromium [Cr(VI)] is regulated in most European countries. National Occupational Exposure Limits (OELs) across Europe respect a range of 8 hour *Time Weighted Average* (TWA) values between 1 µg/m^3 and 50 µg/m^3. In 2014, France introduced a new OEL of 1 µg/m^3. This is one of the most stringent OEL currently in place anywhere in the World and compliance requires substantial research and investment. In Germany, the evaluation standard is 1 µg/m^3. Chromium (VI) compounds have been included in Directive 2004/37/EC - carcinogens or mutagens at work, last amended by Directive (EU) 2017/2398 of the European Parliament and of the Council of 12 December 2017 with a transitional occupational exposure limit of 10 µg/m^3 until January 2025 (after that 5 µg/m^3).

The Carcinogens and Mutagens Directive (2004/37/EC) requires each Member State to ensure employers reduce and replace use of hexavalent chromium substances, and the introduction of a new OEL in France provides one clear example of regulation by Member States to effect a reduction in workplace exposure to Cr(VI). Industry is proactively engaged in delivering continuous reduction through the development and implementation of appropriate RMMs.

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

9.0.1. Overview of uses and Exposure Scenarios

Tonnage information:

The overall assessed tonnage is 100-400 ([redacted]) tonnes chromium trioxide/year [containing approximately [redacted] tonnes Cr(VI)]. In Table 6, an overview is displayed on how the tonnage is spread among the sites of *thyssenkrupp* Electrical Steel (hereinafter named *thyssenkrupp*). Furthermore, details on the amount and kind of surface treatment lines per site is indicated.

Table 6: Overview of all surface treatment lines operated by thyssenkrupp at the sites in Germany and France, CrO3 tonnage

Surface treatment facilities		
	Gelsenkirchen, Germany	Isbergues, France
Tonnes chromium trioxide/ year (2018)	50-200 ([redacted]) tonnes	50-200 ([redacted]) tonnes
Types of surface treatment lines	[redacted] surface treatment lines for the manufacture of grain oriented electrical steel	[redacted] surface treatment lines for the manufacture of grain oriented electrical steel

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

Table 7. Overview of exposure scenarios and contributing scenarios

Identifiers	Market Sector	Titles of exposure scenarios and the related contributing scenarios	Tonnage (tonnes per year)
ES1 – IW1		Use at industrial site – Surface treatment for the manufacture of grain-oriented electrical steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers PROC 1: Delivery and storage of raw material PROC 10: Surface treatment (Application of the insulation coating) PROC 8a: Preparation of the insulation coating solution PROC 28: Maintenance and cleaning of equipment performed by surface treatment staff PROC 28: Maintenance and cleaning of equipment performed by maintenance staff PROC 8b: Waste and wastewater management	100-400 t/a ([redacted] t/a) (approx. [redacted] t/a Cr(VI)
Industrial end use at site: IW-#			

9.0.2. Introduction to the assessment

9.0.2.1. Environment

__Scope and type of assessment__

The current Chemical Safety Report (CSR) and the associated exposure scenarios are tailored to support the Application for Authorization (AfA) to continue use of chromium trioxide for use in surface treatment for the manufacture of Grain Oriented Electrical Steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers after the sunset date in September 2017.

Chromium trioxide has been included in Annex XIV to Regulation (EC) No 1907/2006 ('REACH') due to its intrinsic properties as being carcinogenic (Carc. 1A) and mutagenic (Mut. 1B).

Following REACH, Article 62(4)(d), the CSR supporting an AfA needs to cover only those potential risks arising from the intrinsic properties specified in Annex XIV. Accordingly, only the potential human health risks related to the classification of chromium trioxide as a carcinogenic and mutagenic toxicant are considered in the current CSR. The dominating health effect resulting from the intrinsic hazardous properties of chromium trioxide is lung cancer due to inhalation of dust and/or aerosols.

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

Measures to prevent or limit release of Cr(VI) to the environment are provided as best practice at facilities carrying out operations using chromium trioxide. During industrial surface treatment operations, prevention of releases of substances to the aquatic environment is a matter of good practice. In general, treatment technology (on-site or off-site) to reduce Cr(VI) to trivalent chromium [Cr(III)] in wastewater is generally highly effective, such that residual concentrations of Cr(VI) in effluent are very low and often non-detectable, and may be considered negligible. The exact process of wastewater treatment at the sites is further described in section 9.1.1. Solid and liquid waste containing Cr(VI) is collected and treated as hazardous waste where residual Cr(VI) can be effectively safely treated. In view of the RMMs in place at the production facilities, emissions to the aquatic environment associated with surface treatment operations are effectively prevented.

Since the volatility of chromium trioxide is low it will not normally be present in air. Furthermore, the concentration of Cr(VI) in the insulation coating solution is under 5% and the occurrence of aerosols is unlikely due to the type and temperature of the production process. This is moreover confirmed by workplace exposure measurement results.

