9.9. Exposure scenario 9: Use at industrial sites - Use of disilver oxide as intermediate in the production of silver or silver compounds

Sector of use: SU 14: Manufacture of basic metals, including alloys

Environment contributing scenario(s):			**SPERC**
CS 1	Use of disilver oxide as intermediate in the production of silver or silver compounds	ERC 6a	Eurometaux SPERC 6a.1.v3
CS 2	Use of disilver oxide as intermediate in the production of silver or silver compounds - no emissions to water	ERC 6a	
Worker contributing scenario(s):			**SWED**
CS 3	Handling of solid inorganic substances at ambient temperature	PROC 26	
CS 4	Reaction	PROC 4	
CS 5	Packaging	PROC 8b	
CS 6	Cleaning and maintenance	PROC 28	

9.9.1. Env CS 1: Use of disilver oxide as intermediate in the production of silver or silver compounds (ERC 6a)

Assessment entity group used for the assessment of this contributing scenario: ERA

9.9.1.1. Conditions of use

Amount used, frequency and duration of use (or from service life)
• Annual use amount at site: <= 24.93 tonnes/year *All the amounts are expressed as Ag as this is the driver for the environmental risk assessment.*
• Daily use amount at site: <= 0.137 tonnes/day *Default number of emission days are derived from a multi-metal background database of measured site-specific release factors collected under the former Directive of New and Existing Substances and REACH 2010 registration dossiers.* *182 days/year is the 10th percentile of reported site-specific number of emission days for 168 sites from production of metal compounds.*
Technical and organisational conditions and measures
• On site treatment of off-air: Electrostatic precipitators or wet electrostatic precipitators or cyclones or fabric/bag filter or ceramic/metal mesh filter according to the BAT Reference Document in the Non-Ferrous Metals Industry *Direct air emissions should be reduced by implementing one or more of the following RMMs (air concentration range for which the RMM is suitable is specified in parenthesis):* *• Electrostatic precipitators using wide electrode spacing: 5 – 15 mg/Nm³* *• Wet electrostatic precipitators: < 5 mg/Nm³* *• Cyclones, but as primary collector: < 50 mg/Nm³* *• Fabric or bag filters: high efficiency in controlling fine particulate (melting): achieve emission values < 5mg/Nm³. Membrane filtration techniques can achieve < 1 mg/Nm³* *• Ceramic and metal mesh filters. PM10 particles are removed: 0.1 mg/Nm³* *Wet scrubbers: < 4 mg/Nm3*
• On site treatment of wastewater: Chemical precipitation or sedimentation or filtration or electrolysis or reverse osmosis or ion exchange according to the BAT Reference Document in the Non-Ferrous Metals Industry (2017) applying minimum xx% removal efficiency *Direct water emissions should be reduced by implementing one or more of the following RMMs:* *• Chemical precipitation: used primarily to remove the metal ions (e.g. the use of Ca(OH)2 to a pH 11: >99% removal efficiency; the use of Fe(OH)3 to a pH 11: 96% removal efficiency)* *• Sedimentation (e.g. Na2S, pH 11, >99% removal efficiency) • Filtration: used as final clarification step (e.g. ultrafiltration, pH 5.1: 93% removal efficiency, nanofiltration: 97% removal efficiency, reverse osmosis, pH*

4-11: 99% removal efficiency) *• Electrolysis: for low metal concentration at about 2 g/L (e.g. electrodialysis: 13% removal efficiency within 2 hours, membrane electrolysis, electrochemical precipitation, pH 4-10, >99% removal efficiency) • Reverse osmosis: extensively used for the removal of dissolved metals; Ion exchange: final cleaning step in the removal of heavy metal from process wastewater (e.g. 90% removal efficiency for clinoptinolite and 100% removal efficiency for synthetic zeolite)* *Following the Integrated Pollution Prevention and Control – BAT Reference note document, the treatment methods are very much dependent on the specific processes and the metals involved. More information can be found in the BAT Reference Document for the Non-Ferrous Metals Industry (2017).*
Conditions and measures related to biological sewage treatment plant
• Biological STP: None [Effectiveness Water: 0%]
Conditions and measures related to external treatment of waste (including article waste)
• Particular considerations on the waste treatment operations: No (low concentration) *Waste includes sludge, filter cakes and solid waste. waste shall be handled according to the Waste Framework Directive and disposed of according to national/local legislation. If the metal content of the waste is elevated, internal or external recovery/recycling is considered.*
Other conditions affecting environmental exposure
• Discharge rate of effluent: >= 2E3 m3/day

9.9.1.2. Releases

The releases have been estimated on the basis of SPERC Eurometaux SPERC 6a.1.v3: Intermediate use of metal compounds
Modification date: 09/09/2021

Description of activities/processes covered by the SPERC

Since this metal SPERC is based on measured data at end-of-pipe on-site, all indicated PROCs are integrated in the release fractions from raw materials handling to cleaning and maintenance.

