9.1. Exposure scenario 2: Use at industrial site - Use as an intermediate

Market sector: Manufacture of other substances

PC 19: Intermediate

Sector of use:

SU 9, Manufacture of fine chemicals

SU 14, Manufacture of basic metals, including alloys

Environment contributing scenario(s):	
Use as an intermediate	ERC 6a
Worker contributing scenario(s):	
Handling of raw materials	PROC 8b, 26
Handling of solutions and reaction	PROC 4, 8b
Vacuum cleaning	PROC 26

Explanation on the approach taken for the ES

It is noted that this exposure scenario focusses on exposure to the substance to be registered. Please refer to information on safe use for the handling of the individual manufactured substances for process steps commencing the chemical transformation step.

9.2.1 Environmental contributing scenario 1: Use as an intermediate

9.2.1.1. Conditions of use

The conditions of use are as described in the generic exposure scenario (GES) below

9.2.1.2 Releases

The GES and associated risk assessment are concerned with releases of Rh to wastewater and air arising from the use of diammonium sodium hexakis(nitrito-N)rhodate as an intermediate at an industrial site. Wastewater is treated by an on-site wastewater treatment plant (WWTP) prior to discharge to the receiving water body in a number of ways:

- To freshwater via a municipal sewage treatment plant (STP) [ES 2.1]; or
- Direct discharge to freshwater [ES 2.2].

Airborne emissions are treated by in-stack mitigation systems prior to discharge (all ES). Exposure assessment for the environment is based on representative exposure characteristics from the Rh manufacturing and processing sector for wastewater emissions and SpERC values for stack emissions to air.

A sector-wide monitoring dataset is available, based on emissions of total Rh, resulting from production and use of a variety of Rh compounds collected during 2013 - 2015 from sites across Europe. In this assessment the release factor (RF) for wastewater is set at 0.0113 % (equivalent to 113 g/T); the 50th percentile measured wastewater release factor from 6 sites. . In this assessment the release factor (RF) to air is set at the SpERC RF to air for 'manufacture of metal compounds'[1] of 0.03% (equivalent to 300 g/T).

9.2.1.3. Risk Management Measures (RMMs)

All sites from the Rh manufacturing and processing sector that provided data on emissions to water reported that wastewater treatment was primarily based on chemical precipitation followed by sedimentation and/or filtration. Two sites reported an additional step involving ion exchange. The reported efficiency for treatment of wastewater containing Rh compounds was >99%. Similarly, all sites reporting on RMMs for stack emissions to air stated the use of wet scrubbers, with reported efficiency of ≥99%

9.2.1.4. Exposure Scenario

The use of diammonium sodium hexakis(nitrito-N)rhodate as an industrial intermediate is considered to have the same operating conditions and emission characteristics as manufacture on the basis that many companies in this sector manufacture diammonium sodium hexakis(nitrito-N)rhodate for use as an intermediate and facilities using this compound as intermediate would be undertaking similar processes.

A summary of the emission characteristics used to quantify the environmental aspects of the generic exposure scenario (GES) for use of diammonium sodium hexakis(nitrito-N)rhodate as an intermediate at industrial sites is detailed below:

1. Title **ES2: Use as an intermediate at industrial site**	
Life cycle	Use as an intermediate at industrial site
Systematic title based on use descriRuor	ERC: ERC 6A Use as an intermediate – industrial
2. Operational conditions and risk management measures	