While emissions to air are therefore very low, they have been considered in this assessment as a factor potentially contributing to Cr(VI) exposure of humans via the environment. The scope and type of the assessment of the pathway "man via the environment" is discussed in section 9.0.2.2 below.

Cr(VI) is neither directly nor indirectly released to soil due to adequate technical and organizational measures and therefore releases to soil are considered negligible.

Table 8. Type of risk characterisation required for the environment

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

Comments on assessment approach:

In accordance with REACH, Article 62(4)(d), potential risks to the environment need not be considered.

9.0.2.2. Man via environment

Scope and type of assessment

As discussed in 9.0.2.1., humans may potentially be exposed to chromium trioxide via the environment. Since strict emission control measures are implemented, releases to the aquatic environment (and also to soil), if any, are negligible, and the only relevant potential exposure path is inhalation, and expressed as Cr(VI).

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

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

Comments on assessment approach:

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

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

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

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

Therefore, in accordance with the above findings and provisions on the risk assessment for humans exposed via the environment, since it is assumed that all particles are in the respirable size range, no exposure via the oral route due to inhalation of particles needs to be considered. This constitutes a worst case approach, since the potential lung cancer risk is an order of magnitude higher compared to the potential intestinal cancer risk, based on the dose-response relationships agreed by RAC.

Food chain through drinking water and fish is assessed quantitatively.

9.0.2.3. Workers

Scope and type of assessment

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

Table 10. Type of risk characterisation required for workers

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

Comments on assessment approach related to toxicological hazard:

Chromium trioxide has been included into Annex XIV to REACH due to its intrinsic properties as being carcinogenic (Carc. 1A) and mutagenic (Mut. 1B).

Following REACH, Article 62(4)(d), the CSR supporting an AfA needs to cover only those potential risks arising from the intrinsic properties specified in Annex XIV. The dominating health effect resulting from the intrinsic hazardous properties of chromium trioxide is lung cancer due to inhalation of dust and/or aerosols.

Exposure estimates generated by ART 1.5., or measured values are given in terms of Cr(VI) and are expressed as 8 hour Time Weighted Average (TWA).

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

Comments on assessment approach related to physicochemical hazard:

Not relevant – physicochemical hazards are not subject of this CSR.

General information on risk management related to toxicological hazard:

The Exposure Scenarios specify OC and RMM employed by the *thyssenkrupp* facilities carrying out good practice to minimise exposure. The sites must ensure that the controls that they have in place provide an equivalent or better level of protection than those set out in the Exposure Scenario.

The following risk management measures are in place

- Access to the chrome surface treatment lines and the CrO3 storage area is restricted to authorised personnel;

- Standard Operating Procedures (SOPs) are in place and workers receive regular training with regards to chemical risk management and how to properly wear the Personal Protective Equipment (PPE).

Potential exposure of workers handling chromium trioxide is restricted to the lowest possible level.

Aqueous solutions of chromium trioxide are expected to entail only a low potential for generating mists, not requiring Respiratory Protective Equipment (RPE). Nevertheless, protective clothing, chemical-resistant gloves, and goggles are mandatory for those tasks involving handling of the liquid formulation or potential contact with liquid formulations, e.g. during maintenance. A detailed catalogue of PSA is available for workers at both sites. The respective catalogue for Gelsenkirchen is given in Annex CSR 1 as an example for both sites.

As already mentioned earlier, operators are trained in the safe use of PPE.

In some cases, RPE is worn (WCS 4, sub-scenario 2). For determining the efficiency of RPE, the German BG rule "BGR/GUV-R190[2] was used because it provides a robust and consistent approach. Another approach could equally have been used. In any case, such approaches rely on the assigned protection factor (APF) for RPE that may or may not be based on actual workplace measurements under relevant or non-relevant conditions. The German BGs, especially its Institute for Occupational Safety and Health (IFA) is an internationally highly recognized Institute in the field of industrial hygiene. The BG rule was used as a reference with this in mind, but with full respect for the advice of other member states in this regard. As members will appreciate, the BG rule has published a comprehensive overview of respiratory protection devices and their APFs which refers to efficiencies of 96.6% (i.e. an APF of 30) in RPE in the workplace.

Based on national recommendations published for example by HSE[3] or DGUV[4], wearing times of RPE are determined based on results of the workplace/task specific risk assessments and limited by company specific guidelines, as appropriate. The results of the company specific risk assessments are documented, regularly reviewed and updated in accordance with Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work and Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC. In addition, the Council Directive 89/656/EEC on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace is followed. Workers are regularly trained accordingly. Compliance with these rules is controlled by supervisors.

[2] http://publikationen.dguv.de/dguv/pdf/10002/r-190.pdf
[3] British Control of Substances Hazardous to Health regulation (COSHH).http://www.hse.gov.uk/pUbns/priced/hsg53.pdf
[4] German BG rule "BGR/GUV-R190". http://publikationen.dguv.de/dguv/pdf/10002/r-190.pdf

Example for personal protective equipment worn at both sites (picture provided by the plant in Gelsenkirchen)

<u>General information on risk management related to physicochemical hazard:</u>

Not relevant – physicochemical hazards are not the subject of this CSR.