Product/substance domain:

Substance groups or functions:
SPERC valid for metals with solid water partition coefficient for suspended matter between 1,000 L/kg and 400,000 L/kg.
Included in the metal definition (Eurometaux SPERCs): alkali metals, alkaline earth metals, transition metals, post-transition metals, metalloids and their compounds
Excluded from the metal definition: non-metals, halogens, noble gases and metallo-organic compounds.

Explanation for the release factor to soil:

ERC default

Sub-SPERC Eurometaux SPERC 6a.1g.v3 is used for Ag dissolved:

Explanation for the release factor to water:

After on-site STP.
Realistic worst-case regression line (RF = 10^(1.59 – 1.14 x log(Kd)) of the metal-specific 90th percentile reported site- specific release factors to wastewater for 201 sites from the production of massive metal and metal powder.
A relationship between solid-water partitioning coefficient for suspended matter Kd and the release factor to water can be justified because the Kd expresses the distribution between aqueous phase and suspended matter. Kd is an important parameter impacting the removal efficiency especially in sedimentation and precipitation RMMs but also in on-site runoff, cleaning operations, wet processes, etc

Explanation for the release factor to air:

Release after RMM. The 90th percentile of reported site-specific release factors to air for 145 sites from the production of massive metal and metal powder
The local releases to the environment are reported in the following table.

Table 9.57. Local releases to the environment

Release	Assessment entity	Release factor	Local release rate
Water	Ag dissolved	2E-3%	2.74E-3 kg/day
Air	Ag dissolved	0.03%	0.041 kg/day
Non agricultural soil	Ag dissolved	0.01%	- kg/day

Releases to waste

Release factor to external waste: 2.3 %
The 90th percentile of reported site-specific release factors to solid waste for 62 manufacturing sites covering zinc, nickel, lead, cobalt, cadmium, antimony

9.9.1.3. Exposure and risks for the environment and man via the environment

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table. The exposure estimates have been obtained with EUSES 2.1.2 unless stated otherwise.

Table 9.58. Exposure concentrations and risks for the environment and man via the environment

Protection target	Assessment entity	Exposure concentration	Risk quantification
Fresh water	Ag dissolved	**Local PEC:** 4.16E-5 mg/L RCR = 0.904	Final RCR = 0.904
Sediment (freshwater)	Ag dissolved	**Local PEC:** 7.921 mg/kg dw RCR = 0.018	Final RCR = 0.018
Marine water	Ag dissolved	**Local PEC:** 5.46E-6 mg/L RCR = 6.35E-3	Final RCR < 0.01
Sediment (marine water)	Ag dissolved	**Local PEC:** 1.041 mg/kg dw RCR = 2.38E-3	Final RCR < 0.01
Sewage Treatment Plant	Ag dissolved	**Local PEC:** 0 mg/L RCR = 0	Final RCR < 0.01
Agricultural soil	Ag dissolved	**Local PEC:** 0.098 mg/kg dw RCR = 0.094	Final RCR = 0.094
Man via environment - Inhalation (systemic effects)	Ag dissolved	**Concentration in air:** 5.78E-6 mg/m³ RCR = 3.86E-5	Final RCR < 0.01
Man via environment - Oral	Ag dissolved	**Exposure via food consumption:** 3.84 µg/kg bw/day (Measured data: See section 9.0.3.6) RCR = 0.035	Final RCR = 0.035
Man via environment - combined routes			Final RCR = 0.035

Remarks on measured exposure:

See section 9.0.3.6 for Ag dissolved:
Identity of the substance used: Ag
Explanation: Worst case exposure of 3.84 µg Ag/kg bw/day from food (section 9.0.3.6) was taken forward to the risk characterisation.
The intake via drinking water calculated with CHESAR was 3-4 orders of magnitudes lower compared to the intake via food and has thus not been taken into account.

9.9.2. Env CS 2: Use of disilver oxide as intermediate in the production of silver or silver compounds - no emissions to water (ERC 6a)

Assessment entity group used for the assessment of this contributing scenario: ERA