[1] http://www.arche-consulting.be/content/documents/Eurometaux-1.2.v2.1.pdf

2.1 Control of environmental exposure	
Environmental related free short title	Use as an industrial intermediate
Systematic title based on use descriRuor (environment)	ERC 6A Use as an intermediate – industrial
Processes, tasks, activities covered (environment)	Use as an industrial intermediate: delivery and processing of diammonium sodium hexakis(nitrito-N)rhodate, cleaning & maintenance.
Environmental Assessment Method	Estimates based on monitoring data of emissions, local and regional concentrations are used for calculation of PECs
Product characteristics Diammonium sodium hexakis(nitrito-N)rhodate as solid or aqueous solution. Environmental assessment is based on the estimated emission of diammonium sodium hexakis(nitrito-N)rhodate in wastewater discharge and in stack emissions to air.	
Amounts used	
Annual production/use at a site	ES 2.1 and ES 2.2: 19.2 tonnes diammonium sodium hexakis(nitrito-N)rhodate (4.5 tonnes Rh metal equivalent); 90P from sector data
Frequency and duration of use	
Pattern of release to the environment	330 days per year per site (50P from sector data)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 2.1: STP: 3,000 m^3/d (minimum STP size from sector data) Receiving water: 147,000 m^3/d (based on 50P dilution factor from sector data) ES 2.2: Receiving water: 2,997,000 m^3/d (maximum allowable dilution factor of 1000; assumption made on knowledge of sector data.)
Dilution capacity, freshwater	ES 2.1: Discharge to freshwater via STP: DF in STP = 27; DF in receiving water = 50 (sector data) ES 2.2: Direct discharge to freshwater: DF = 1,000 (maximum allowable, based on sector data)
Dilution capacity, marine	Not relevent
Other given operational conditions affecting environmental exposure	
None	
Technical conditions and measures at process level (source) to prevent release	
Appropriate process control systems shall be implemented.	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and	

releases to soil	
Waste water: All ES: On-site wastewater treatment by chemical precipitation, sedimentation and/or filtration. Efficiency 99 % (sector data) Release factor after on-site treatment: 113 g/T (50P from sector data) ES 2.1. Off-site municipal sewage treatment plant (STP) Efficiency 48 % (based on European STP monitoring programme[2]) **Air:** All ES: Treatment of air emissions by wet scrubbers and filters (e.g. fabric, bag). Release factor after on-site treatment: 300 g/T (SpERC RF for 'Manufacture of metal compounds'[3])	
Organizational measures to prevent/limit release from site	
Regular operator training.	
Conditions and measures related to municipal sewage treatment plant (if applicable)	
Municipal Sewage Treatment Plant (STP)	ES 2.1: Yes ES 2.2: No
Discharge rate of the Municipal STP	ES 2.1: 3 000 m^3/d (10P from sector data)
Fate of the sludge from Municipal STP	The sludge is incinerated (with ash going to landfill)
Conditions and measures related to external treatment of waste for disposal	
Hazardous wastes from onsite risk management measures and solid or liquid wastes from production, use and cleaning processes should be disposed of separately to hazardous waste incineration plants or hazardous waste landfills as hazardous waste. Releases to the floor, water and soil are to be prevented. If the rhodium content of the waste is elevated enough, internal or external recovery/recycling should be considered. Fraction of daily/annual use expected in waste: 0% Appropriate waste codes: 06 04 05*, 06 05 02*, 10 08 09, 10 08 11, 10 08 16, 10 08 18, 15 02 02*, 16 01 18, 16 08 01, 16 08 06*, 16 08 07*, 19 08 06*, 20 01 40	

[2] Stutt E, Wilson I, Merrington G & Rothenbacher K (2016) Determining the Removal of Rhodium Group Metals in Industrial Effluent during Sewage Treatment. In: Abstracts Book of the SETAC Europe 26th Annual Meeting – 22-26 May 2016, Nantes, France, Society of Environmental Toxicology and Chemistry

[3] ARCHE (2013) Manufacture of metal compounds. spERC code Eurometaux 1.2.v2.1. Available online at http://www.arche-consulting.be/metal-csa-toolbox/SPERCs-tool-for-metals/

Suitable disposal: Hazardous waste produced during the manufacture and downstream use is sent to a recycler only marginal amounts are sent to a landfill or an incinerator. Waste containing rhodium is recycled for almost a 100%

A detailed assessment has been performed and is reported in the Waste report (ARCHE, 2017)

Conditions and measures related to external recovery of waste

Diammonium sodium hexakis(nitrito-N)rhodate- and other Rh -containing waste suitable for recycling may be recycled either internally or at licensed recycling facility.
The sludge from the on-site treatment plant is processed for metal reclamation (recycling).