9.0.2.4. Consumers

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

9.1. Exposure scenario 1: Surface treatment for the manufacture of Grain Oriented Electrical Steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers

Thyssenkrupp manufactures grain oriented electrical steel (GOES) at the EU production facilities in Gelsenkirchen, Germany and Isbergues, France. The production process is identical for both sites.

In general, the manufacturing of GOES is a complex multi-step and long-lasting process. Chromium trioxide is only used within the last process step, the application of the final insulation coating, which is required to achieve all the products desired and unique performance characteristics. A graphical illustration of the overall GOES production process including all relevant steps is provided in the figure below and further described below.

[redacted]

(1) [redacted]

(2) [redacted]

(3) [redacted]

(4) [redacted]

(5) [redacted]

(6) [redacted]

The aqueous coating solution applied in the final manufacturing step of GOES is composed of colloidal silica, aluminium(III) phosphate and chromium trioxide present in a concentration below [redacted] % w/w chromium trioxide. The coating solution is prepared in a mixing tank, pumped to the quenching coater and applied on both sides of the GOES strip (upper roll and lower roll) at a temperature of [redacted] - [redacted] °C. [redacted] At both sites [redacted] lines ([redacted]) are in operation. In Gelsenkirchen the application of the insulation coating solution containing Cr(VI) started in 2018.

[redacted]

Graphical illustration of chromium trioxide application process on GOES surface

Example of *thyssenkrupp* products

Operating conditions and RMMs are specified to limit workers (inhalation and dermal) exposure to various components in the treatment solution and environmental exposure. Personal Protective Equipment (PPE) like goggles, chemical resistant gloves and clothing is also specified to minimize potential dermal exposure. Equipment is maintained regularly.

Workers are skilled and receive regular training with regards to chemical risk management and how to properly wear PPE[5]. Regular housekeeping and management systems are in place ensuring high standards of operational procedure.

In Gelsenkirchen, mandatory preventive and follow-up occupational medical examinations for all employees including maintenance staff with potential exposure to hexavalent chromium are conducted according to the BG

[5] The work safety specialist conducts work safety training with all new employees upon employment and with all workers at least one time a year based on the standard operating procedures and the risk assessment. Of special emphasis is the handling of chromium trioxide and the correct use of PPE to ensure a safe handling of this material. The training will be documented and signed by the employee, and the document will then be archived.

rule G15. A first follow-up examination is conducted within 6-12 months of employment and then every 12-24 months. These examinations include, among others, general medical examination and biomonitoring. The results of the examinations are confidential. Results are provided to the workers in writing (confidential). In case the measurements exceed the guidance value, re-measurements are conducted. If these re-measurements again exceed the guidance value, the line manager will be informed to discuss necessary provisions.

In Isbergues, the occupational physician is currently working on the implementation of medical examinations according to the BG rule G15, as it is already performed in Gelsenkirchen. Medical examinations of those workers with possible exposure to chromium trioxide will start in a timely manner.

Environment contributing scenario(s):	
Use at industrial site - Surface treatment for the manufacture of grain-oriented electrical steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers	ERC5
Worker contributing scenario(s):	
Delivery and storage of raw material	PROC 1
Surface treatment (Application of the insulation coating)	PROC 10
Preparation of the insulation coating solution	PROC 8a
Maintenance and cleaning of equipment performed by surface treatment staff	PROC 28
Maintenance and cleaning of equipment performed by maintenance staff	PROC 28
Waste and wastewater management	PROC 8b

Subsequent service life exposure scenario(s):

Not relevant.

Explanation on the approach taken for the ES

Occupational exposure estimates are based on measured data and/or on modelled data. Inhalation exposure has been estimated using the exposure model '*Advanced REACH Tool 1.5' or 'ART'*[6]. ART is a second tier model calibrated to assess exposure to inhalable dust, vapours, and mists; this Exposure Scenario is within the scope of ART. The figures obtained by modelling are considered to be worst-case estimates: supportive evidence for the conservative character of the modelled estimates is provided by comparison with relevant measured exposure data (measured concentrations of particulate residues of Cr(VI) in air), where available.

Thyssenkrupp has workplace exposure measurements performed by accredited and certified institutes, such as [redacted] at the Gelsenkirchen site, and [redacted] at the Isbergues site. The results of these measurements are shown in Annex CSR 2.

Where the sample size and sampling strategy is adequate, the risk characterisation relies on the measured exposure values; in other cases the results of the exposure modelling were used, as adequate measurement data were not available.

The detailed Exposure Scenario has been developed based on information provided by the sites. The sites provided details of the conditions under which the activity was carried out as well as the duration and frequency of each task. This information was verified during a site visit at both sites.

The frequency of a specific activity in the worker sub-scenarios is expressed as daily activity unless otherwise stated.

