

9.4. Exposure scenario 4: Formulation - Formulation

Market sector: Treatment of surfaces

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

Environment contributing scenario(s):	
Formulation	ERC 2
Worker contributing scenario(s):	
Handling/Transfer of solutions	PROC 8b
Small scale handling/transfer of solutions	PROC 9
Formulation step	PROC 4
Wet cleaning	PROC 8a

9.4.1. Environmental contributing scenario 1: Formulation

9.4.1.1. Conditions of use

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

9.4.1.2. Releases

The GES and associated risk assessment are concerned with releases of Pd to wastewater and air occurring during the formulation of dihydrogen tetrachloropalladate at an industrial facility. It is assumed that wastewater is discharged to freshwater following treatment at a municipal STP. Exposure assessment for the aquatic environment is based on parameter values from the SpERC for formulation of metal compounds¹ ('formulation of metal compounds in other than plastics and paint sectors') and calculation of the maximum tonnage (M_{safe}) of dihydrogen tetrachloropalladate that can be formulated without risk to the environment. The release factor for wastewater in this SpERC is given as '2% before on-site treatment'. However, all sites formulating dihydrogen tetrachloropalladate will have wastewater treatment plants (WWTPs), predominantly using pH adjustment and precipitation. The M_{safe} tonnage for formulation is therefore calculated using a release factor (RF) adjusted to include a WWTP efficiency of 99% (i.e. the RF for water is reduced from 2% to 0.02%).

A summary of the emission characteristics used to quantify the environmental aspects of the generic exposure scenario (GES) for formulation of dihydrogen tetrachloropalladate is detailed below.

¹ <http://www.arche-consulting.be/content/documents/Eurometaux-2.2a-c.v2.1.pdf>

**Dihydrogen
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1. Title	
ES4: Formulation	
Life cycle	Formulation – Formulation
Systematic title based on use descriptor	ERC: ERC 2 Formulation of preparations containing dihydrogen tetrachloropalladate
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Formulation
Systematic title based on use descriptor (environment)	ERC 2 Formulation of preparations
Processes, tasks, activities covered (environment)	Formulation: delivery, mixing, dissolving and packaging
Environmental Assessment Method	Estimates based on adjusted SpERC RFs are used for calculation of the maximum tonnage that can be safely used without risk to the environment
Product characteristics	
Dihydrogen tetrachloropalladate as solid or aqueous solution.	
Environmental assessment is based on the modelled emission of dihydrogen tetrachloropalladate in wastewater discharge and dihydrogen tetrachloropalladate emissions to air.	
Amounts used	
Maximum annual safe use at a site (M_{safe})	5.17 tonnes dihydrogen tetrachloropalladate (2.20 tonnes Pd metal equivalent)
Frequency and duration of use	
Pattern of release to the environment	280 days per year per site (standard for sector; see ES1)
Environment factors not influenced by risk management	
Receiving surface water flow rate	STP: 2,000 m ³ /d (default) Receiving water: 18,000 m ³ /d (default)
Dilution capacity, freshwater	Discharge to freshwater via STP: DF = 10 (default)
Dilution capacity, marine	Not relevant
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:	

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<p>ES 4 Discharge to freshwater via STP: On-site wastewater treatment by chemical precipitation, sedimentation and/or filtration. Efficiency >99 % (sector data)</p> <p>and off-site municipal sewage treatment plant (STP) Efficiency 73.4 % (based on European STP monitoring programme²)</p> <p>Release factor after on-site treatment: 200 g/T (99% treatment WWTP efficiency applied to 2% RF before on-site treatment)</p> <p>Air: Treatment of air emissions by filters, electrostatic precipitation and/or wet scrubbers. (SpERC for 'Formulation of metal compounds') Release factor after on-site treatment: 10 g/T (10% of SpERC RF for air)</p>							
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)		Yes					
Discharge rate of the Municipal STP		2 000 m ³ /d					
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							
Dihydrogen tetrachloropalladate- and other Pd-containing waste is filled into containers and transported to licensed recycling facilities for recovery or disposed of at landfill.							
Conditions and measures related to external recovery of waste							
Dihydrogen tetrachloropalladate- and other Pd-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 Pd emissions]							
ERC 2							
ES 4 Formulation of dihydrogen tetrachloropalladate*							
Compartment	Unit	PNEC	PEC_{regional}	C_{local}	PEC	RCR	Methods for calculation of