3. Exposure and risk estimation

Environment [based on total Rh emissions]
ERC 6A

ES 2 Use as an industrial intermediate*

Compartment	Unit	PNEC	$PEC_{regional}$	C_{local}	PEC	RCR	Methods for calculation of environmental concentrations
Discharge to STP (ES 1.1)	mg Rh/L	14.6 mg/L	N.A.	2.7 $x10^{-4}$	2.7 $x10^{-4}$	1.8 $x10^{-5}$	Reasonable worst case exposure modelling based on 90P sector tonnage & 50P release factor
Freshwater via STP (ES 1.1)	mg Rh/L	2.9 x 10^{-4} mg/L	8.69 $x10^{-8}$ mg/L	4.36 $x10^{-6}$	4.44 $x10^{-6}$	0.015	
Freshwater following direct discharge (ES 1.2)	mg Rh/L	2.9 x 10^{-4} mg/L	8.69 $x10^{-8}$ mg/L	4.19 $x10^{-7}$	5.06 $x10^{-7}$	0.00174	
Freshwater sediment via STP (ES 1.1)	mg Rh/kg w.w.	0.95 mg/kg	N.A.[4]	0.00146	0.00146	0.15[4]	

[4] The concentration in freshly deposited sediment is taken as the PEC for sediment, therefore, the properties of suspended matter are used. The concentration in bulk sediment can be derived from the corresponding water body concentration, assuming a thermodynamic partitioning equilibrium. (ECHA (2016) Guidance on information requirements and chemical safety assessment. Chapter R16: Environmental exposure estimation (Version 3.0, February 2016))

Freshwater sediment via direct discharge (ES 1.2)	mg Rh/kg w.w.	0.95 mg/kg	N.A.[14]	0.00166	0.00166	0.0175 ǂ	
Terrestrial (ES 1.1 and 1.2)	mg Rh/kg w.w.	1.00 x 10^{-3} mg/kg	1.64 x10^{-6} mg/kg	2.44 x10^{-6} mg/kg	4.08 x10^{-6} mg/kg	0.0041	Modelled increase in soil concentrations due to deposition from atmospheric emissions (i.e. assuming no application of sewage sludge to land)

* All concentrations reported as Rh equivalent due to the PNEC based on rhodium concentration being used for assessment.
ǂ Additional factor of 10 applied in RCR calculation to account for use of PNEC derived by equilibrium partitioning.
N.A. = not applicable

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment

Scaling tool: Metals EUSES IT tool (free download: http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool)

Scaling of the release to air and water environment includes:

- Refining of the release factor to air and waste water and/or and the efficiency of the air filter and wastewater treatment facility.
- Adjustment of the flow rate for the receiving water body and subsequent dilution factor.

9.2.2. Worker contributing scenario 1: Handling of medium/high dusty

materials (PROC 8b, 26)

9.2.2.1. Conditions of use (PROC 26)

	Method
Product (article) characteristics	
• Physical form of substance: solid	Analogous data
• Maximum emission potential of the substance: High (Only the highest emission potential (EP) is reported). Lower EPs (e.g. if rhodium substances of lower dustiness are being handled in parallel) are thus automatically covered in this assessment. It is further noted that spraying operations of rhodium compounds in liquid/suspension/solution forms are not covered in this assessment.	Analogous data
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	Analogous data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Maximum duration of exposure: > 240 min (not restricted) [Effectiveness Inhal: 0%; Dermal: 0%]	Monitoring data
Technical and organisational conditions and measures	
• The following types of exhaust ventilations are appropriate: - Generic local exhaust ventilation - Exterior exhaust ventilation - Integrated exhaust ventilation A minimum efficiency of 80% has to be assured.	Analogous data
• Level of containment: - Rhodium substances have to be handled in at least partly-contained systems with only limited manual interventions. - The level of containment should be as high as possible, easy maintenance should be allowed by system design.	