[6] The use ART for workers exposure assessment under REACH is described in ECHA's updated Guidance on Information Requirements and chemical safety assessment R.14, Vers. 2, May 2010. Background information for ART are provided in: Fransman W., Cherrie J., van Tongeren M., Schneider T., Tischer M., Schinkel J., Marquart H., Warren, N.D., Spankie S., Kromhout H., Tielemans E. Development of a mechanistic model for the Advanced REACH Tool (ART). Version 1.5, January 2013.

Any releases to the aquatic environment are essentially negligible. Chromium trioxide is contained within the preparation and the water used to rinse out the equipment is collected and disposed of in specialist facilities. This is reflected in the environmental contributing scenario below.

9.1.1. Environmental contributing scenario 1: Use at industrial site - Surface treatment for the manufacture of Grain Oriented Electrical Steel used in magnetic circuits of electric devices, in particular magnetic cores of high-performance transformers

Cr(VI) releases to the environment are carefully controlled by *thyssenkrupp* and monitored by regulators.

Emissions of Cr(VI) relating to extraction systems in the furnaces have been monitored by thyssenkrupp in Gelsenkirchen and could not detect any Cr(VI) in the samples. These measured data nevertheless have been used, in line with the applicable models and guidance, to estimate the local concentration of Cr(VI) in air, and exposure to man via the environment, as set out below.

At the Gelsenkirchen site, all Cr(VI) containing wastewater is collected and treated by an external licensed waste management company.

At the Isbergues site, all Cr(VI) containing wastewater is pumped to the wastewater treatment plant owned and operated by company Aperam. The wastewater treatment plant is located close to the *thyssenkrupp* site in the industrial area of Isbergues. Cr(VI) containing wastewater is reduced to Cr(III).

Waste materials containing Cr(VI) are classified and treated as hazardous wastes according to EU and national regulations. Furthermore, reductive treatment of any liquid waste containing Cr(VI) additionally ensures that there is, if any, negligible release of Cr(VI) to wastewater.

9.1.1.1. Conditions of use (Gelsenkirchen Site)

Amount used, frequency and duration of use (or from service life)
• Daily use at site: <= [redacted] tonnes/day
• Annual use at a site: <= [redacted] tonnes/year
• Percentage of EU tonnage used at regional scale: = 50 %
Conditions and measures related to sewage treatment plant
• Municipal STP: Yes [Effectiveness Water: 0.148%]
• Discharge rate of STP: >= 2E3 m3/d
• Application of the STP sludge on agricultural soil: Yes
Conditions and measures related to treatment of waste (including article waste)
• Particular considerations on the waste treatment operations: No (low risk) (ERC based assessment demonstrating control of risk with default conditions. Low risk assumed for waste life stage. Waste disposal according to national/local legislation is sufficient.)
Other conditions affecting environmental exposure
• Receiving surface water flow rate: >= 1.8E4 m3/d

9.1.1.2. Releases

There is no exhaust ventilation at the application of the coating solution to the GOES strip (as described in 9.1.) Static measurements directly at the application could not detect any Cr(VI) in air (see Annex CSR 2). Relevant air emissions for man via the environment can only occur in the furnaces where exhaust ventilation exists (but without any air abatement technique).

Point source emission data are available for 2018 from the Gelsenkirchen site and reflect potential Cr(VI) emission to air. Six measurements à 30 minutes at each of the four chimneys were conducted by an external accredited and certified institute. None of these measurements could detect any Cr(VI) in the respective sample (detection limit 1 µg/m^3) showing the low potential of exposure to man via the environment. The same is expected for the Isbergues site due to identical processes.

The data from the Gelsenkirchen site 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: Environmental exposure assessment, Version 3, 2016.

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

Table 11. Parameters for estimating PECregional$_{air}$

Tonnage [as Cr(VI)]	Release factor* (%)	Regional fraction** (%)
[redacted]	4E-04	50 %

* The release factor was estimated using tonnage and PEC$_{local}$ information, provided by the site
** Percentage of tonnage used at regional scale

9.1.1.2.1. Exposure estimate for man via the environment - air

The estimated air exposure concentrations are reported in the following table.

Table 12. Cr(VI) exposure concentrations in air, 100 meter from point source

No of Sites	Reporting Years	Exposure estimate (mg/m^3)
1	2018	9.33E-08

The estimated exposure concentration of 9.33E-08 mg/m^3 is used as worst-case estimate (all measurements below the limit of detection) of Clocal$_{air,ann.}$

The PEClocal$_{air,ann}$ of 9.33E-08 mg/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:

2.71E-03 per 1000 exposed. Again, this is assumed to be an absolute worst-case estimate.