² Stutt E, Wilson I, Merrington G & Rothenbacher K (2016) Determining the Removal of Platinum 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

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							environmental concentrations
Discharge to STP	mg Pd/L	1.46 mg/L	1.75×10^{-7} mg/L	2.09×10^{-4} mg/L	2.09×10^{-4} mg/L	1.4×10^{-4}	Adjusted SpERC emission factors applied to Msafe tonnage
Freshwater via STP	mg Pd/L	2.66×10^{-5} mg/L	1.75×10^{-7} mg/L	2.02×10^{-5} mg/L	2.03×10^{-5} mg/L	0.76	
Freshwater sediment via STP	mg Pd/k g w.w.	0.060 mg/kg	3.33×10^{-4} mg/kg	0.011 mg/k g	0.112 mg/kg	0.19	
Terrestrial (all scenarios)	mg Pd/k g w.w.	1.04×10^{-2} mg/kg	1.64×10^{-3} mg/kg	4.40×10^{-8} mg/k g	1.64×10^{-3} mg/kg	0.16	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 Pd equivalent due to the Pd metal PNEC used for assessment.							

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES³

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.

³ Msafe exposure scenarios for downstream use of dihydrogen tetrachloropalladate (2-) are based on the maximum amount of palladium (metal equivalent) that can be safely used in a specific application without an unacceptable level of risk to the environment. It is therefore important to consider the total use of palladium compounds for each specific downstream use at an individual site and where relevant, combine the contribution from each palladium compound if a number of different Pd compounds are used for the same downstream use.

9.4.2. Worker contributing scenario 1: Handling/Transfer of solutions (PROC 8b)

9.4.2.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of substance: Solution	External Tool (MEASE)
• Maximum emission potential of the substance: Very low (Only the highest emission potential (EP) is reported. Lower EPs (e.g. if materials of lower dustiness are being handled in parallel) are thus automatically covered in this assessment.)	External Tool (MEASE)
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	External Tool (MEASE)
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%]	External Tool (MEASE)
Technical and organisational conditions and measures	
• Pattern of use: Non-dispersive use	External Tool (MEASE)
• Pattern of exposure control: Non-direct handling	External Tool (MEASE)
• Contact level: Intermittent	External Tool (MEASE)
Conditions and measures related to personal protection, hygiene and health evaluation	
• Eye protection: Eye protection to be worn to protect from adverse effects to the eyes (Due to the adverse effects of the substance to the eyes, direct contact of the eyes with the substance is to be avoided including hand to eye transfer after touching contaminated surfaces. Suitable eye protection equipment (e.g. goggles or visors) must be worn.)	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from local effects via inhalation (Due to potential adverse effects of the substance to the respiratory tract, 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.)	
• Gloves as precautionary measure: Gloves protecting from local effects to the skin (high hazard) (Due to the potential adverse effects of the	

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	Method
substance to skin, protective gloves according to EN 374 have to be worn at all workplaces. Additionally, face protection is required to be worn as appropriate.)	

9.4.2.2. Exposure and risks for workers

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

Table 1. Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	10 µg/m³ (External Tool (MEASE))	RCR < 0.01
Inhalation, local, long-term		Qualitative (see below)
Inhalation, local, acute		Qualitative (see below)
Dermal, systemic, long-term	3.43 µg/kg bw/day (External Tool (MEASE))	RCR < 0.01
Dermal, local, long-term		Qualitative (see below)
Dermal, local, acute		Qualitative (see below)
Eye, local		Qualitative (see below)
Combined routes, systemic, long-term		RCR < 0.01

Remarks on exposure data

External Tool (MEASE)

- Dermal, systemic, long-term:
For calculation of systemic exposure, the exposure estimate for total dermal loading as obtained in MEASE (reported in mg/day) is divided by a body weight of 70 kg for workers.