	Method
• Level of automation: The level of automation should be as high as possible in order to reduce potential for exposure. This is inherently covered in the dermal exposure assessment by the reflection of an "incidental or intermittent" contact level (please refer to the dermal exposure pattern below).	
• Removal of residuals: Removal of dusty residuals is considered to be part of regular work. Dust may not be blown off with compressed air. Please refer to the introduction for more detailed information on how clean work environments are ensured and on how to contamination is avoided in the rhodium industry.	
• Dermal exposure pattern: - Pattern of use: Non-dispersive use - Pattern of exposure control: Direct handling - Contact level: Intermittent	Analogous data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Gloves: Protective gloves according to EN 374 have to be worn. Gloves have to be changed according to manufacturer's information or when damaged, whatever is the earlier.	
• Eye protection: Suitable eye protection equipment (e.g. goggles or visors) must be worn.	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from effects via inhalation exposure (Due to potential mutagenic effects of the substance, RPE (minimum assigned protection factor of 10) is prescribed on a precautionary basis for all workplaces unless inhalation exposure to the substance can be excluded.) Please note that higher APFs may be required as reported in exposure and risk section for this sub-contributing exposure scenario.	

9.2.2.2. Exposure and risks for workers

The ECs and RCs are reported in the following table.

Table 11. Exposure concentrations and risks for workers (for long-term, systemic effects)

	Rh
RC inhalation route	qualitative
EC inhalation, long-term, systemic	25.5 µg Rh/m³ (Analogous data)
EC inhalation, long-term, systemic in consideration of APF	APF = 40: 0.64 µg Rh/m³
RC inhalation, long-term, systemic	risk adequately controlled
RC dermal route	qualitative
EC dermal, long-term, systemic	0.03 mg/kg bw/day (Analogous data)
RC dermal, long-term, systemic	risk adequately controlled
RC combined long-term, systemic	risk adequately controlled

EC = Exposure concentration; RC = Risk characterisation

Remarks on exposure data

Inhalation

Analogous data (Rh, manufacturer WP01)

- Inhalation, systemic, long-term:
  Number of measured data points: 4

  The represents 150% of the maximum measured exposure (17 μg Rh/m^3).

Dermal

Analogous data (Ni)

- Dermal, systemic, long-term:
  Number of measured data points: 26
  Assigned exposure scenario: non-dispersive use, direct handling, incidental exposure (NDI)

  The estimated exposure level used above represents the 90th percentile of the exposure distribution for NDI in consideration of appropriate use of gloves (0.58 μg Ni/cm^2), adjusted as described in more detail in the methodology document.

Conclusion on risk characterisation

Further information on the RC for all qualitative hazard conclusions is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is maintained at a very low level and the risk for any adverse health effects is minimised to the technically feasible level. Therefore, risks are adequately controlled.

Furthermore, in consideration of the potential other effects besides mutagenicity, comparison of the ECs in Table 9 with the DNELs calculated for this substance from the reliable repeated dose toxicity data (described in Section 9.0.2.3) results in exposure estimates > 1000-fold lower than the DNELs. This provides reassurance that the estimated exposures pose a negligible risk to human health.