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

9.1.1.2.2. Exposure estimate for man via the environment – water

Table 13. Contribution to oral intake for man via the environment from local contribution

Type of food	Estimated daily dose	Concentration in food
Drinking water	1.067E-8 mg/kg bw/day	3.735E-7 mg/L
Fish	2.46E-12 mg/kg bw/day	1.497E-9 mg/kg ww
Leaf crops	1.427E-5 mg/kg bw/day	8.326E-4 mg/kg ww
Root crops	1.939E-9 mg/kg bw/day	3.535E-7 mg/kg ww
Meat	1.923E-10 mg/kg bw/day	4.473E-8 mg/kg ww
Milk	3.585E-9 mg/kg bw/day	4.473E-7 mg/kg ww

Calculation for drinking water and fish

Sum of estimated dose Drinking Water and Fish:

Drinking water	1.067E-8 mg/kg bw/day
Fish	2.46E-12 mg/kg bw/day
Total	1.07E-8 mg/kg bw/day

Accounting for the transformation of Cr(VI) to Cr(III) with a reduction factor of 97% (see EU RAR 2005):

1.07E-8 mg/kg bw/day x 0.03 = 3.20E-10 mg/kg bw/day = 3.20E-7 µg/kg bw/day

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

2.56E-07 per 1000 exposed.

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

In Gelsenkirchen, chromium trioxide solution is delivered [redacted] in [redacted] IBC containers. [redacted] stored in a locked designated storage cabinet located in the production and [redacted] currently directly transferred to the mixing area. However, the site purchased a second designated storage cabinet. The sealed containers are transferred from the storage to the substance preparation unit by a forklift. Access to the storage area is restricted to authorized, trained personnel only.

At the Isbergues site, chromium trioxide solution is delivered [redacted] in IBCs ([redacted]). The IBCs are stored in a locked, designated outside storage area, in distance to the production areas and transported by a forklift to the mixing area. The IBCs are located above secondary containment. The secondary containment is inspected by a certified company on a regular basis. Access to the storage area is restricted to authorized, trained personnel only.

There is no potential for exposure. A maximum of two workers are engaged in this activity.

[redacted] [redacted]

Isbergues: Outside storage area

[redacted] [redacted]

Isbergues: Storage area in the production hall

[redacted]

Gelsenkirchen: Chromium trioxide storage container

9.1.2.1. Conditions of use

	Method
Product (article) characteristics	
▪ Substance as such/in a mixture Concentration of Cr(VI): < 40 %	Qualitative
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 20 min	Qualitative
Technical and organisational conditions and measures	
▪ 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 and outdoor	Qualitative
▪ Process temperature: Room temperature	Qualitative

* Advanced Health and Safety management systems is terminology referred to within exposure assessment models such as ECETOC TRA. Such models assume that a significant reduction in exposure can be achieved through use of Health and Safety management systems and assume this to be the default for industrial operations. This can be seen to reflect the fact that companies have a duty of care to their employees through general Health and Safety at Work legislation, as well as via more specific legislation, such as the Carcinogens Directive (2004/37/EC) and the Chemical Agents at Work Directive (98/24/EC).
There is no standard definition of this term but, based on regulatory requirements, it can be considered to include:

- Requirement to ensure only workers essential for repairs shall be permitted to work in the affected area, and only with appropriate protection. The exposure may not be permanent and shall be minimised.

	Method
• Requirement to ensure if a temporary, planned higher exposure is unavoidable (e.g. maintenance), the employer shall consult workers/representatives on the measures to minimise exposure, and provide appropriate prevention, together with access control. • Provision of appropriate hygienic circumstances for workers free of charge o Prohibition of eating/drinking/smoking in contamination risk areas o Appropriate protective clothing o Separate storage places for working/protective clothing and for street clothes o Appropriate and adequate washing and toilet facilities o Cleaned, checked and maintained protective equipment, stored in a well-defined place. • Provision of appropriate training on potential risks to health, precautions to prevent exposure, hygiene requirements, protective equipment, clothing and incidents. • Requirement to inform on objects containing carcinogens or mutagens, and label them clearly and legibly, together with warning and hazard signs. • Requirement to inform workers and/or representatives on abnormal exposures as quickly as possible.	

9.1.2.2. Exposure and risks for workers

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

Table 14. Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0 µg/m³**	Based on the dose-response relationship 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 per 1000 exposed workers

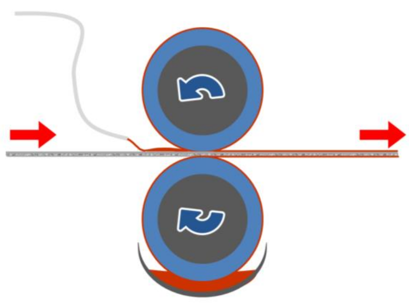
Conclusion on risk characterisation

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 lung cancer risk of 0 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

9.1.3. Worker contributing scenario 2 Surface treatment (Application of the insulation coating) (PROC 10)

The application of the insulation coating at both sites is a fully automatic process. The coating solution is pumped from the dosing area to a production tank near each surface treatment line. The coating unit consists of two engraved rolls which apply the coating on both sides of the GOES strip on a continuous processing. The insulation solution is led onto the GOES strip as well as into a pan below the coating roll via two lateral feeding pipes. The solution is evenly spread on the surface due to the continuous movement of the strip. The liquid collected in the pan below the coating roll is re-heated in the production tank to [redacted]°C for further processing.