9.9.2.1. Conditions of use

Amount used, frequency and duration of use (or from service life)
• Annual use amount at site: <= 100 tonnes/year *All the amounts are expressed as Ag as this is the driver for the environmental risk assessment.*
• Daily use amount at site: <= 0.55 tonnes/day *Default number of emission days are derived from a multi-metal background database of measured site-specific release factors collected under the former Directive of New and Existing Substances and REACH 2010 registration dossiers.* *182 days/year is the 10th percentile of reported site-specific number of emission days for 168 sites from production of metal compounds.*
Technical and organisational conditions and measures
• On site treatment of off-air: Electrostatic precipitators or wet electrostatic precipitators or cyclones or fabric/bag filter or ceramic/metal mesh filter according to the BAT Reference Document in the Non-Ferrous Metals Industry *Direct air emissions should be reduced by implementing one or more of the following RMMs (air concentration range for which the RMM is suitable is specified in parenthesis):* *• Electrostatic precipitators using wide electrode spacing: 5 – 15 mg/Nm³* *• Wet electrostatic precipitators: < 5 mg/Nm³* *• Cyclones, but as primary collector: < 50 mg/Nm³* *• Fabric or bag filters: high efficiency in controlling fine particulate (melting): achieve emission values < 5mg/Nm³. Membrane filtration techniques can achieve < 1 mg/Nm³* *• Ceramic and metal mesh filters. PM10 particles are removed: 0.1 mg/Nm³* *Wet scrubbers: < 4 mg/Nm3*
• The substance should not be released to water *Emissions to surface water or to the sewage system are not allowed in this scenario*
Conditions and measures related to biological sewage treatment plant
• Biological STP: None [Effectiveness Water: 0%]
Conditions and measures related to external treatment of waste (including article waste)
• Particular considerations on the waste treatment operations: No (low concentration) *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 silver content of the waste is elevated enough, internal or external recovery/recycling might be considered.* *Appropriate waste codes: 06 05 02*, 08 01 11, 08 03 12*, 09 01 01*, 09 01 03*, 09 01 04*, 09 01 05*, 09 01 06*, 09 01 13*, 10 06 06*, 10 07 01, 10 07 02, 10 07 03, 10 07 04, 10 07 05, 11 01 09*, 15 01 10*, 15 02 02*, 16 01 18, 16 03 03*, 16 08 01, 16 11 04* *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 silver is recycled for almost a 100%* *A detailed assessment has been performed on modelled and measured data and is reported in the Waste report (ARCHE, 2013)*
Other conditions affecting environmental exposure
• Receiving surface water flow rate: >= 1.8E4 m3/day
• Discharge rate of effluent: >= 2E3 m3/day

9.9.2.2. Releases

The local releases to the environment are reported in the following table. Note that the releases reported do not account for the removal in the modelled biological STP.

Table 9.59. Local releases to the environment

Release	Assessment entity	Release estimation method	Explanations
Water	Ag dissolved	Estimated release	**Release factor before on site RMM:** 0%

Release	Assessment entity	Release estimation method	Explanations
		factor	**Release factor after on site RMM:** 0% **Local release rate:** 0 kg/day **Explanation:** Several companies have reported that they do not have emissions to water.
Air	Ag dissolved	Estimated release factor (based on SPERC Eurometaux SPERC 6a.1.v3)	**Release factor before on site RMM:** 0.03% **Release factor after on site RMM:** 0.03% **Local release rate:** 0.165 kg/day **Explanation:** Release after RMM. The 90th percentile of reported site-specific release factors to air for 145 sites from the production of massive metal and metal powder
Non agricultural soil	Ag dissolved	Estimated release factor	**Release factor after on site RMM:** 0% **Explanation:** No direct release to soil.

9.9.2.3. Exposure and risks for the environment and man via the environment

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table. The exposure estimates have been obtained with EUSES 2.1.2 unless stated otherwise.

Table 9.60. Exposure concentrations and risks for the environment and man via the environment

Protection target	Assessment entity	Exposure concentration	Risk quantification
Fresh water	Ag dissolved	**Local PEC:** 6.06E-6 mg/L RCR = 0.132	Final RCR = 0.132
Sediment (freshwater)	Ag dissolved	**Local PEC:** 1.155 mg/kg dw RCR = 2.64E-3	Final RCR < 0.01
Marine water	Ag dissolved	**Local PEC:** 1.91E-6 mg/L RCR = 2.22E-3	Final RCR < 0.01
Sediment (marine water)	Ag dissolved	**Local PEC:** 0.364 mg/kg dw RCR = 8.31E-4	Final RCR < 0.01
Sewage Treatment Plant	Ag dissolved	**Local PEC:** 0 mg/L RCR = 0	Final RCR < 0.01
Agricultural soil	Ag dissolved	**Local PEC:** 0.106 mg/kg dw RCR = 0.101	Final RCR = 0.101
Man via environment - Inhalation (systemic effects)	Ag dissolved	**Concentration in air:** 2.29E-5 mg/m³ RCR = 1.53E-4	Final RCR < 0.01
Man via environment - Oral	Ag dissolved	**Exposure via food consumption:** 3.84 µg/kg bw/day (Measured data: See section 9.0.3.6) RCR = 0.035	Final RCR = 0.035
Man via environment - combined routes			Final RCR = 0.035

Remarks on measured exposure:

See section 9.0.3.6 for Ag dissolved:
Identity of the substance used: Ag
Explanation: Worst case exposure of 3.84 µg Ag/kg bw/day from food (section 9.0.3.6) was taken forward to the risk characterisation.