Conclusion on risk characterisation

Further information on the risk characterisation for local effects via inhalation, for local dermal effects and local effects to the eyes is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is well below the DNELs and no local effects are expected. Therefore, risks are adequately controlled.

9.4.3. Worker contributing scenario 2: Small scale

handling/transfer of solutions (PROC 9)

9.4.3.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of substance: Solution	External Tool (MEASE)
• Maximum emission potential of the substance: Very low (Only the highest emission potential (EP) is reported. Lower EPs (e.g. if materials of lower dustiness are being handled in parallel) are thus automatically covered in this assessment.)	External Tool (MEASE)
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	External Tool (MEASE)
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%]	External Tool (MEASE)
Technical and organisational conditions and measures	
• Pattern of use: Non-dispersive use	External Tool (MEASE)
• Pattern of exposure control: Direct handling	External Tool (MEASE)
• Contact level: Intermittent	External Tool (MEASE)
Conditions and measures related to personal protection, hygiene and health evaluation	
• Eye protection: Eye protection to be worn to protect from adverse effects to the eyes (Due to the adverse effects of the substance to the eyes, direct contact of the eyes with the substance is to be avoided including hand to eye transfer after touching contaminated surfaces. Suitable eye protection equipment (e.g. goggles or visors) must be worn.)	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from local effects via inhalation (Due to potential adverse effects of the substance to the respiratory tract, 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.)	
• Gloves as precautionary measure: Gloves protecting from local effects to the skin (high hazard) (Due to the potential adverse effects of the substance to skin, protective gloves according to EN 374 have to be worn at all workplaces. Additionally, face protection is required to be worn as appropriate.)	

9.4.3.2. 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 workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	10 µg/m³ (External Tool (MEASE))	RCR < 0.01
Inhalation, local, long-term		Qualitative (see below)
Inhalation, local, acute		Qualitative (see below)
Dermal, systemic, long-term	34.29 µg/kg bw/day (External Tool (MEASE))	RCR < 0.01
Dermal, local, long-term		Qualitative (see below)
Dermal, local, acute		Qualitative (see below)
Eye, local		Qualitative (see below)
Combined routes, systemic, long-term		RCR < 0.01

Remarks on exposure data

External Tool (MEASE)

- Dermal, systemic, long-term:
For calculation of systemic exposure, the exposure estimate for total dermal loading as obtained in MEASE (reported in mg/day) is divided by a body weight of 70 kg for workers.

Conclusion on risk characterisation

Further information on the risk characterisation for local effects via inhalation, for local dermal effects and local effects to the eyes is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is well below the DNELs and no local effects are expected. Therefore, risks are adequately controlled.

9.4.4. Worker contributing scenario 3: Formulation step (PROC 4)

9.4.4.1. Conditions of use

	Method
Product (article) characteristics	

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	Method
• Physical form of substance: Solution	External Tool (MEASE)
• Maximum emission potential of the substance: Very low (Only the highest emission potential (EP) is reported. Lower EPs (e.g. if materials of lower dustiness are being handled in parallel) are thus automatically covered in this assessment.)	External Tool (MEASE)
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	External Tool (MEASE)
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%]	External Tool (MEASE)
Technical and organisational conditions and measures	
• Pattern of use: Non-dispersive use	External Tool (MEASE)
• Pattern of exposure control: Non-direct handling	External Tool (MEASE)
• Contact level: Intermittent	External Tool (MEASE)
Conditions and measures related to personal protection, hygiene and health evaluation	
• Eye protection: Eye protection to be worn to protect from adverse effects to the eyes (Due to the adverse effects of the substance to the eyes, direct contact of the eyes with the substance is to be avoided including hand to eye transfer after touching contaminated surfaces. Suitable eye protection equipment (e.g. goggles or visors) must be worn.)	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from local effects via inhalation (Due to potential adverse effects of the substance to the respiratory tract, 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.)	
• Gloves as precautionary measure: Gloves protecting from local effects to the skin (high hazard) (Due to the potential adverse effects of the substance to skin, protective gloves according to EN 374 have to be worn at all workplaces. Additionally, face protection is required to be worn as appropriate.)	