[redacted]	
Application of the insulation coating solution	Rolls applying the coating on both sides of the GOES strip

Following the application of the coating solution, the GOES strip continues to the furnace, where Cr(VI) is reduced to Cr(III).

[redacted]

The operator does not enter the surface treatment unit. However, the operator controlling the process carries out walk-throughs during the shift, in Gelsenkirchen every hour and in Isbergues three times per shift. Adequate PPE is worn (helmet, safety shoes, protective clothing, chemical-resistant gloves, goggles). The surface treatment unit is also video monitored. Therefore, the operator can observe the process from the control room.

The surface treatment lines are integrated in the general production areas. Areas in Gelsenkirchen and Isbergues where Cr(VI) is applied are mapped in the layouts at the end of the present worker contributing scenario.

In total, [redacted] workers are engaged in the operation of the surface treatment lines per shift.

Table 15: Overview of the number of shifts[7] and operation time per year (in days) separated by surface treatment line and site.

[redacted]

[redacted]	[redacted]
Examples of surface treatment lines	
Gelsenkirchen (detail)	Isbergues (overview)

9.1.3.1. Conditions of use

	Method
Product (article) characteristics	
▪ Concentration of Cr(VI) in mixture: < 5%	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	
▪ Good natural ventilation	Measured data
▪ Containment: No	Measured data
▪ Local exhaust ventilation: No	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data

[7] [redacted] teams are working in [redacted] consecutive shifts.

	Method
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: No	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature: > 40°C	Measured data

9.1.3.2. Exposure and risks for workers

Exposure potential to Cr(VI) of workers operating the surface treatment lines was measured by personal and static air sampling at both sites since 2015 (in Isbergues) and 2018 (in Gelsenkirchen). Most of the results of the measurements were below the respective detection limit of the measurement (see Annex CSR 2), showing the low level of potential inhalative exposure of operators. For the purpose of this risk assessment, an exposure value of 0.29 µg Cr(VI)/m^3 is assumed (90th percentile value of the data). This, however, is likely an overestimate because this percentile value is driven by the data from Gelsenkirchen, which have a higher detection limit than those of Isbergues.

<u>Conclusion on risk characterisation</u>

The exposure estimate based on measured data of 0.29 µg Cr(VI)/m^3 is used as the basis for risk characterisation (worst case).

An excess lifetime lung cancer risk of 1.16 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)/m^3] might be an over-estimate.

[redacted]

Layout map with chrome working areas in Gelsenkirchen

[redacted]
Layout map with chrome working areas in Isbergues

9.1.4 Worker contributing scenario 3: Preparation of the insulation coating solution (PROC 8a)

The preparation of the insulation coating solution with aqueous chromium solution occurs automatically at both sites. When necessary, an IBC is transferred from the storage area to the fenced dosing area by a forklift. A small plug is removed from the IBC and the IBC is equipped with a suction lance. The chromium containing solution is dosed into the closed mixing tank, according to the desired concentration.

In Isbergues, a new cabinet for the IBCs connected to the mixing tanks is under construction. The estimated completion date of the area is February 2019.

[redacted]	[redacted]
Isbergues: New retention area where the cabinet is to be built	Plan of the cabinet

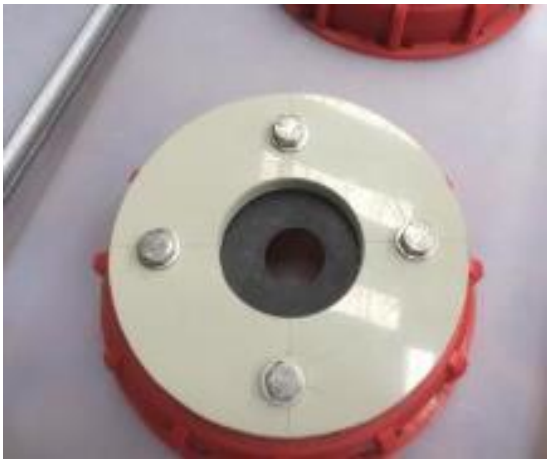
It is assumed as a worst case that the preparation of the insulation coating solution takes place [redacted] per month.

A maximum of [redacted] surface treatment operators are engaged in this activity.

Gelsenkirchen: Dosing area

[redacted]

Isbergues: Dosing area



Isbergues: Plug for the IBC

9.1.4.1. Conditions of use

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: 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: < 10 min ▪ Frequency of activity: 12 times / month (reduction factor of 0.6 applied)	ART 1.5 ART 1.5 (extended)
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Bottom loading	ART 1.5
▪ Situation: Transfer of liquid product with flow of 0.1 - 1 l/minute	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: 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	ART 1.5

9.1.4.2. Exposure and risks for workers

Table 16. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		
ART model output	0.021 µg/m³ (90th percentile value)	
Further adjusted for frequency (factor 0.3)	**0.0126µg/m³**	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: 0.05 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5)[8] of 0.0126 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure.