9.2.3. Worker contributing scenario 2: Handling of solutions and reaction (PROC 4, 8b)

9.2.3.1. Conditions of use (PROC 4, 8b)

	Method
Product (article) characteristics	
• Physical form of substance: liquid (solution, suspension)	Analogous data
• Maximum emission potential of the substance: Very low (It is noted that spraying operations are not covered in this assessment.)	Analogous data
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	Analogous data

	Method
Amount used (or contained in articles), frequency and duration of use/exposure	
• Maximum duration of exposure: > 240 min (not restricted) [Effectiveness Inhal: 0%; Dermal: 0%]	Analogous data
Technical and organisational conditions and measures	
• The following types of exhaust ventilations are appropriate: - Generic local exhaust ventilation - Integrated exhaust ventilation A minimum efficiency of 80% has to be assured.	Analogous data
• Level of containment: - Rhodium substances have to be handled in at least partly-contained systems with only limited manual interventions. - The level of containment should be as high as possible, easy maintenance should be allowed by system design.	
• Level of automation: The level of automation should be as high as possible in order to reduce potential for exposure. This is inherently covered in the dermal exposure assessment by the reflection of an "incidental or intermittent" contact level (please refer to the dermal exposure pattern below).	
• Removal of residuals: Splashes are to be removed immediately, before drying. Please refer to the introduction for more detailed information on how clean work environments are ensured and on how to contamination is avoided in the rhodium industry.	
• Dermal exposure pattern: - Pattern of use: Non-dispersive use - Pattern of exposure control: Non-direct handling - Contact level: Intermittent	Analogous data

	Method
Conditions and measures related to personal protection, hygiene and health evaluation	
• Gloves: Protective gloves according to EN 374 have to be worn. Gloves have to be changed according to manufacturer's information or when damaged, whatever is the earlier.	
• Eye protection: Suitable eye protection equipment (e.g. goggles or visors) must be worn.	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from effects via inhalation exposure (Due to potential mutagenic effects of the substance, RPE (minimum assigned protection factor of 10) is prescribed on a precautionary basis for all workplaces unless inhalation exposure to the substance can be excluded.) Please note that higher APFs may be required as reported in exposure and risk section for this sub-contributing exposure scenario.	

9.2.3.2. Exposure and risks for workers

The ECs and RCs are reported in the following table.

Table 12. Exposure concentrations and risks for workers (for long-term, systemic effects)

	Rh
RC inhalation route	qualitative
EC inhalation, long-term, systemic	3.28 µg Rh/m³ (Analogous data)
EC inhalation, long-term, systemic in consideration of APF	APF = 10: 0.33 µg Rh/m³
RC inhalation, long-term, systemic	risk adequately controlled
RC dermal route	qualitative
EC dermal, long-term, systemic	0.003 mg/kg bw/day (Analogous data)
RC dermal, long-term, systemic	risk adequately controlled
RC combined long-term, systemic	risk adequately controlled

EC = Exposure concentration; RC = Risk characterisation

Remarks on exposure data

Inhalation

Analogous data (Rh, manufacturer WP03)

- Inhalation, systemic, long-term:
  Number of measured data points: 2

  The estimated exposure level represents the 95th percentile of the exposure distribution (GSD=1.1).

Dermal

Analogous data (Ni)

- Dermal, systemic, long-term:
  Number of measured data points: 7
  Assigned exposure scenario: non-dispersive use, non-direct handling, incidental exposure (NNI)

  The estimated exposure level used above represents the 90th percentile of the exposure distribution for NNI in consideration of appropriate use of gloves (0.06 μg Ni/cm^2), adjusted as described in more detail in the methodology document.

Conclusion on risk characterisation

Further information on the RC for all qualitative hazard conclusions is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is maintained at a very low level and the risk for any adverse health effects is minimised to the technically feasible level. Therefore, risks are adequately controlled.

Furthermore, in consideration of the potential other effects besides mutagenicity, comparison of the ECs in Table 10 with the DNELs calculated for this substance from the reliable repeated dose toxicity data (described in Section 9.0.2.3) results in exposure estimates > 1000-fold lower than the DNELs. This provides reassurance that the estimated exposures pose a negligible risk to human health.