9.4.4.2. Exposure and risks for workers

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

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Table 3. Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	50 µg/m³ (External Tool (MEASE))	RCR < 0.01
Inhalation, local, long-term		Qualitative (see below)
Inhalation, local, acute		Qualitative (see below)
Dermal, systemic, long-term	3.43 µg/kg bw/day (External Tool (MEASE))	RCR < 0.01
Dermal, local, long-term		Qualitative (see below)
Dermal, local, acute		Qualitative (see below)
Eye, local		Qualitative (see below)
Combined routes, systemic, long-term		RCR < 0.01

Remarks on exposure data

External Tool (MEASE)

- Dermal, systemic, long-term:
For calculation of systemic exposure, the exposure estimate for total dermal loading as obtained in MEASE (reported in mg/day) is divided by a body weight of 70 kg for workers.

Conclusion on risk characterisation

Further information on the risk characterisation for local effects via inhalation, for local dermal effects and local effects to the eyes is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is well below the DNELs and no local effects are expected. Therefore, risks are adequately controlled.

9.4.5. Worker contributing scenario 4: Wet cleaning (PROC 8a)

9.4.5.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of substance: Solution	External Tool (MEASE)
• Maximum emission potential of the substance: Very low (Only the highest emission potential (EP) is reported. Lower EPs (e.g. if materials of lower dustiness are being handled in parallel) are thus automatically covered in this assessment.)	External Tool (MEASE)

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	Method
• Content in preparation: Not restricted [Effectiveness Inhal: 0%; Dermal: 0%]	External Tool (MEASE)
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%]	External Tool (MEASE)
Technical and organisational conditions and measures	
• Pattern of use: Non-dispersive use	External Tool (MEASE)
• Pattern of exposure control: Direct handling	External Tool (MEASE)
• Contact level: Extensive	External Tool (MEASE)
• Immediate removal of splashes: Splashes should be removed immediately before drying of the substance	External Tool (MEASE)
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. [Effectiveness Dermal: 90%]	External Tool (MEASE)
• Eye protection: Eye protection to be worn to protect from adverse effects to the eyes (Due to the adverse effects of the substance to the eyes, direct contact of the eyes with the substance is to be avoided including hand to eye transfer after touching contaminated surfaces. Suitable eye protection equipment (e.g. goggles or visors) must be worn.)	
• Respiratory protective equipment (RPE) as precautionary measure: RPE protecting from local effects via inhalation (Due to potential adverse effects of the substance to the respiratory tract, 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.)	

9.4.5.2. Exposure and risks for workers

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

Table 4. Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	50 µg/m ³ (External Tool (MEASE))	RCR < 0.01

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Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term		Qualitative (see below)
Inhalation, local, acute		Qualitative (see below)
Dermal, systemic, long-term	34.29 µg/kg bw/day (External Tool (MEASE))	RCR < 0.01
Dermal, local, long-term		Qualitative (see below)
Dermal, local, acute		Qualitative (see below)
Eye, local		Qualitative (see below)
Combined routes, systemic, long-term		RCR < 0.01

Remarks on exposure data

External Tool (MEASE)

- Dermal, systemic, long-term:
For calculation of systemic exposure, the exposure estimate for total dermal loading as obtained in MEASE (reported in mg/day) is divided by a body weight of 70 kg for workers.

Conclusion on risk characterisation

Further information on the risk characterisation for local effects via inhalation, for local dermal effects and local effects to the eyes is given in Section 9.0.2.3.

Under the prescribed conditions of use, exposure is well below the DNELs and no local effects are expected. Therefore, risks are adequately controlled.