An excess lifetime lung cancer risk of 0.05 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

[8] ART print-out see Annex CSR 3

9.1.5. Worker contributing scenario 4: Maintenance and cleaning of equipment performed by surface treatment staff (PROC 28)

Maintenance is regularly performed by authorized workers from the surface treatment team. Regular maintenance of the surface treatment lines is strictly controlled and documented with the help of maintenance schedules at both sites.

In Gelsenkirchen, regular maintenance is performed by a team of five workers per line, including the foreman, an insulation worker, a backup worker, as well as the first and second annealing operators. Insulation rolls are cleaned [redacted]. Depending on the type of rolls used at that time, the respective rolls are dismounted and exchanged either [redacted] In parallel, nozzle holders and the pan below the coating roll are cleaned. Before the dismounted rolls are eventually cleaned by a licensed waste contractor (see WCS 6), rolls are decontaminated above secondary containment with the aid of solved Iron (II) sulfate that is spread over the rolls with a hand-held pump. [redacted], the coating solution tanks (one per line) are cleaned. Residual chrome VI is manually collected into a small container using a small hammer, a dustpan and a brush and then transferred to the Cr(VI) waste container. Adequate PPE is worn (protective clothing, chemical-resistant gloves, and goggles). A maximum of 10 workers are engaged in this activity. Currently, the site plans to change the manual cleaning process of the coating solution tanks to an automatic cleaning sequence (compare Isbergues).

In Isbergues, regular maintenance is performed by three operators per line. The most frequent maintenance work is the rinsing of the coating rolls every time an unexpected standstill of more than [redacted] occurs (around [redacted]). [redacted], workers prepare the process of dismounting the insulation rolls (the dismounting itself is done by mechanics), by rinsing them beforehand, see the following sub-scenario. In order to do so, surface treatment workers must enter the coating machine. Prior to entering the coating machine the coating supply is stopped. Two automatic cleaning sequences are launched [redacted] via the control panel, one of which for cleaning the preparation station, and the other for cleaning the using tank. Adequate PPE is worn (protective clothing, chemical-resistant gloves, goggles, and RPE if necessary). A maximum of 4 workers are engaged in this activity.

9.1.5.1. Conditions of use

9.1.5.1.1 Sub-scenario 1: Dismounting and changing of rolls / Cleaning of nozzle holders and pan below the roll

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: 1-5 %	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: < 2.5 hours ▪ Frequency of activity: < 2 times / week (adjustment factor of 0.4 applied)	ART 1.5 ART 1.5 (extended)
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Handling of contaminated objects	ART 1.5
▪ Activities with treated/contaminated objects (surface 1 - 3 m²)	ART 1.5
▪ Level of contamination: Contamination 10-90% of surface	ART 1.5
Surface contamination	
▪ Process fully enclosed? No	ART 1.5
▪ Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	

	Method
▪ Work area: Indoors	ART 1.5
▪ Room size: Large 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	
▪ Respiratory Protection: No	ART 1.

9.1.5.1.2 Sub-scanario 2: Cleaning of coating rolls during standstill

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: 1-5 %	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: < 0.5 hours	ART 1.5
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Handling of contaminated objects	ART 1.5
▪ Activities with treated/contaminated objects (surface 1 - 3 m²)	ART 1.5
▪ Level of contamination: Contamination 10-90% of surface	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: 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: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%]	ART 1.5 (extended)

9.1.5.2. Exposure and risks for workers

Table 17. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		
ART model output: Sub-scenario 1	0.14 µg/m³ (90th percentile value)	
further adjusted for frequency (frequency factor 0.4)	**0.056 µg/m³**	
ART model output: Sub-scenario 2	0.31 µg/m³ (90th percentile value)	
further adjusted for respiratory protection (RPE factor 0.033)	**0.01 µg/m³**	
Total: Sub-scenario 1 + Sub-scenario 2	**0.066 µg/m³**	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: 0.26 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5)[9] 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.

An excess lifetime lung cancer risk of 0.26 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

9.1.6. Worker contributing scenario 5: Maintenance and cleaning of equipment performed by maintenance staff (PROC 28)

Maintenance of the surface treatment lines that is performed by trained maintenance staff is strictly controlled and documented at both sites. Maintenance staff is accompanied by an authorized worker from the surface treatment team (see WCS 4).

In Gelsenkirchen, experts (e.g. a locksmith) will be consulted if required, for example in the case of defective components. Maintenance staff working at the surface treatment line is trained in the handling of chromium trioxide. Adequate PPE is worn (protective clothing, chemical-resistant gloves, goggles). During maintenance work performed by maintenance staff, the flow of the insulation solution is turned off and the pan below the insulation rolls is empty. Maintenance staff is only required to perform maintenance very rarely ([redacted]) when chocks/construction units of the rolls have to be adjusted. A maximum of 6 workers are engaged in this activity.