The intake via drinking water calculated with CHESAR was 3-4 orders of magnitudes lower compared to the intake via food and has thus not been taken into account.

9.9.3. Worker CS 3: Handling of solid inorganic substances at ambient temperature (PROC 26)

Assessment entity group used for the assessment of this contributing scenario: HHRA

9.9.3.1. Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01
• Physical form of the used product: Solid (material with high dustiness)	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Generic local exhaust ventilation: Lower confidence limit (industrial use) [Effectiveness Inhalation: 78%] *Standard efficiency* Inhalation explanation: *Efficiency for industrial use*	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%)	MEASE 1.02.01
• Respiratory protection: Yes (APF >= 10)	MEASE 1.02.01
• Face/eye protection: Eye protection	
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.9.3.2. Exposure and risks for workers

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

Table 9.61. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.44 mg/m³ (MEASE 1.02.01) RCR = 0.338	Final RCR = 0.338
Dermal, systemic, long term	Disilver oxide	0.141 mg/kg bw/day (MEASE 1.02.01) RCR = 0.307	Final RCR = 0.307
Combined routes, systemic, long-term			Final RCR = 0.645

Risk characterisation

Qualitative risk characterisation (Eye, local):
See section 9.0.4.2

9.9.4. Worker CS 4: Reaction (PROC 4)

Assessment entity group used for the assessment of this contributing scenario: HHRA

9.9.4.1. Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01
• Physical form of the used product: Liquid, including paste/slurry/suspension *'Aqueous solution' was selected in MEASE to reflect the very low fugacity.*	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Local exhaust ventilation: No	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%)	MEASE 1.02.01
• Respiratory protection: No	MEASE 1.02.01
• Face/eye protection: Eye protection	
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.9.4.2. Exposure and risks for workers

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

Table 9.62. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.05 mg/m³ (MEASE 1.02.01) RCR = 0.038	Final RCR = 0.038
Dermal, systemic, long term	Disilver oxide	0.034 mg/kg bw/day (MEASE 1.02.01) RCR = 0.075	Final RCR = 0.075
Combined routes, systemic, long-term			Final RCR = 0.113

Risk characterisation

Qualitative risk characterisation (Eye, local):
See section 9.0.4.2

9.9.5. Worker CS 5: Packaging (PROC 8b)

Assessment entity group used for the assessment of this contributing scenario: HHRA

9.9.5.1. Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01

	Method
• Physical form of the used product: Liquid, including paste/slurry/suspension *'Aqueous solution' was selected in MEASE to reflect the very low fugacity.*	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Local exhaust ventilation: No	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%)	MEASE 1.02.01
• Respiratory protection: No	MEASE 1.02.01
• Face/eye protection: Eye protection	
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.9.5.2. Exposure and risks for workers

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

Table 9.63. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.01 mg/m³ (MEASE 1.02.01) RCR = 7.69E-3	Final RCR < 0.01
Dermal, systemic, long term	Disilver oxide	0.034 mg/kg bw/day (MEASE 1.02.01) RCR = 0.075	Final RCR = 0.075
Combined routes, systemic, long-term			Final RCR = 0.082

Risk characterisation

Qualitative risk characterisation (Eye, local):
See section 9.0.4.2

9.9.6. Worker CS 6: Cleaning and maintenance (PROC 28)

Assessment entity group used for the assessment of this contributing scenario: HHRA

9.9.6.1. Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01
• Physical form of the used product: Solid (material with high dustiness) *Dust with high emission potential has been selected as a worst case (compared to aqueous solution).*	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01

	Method
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Generic local exhaust ventilation: Lower confidence limit (industrial use) [Effectiveness Inhalation: 78%] *Standard efficiency* Inhalation explanation: *Efficiency for industrial use*	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%)	MEASE 1.02.01
• Respiratory protection: Yes (APF >= 20)	MEASE 1.02.01
• Face/eye protection: Eye protection	
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.9.6.2. Exposure and risks for workers

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

Table 9.64. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.55 mg/m³ (MEASE 1.02.01) RCR = 0.423	Final RCR = 0.423
Dermal, systemic, long term	Disilver oxide	0.069 mg/kg bw/day (MEASE 1.02.01) RCR = 0.149	Final RCR = 0.149
Combined routes, systemic, long-term			Final RCR = 0.572

Remarks on exposure data from external estimation tools:

MEASE 1.02.01 for Disilver oxide:
Explanation:
As the MEASE 1.02.01 exposure estimation tool for workers does not provide exposure estimates for PROC 28, PROC 8a has been used instead as the input parameter assuming that there are similarities in the exposure.

Risk characterisation

Qualitative risk characterisation (Eye, local):
See section 9.0.4.2