9.2.4. Worker contributing scenario 3: Vacuum cleaning (PROC 26)

9.2.4.1. Conditions of use for vacuum cleaning (PROC 26)

	Method
Product (article) characteristics	
• Physical form of substance: dusty residuals	Analogous data
• Maximum emission potential of the substance: High (Only the highest emission potential (EP) is reported). Lower EPs (e.g. if rhodium substances of lower dustiness are being handled in parallel) are thus automatically covered in this assessment.)	Analogous data
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	Analogous data
Amount used (or contained in articles), frequency and duration of use/exposure	
• Maximum duration of exposure: > 240 min (not restricted) [Effectiveness Inhal: 0%; Dermal: 0%]	Analogous data
Technical and organisational conditions and measures	
• Removal of dusty residuals: A highly efficient vacuum cleaner is to be used. No direct manual removal of dust. Removal of dusty residuals is considered to be part of regular work. Dust may not be blown off with compressed air. Please refer to the introduction for more detailed information on how clean work environments are ensured and on how to contamination is avoided in the rhodium industry. Workplaces are to be cleaned before any maintenance work starts.	
• Dermal exposure pattern: - Pattern of use: Non-dispersive use - Pattern of exposure control: Non-direct handling - Contact level: Extensive	Analogous data
Conditions and measures related to personal protection, hygiene and health evaluation	
• Gloves: Protective gloves according to EN 374 have to be worn. Gloves have to be changed according to manufacturer's information or when damaged, whatever is the earlier.	

	Method
• Eye protection: Suitable eye protection equipment (e.g. goggles or visors) must be worn.	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from effects via inhalation exposure (Due to potential mutagenic effects of the substance, RPE (minimum assigned protection factor of 10) is prescribed on a precautionary basis for all workplaces unless inhalation exposure to the substance can be excluded.) Please note that higher APFs may be required as reported in exposure and risk section for this sub-contributing exposure scenario.	

9.2.4.2. Exposure and risks for workers for vacuum cleaning (PROC 26)

The ECs and RCs are reported in the following table.

Table 23. Exposure concentrations and risks for workers

	Rh

RC inhalation route	qualitative
EC inhalation, long-term, systemic	25.5 µg Rh/m³ (Analogous data)
EC inhalation, long-term, systemic in consideration of APF	APF = 40: 0.64 µg Rh/m³
RC inhalation, long-term, systemic	risk adequately controlled
RC dermal route	qualitative
EC dermal, long-term, systemic	0.006 mg/kg bw/day (Analogous data)
RC dermal, long-term, systemic	risk adequately controlled
RC combined long-term, systemic	risk adequately controlled

EC = Exposure concentration; RC = Risk characterisation

Remarks on exposure data

Inhalation

Analogous data (Rh, manufacturers WP01)

- Inhalation, systemic, long-term:
  Number of measured data points: 4

  The estimated exposure level represents 150% of the maximum measured exposure (17 µg Rh/m³).

Dermal

Analogous data (Ni)

- Dermal, systemic, long-term:
  Number of measured data points: 7
  Assigned exposure scenario: non-dispersive use, non-direct handling, extensive exposure (NNE)

  The estimated exposure level represents the 90th percentile of the exposure distribution for NNE in consideration of appropriate use of gloves (0.11 µg Ni/cm²), adjusted as described in more detail in the methodology document.

Conclusion on risk characterisation

Further information on the RC for all qualitative hazard conclusions is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is maintained at a very low level and the risk for any adverse health effects is minimised to the technically feasible level. Therefore, risks are adequately controlled.

Furthermore, in consideration of the potential other effects besides mutagenicity, comparison of the ECs in Table 11 with the DNELs calculated for this substance from the reliable repeated dose toxicity data (described in Section 9.0.2.3) results in exposure estimates > 1000-fold lower than the DNELs. This provides reassurance that the estimated exposures pose a negligible risk to human health.