In Isbergues, dismounting and changing of the insulation rolls is performed by two internal mechanics [redacted], after the operators have rinsed all contaminated equipment, see WCS 4. During maintenance work performed by maintenance staff, the flow of the insulation solution is turned off and the pan below the insulation rolls is empty. Dismounted rolls are placed on stands in a special area and further

[9] ART print-out see Annex CSR 3

processed using dedicated tools. The pumps, tubes and valves are cleaned and replaced [redacted] with possible contact to liquid Cr(VI). This process takes [redacted]. Adequate PPE is worn (protective clothing, chemical-resistant gloves, security glasses or goggles, and RPE if necessary). A maximum of 6 workers are engaged in this activity.

9.1.6.1. Conditions of use

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: 1-5%	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: < 2 h	ART 1.5
▪ Frequency of activity:4 times / month (adjustment factor of 0.2 applied)	ART 1.5 (extended)
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Handling of contaminated objects	ART 1.5
▪ Activities with treated/contaminated objects (surface 1 - 3 m²)	ART 1.5
▪ Level of contamination: Contamination 10-90% of surface	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: 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	ART 1.5

9.1.6.2. Exposure and risks for workers

Table 18. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		
ART model output	0.075 µg/m³ (90th percentile value)	
further adjusted for frequency (frequency factor 0.2)	**0.015µg/m³**	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: 0.06 per 1000 exposed workers

Measured data
Exposure potential to Cr(VI) of maintenance workers performing the dismounting and change of the insulation rolls was measured by personal air sampling in Isbergues in 2015. Measured results were below the respective detection limit of the measurement (see Annex CSR 2), confirming the low level of potential inhalative exposure of operators.

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5)[10] of 0.015 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure.

An excess lifetime lung cancer risk of 0.06 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

9.1.7. Worker contributing scenario 6: Waste and wastewater management (PROC 8b)

Very low amounts of contaminated process waste are infrequently handled at the facilities, (e.g. waste from cleaning activities, for example potentially contaminated PPE), all with very low potential for inhalation exposure. Process wastes are stored in closed containers which further are collected by licensed waste management companies for treatment, incineration and disposal of incineration residues at licensed landfills.

At the Gelsenkirchen site, Cr(VI) contaminated wastewater is collected and disposed of by a certified licensed waste management company. No Cr(VI) contaminated wastewater is released to the environment from the site.

At the Isbergues site, Cr(VI) contaminated wastewater is pumped to the wastewater treatment system operated by an external company in the industrial area of Isbergues. According to the permit granted by French authorities the site monitors the wastewater prior to discharge to the wastewater treatment plant for total metals including chromium weekly. The limit value is set to ≤ 100 mg/L for total metals. Sampling before discharging is a short-term activity performed by the environmental technician and the concentration of Cr(VI) is very low. Therefore, potential of inhalation exposure and risk is assessed as negligible. This is demonstrated by the modelled scenario below.

[10] ART print-out see Annex CSR 2

9.1.7.1. 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: < 30 min ▪ Frequency of activity: 1/week	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	ART 1.5

9.1.7.2. Exposure and risks for workers

Table 19. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		
ART model output further adjusted for frequency (frequency factor 0.2)	0.0069 µg/m³ (90th percentile value) **0.0014 µg/m³**	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: 0.0056 per 1000 exposed workers

<u>**Conclusion on risk characterisation**</u>

The modelled exposure estimate (ART 1.5)[11] of 0.0069 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case). The estimate is based on several conservative assumptions regarding exposure.

An excess lifetime lung cancer risk of 0.0056 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

[11] ART print-out see Annex CSR 2

10. RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

10.1. Human health

10.1.1. Workers

Workers in the surface treatment process with chromium trioxide at the sites may have some combinations of tasks.

The highest combined exposure estimate would arise from the combination of WCSs 2, 3, 4 and 5 which results in a combined exposure estimate of 0.39 µg Cr(VI)/m³.

Worker Contributing Scenario	Exposure Concentration (µg CrVI/m³)
WCS 2	0.3
WCS 3	0.0126
WCS 4	0.066
WCS 5	0.015
∑ (Combined exposure estimate)	0.39

In this case, an excess lifetime lung cancer risk of 1.56 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship for lung cancer mortality.

10.1.2. Consumer

Not relevant as there is no consumer use.

10.2. Environment (combined for all emission sources)

10.2.1. All uses (regional scale)

10.2.1.1. Regional exposure

Environment

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

The PEC regional have been estimated with EUSES.

Table 20. Predicted regional exposure concentrations (Regional PEC)

Protection target	Regional PEC	RCR
Freshwater	Not relevant	Not relevant
Sediment (freshwater)	Not relevant	Not relevant
Marine water	Not relevant	Not relevant
Sediment (marine water)	Not relevant	Not relevant
Air	negligible	Not relevant
Agricultural soil	Not relevant	Not relevant

Man via environment

The exposure to man via the environment by inhalation or oral uptake from regional exposure is negligible.

10.2.2. Local exposure due to all wide dispersive uses

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

10.2.3. Local exposure due to combined uses at a site

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