



9.6. Exposure scenario 6: Use at industrial sites - Use of silver metal in electronics, contact materials and electroplating

Product category used: PC 1: Adhesives, Sealants; PC 7: Base metals and alloys; PC 9a: Coatings and Paints, Thinners, paint removers; PC 14: Metal surface treatment products; PC 18: Ink and Toners

Sector of use: SU 14: Manufacture of basic metals, including alloys; SU 16: Manufacture of computer, electronic and optical products, electrical equipment; SU 17: General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment.; SU 24: Scientific research and development

Environment contributing scenario(s):		
CS 1	Use of silver metal in electronics, contact materials and electroplating	ERC 5
Worker contributing scenario(s):		
CS 2	Raw material handling	PROC 3, PROC 26, PROC 4, PROC 5, PROC 8a, PROC 8b, PROC 9
CS 3	Handling of solutions/suspensions	PROC 8b, PROC 15, PROC 9
CS 4	Processes in closed systems	PROC 1, PROC 2
CS 5	Mechanical treatment	PROC 14, PROC 21, PROC 24
CS 6	Hot processes	PROC 22, PROC 23, PROC 25
CS 7	Wet processes	PROC 2, PROC 13, PROC 27b, PROC 3, PROC 4
CS 8	Finishing	PROC 14, PROC 10, PROC 21, PROC 24
CS 9	Production and handling of powders	PROC 26, PROC 27a, PROC 27b
CS 10	Packaging of massive objects	PROC 21
CS 11	Cleaning and maintenance	PROC 8a, PROC 26, PROC 28

Subsequent service life exposure scenario(s):

ES17: Service life (worker at industrial site) - Processing of electronics, contact materials and electroplating articles containing silver metal

9.6.1. Env CS 1: Use of silver metal in electronics, contact materials and electroplating (ERC 5)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form

9.6.1.1. Conditions of use

Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Daily use amount at site: $\leq 4.6E-3$ tonnes/day <i>This value is the highest reported daily use of silver by 4 companies.</i> Annual use amount at site: ≤ 1.15 tonnes/year <i>Based on the median number of emission days (251 d/y) reported by 7 companies</i>
Technical and organisational conditions and measures
<ul style="list-style-type: none"> The substance should not be released to air <i>Emissions to air are not allowed in this scenario</i>



<ul style="list-style-type: none"> 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 <p><i>Direct water emissions should be reduced by implementing one or more of the following RMMs:</i></p> <ul style="list-style-type: none"> <i>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)</i> <i>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)</i> <i>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)</i> <p><i>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).</i></p>
Conditions and measures related to biological sewage treatment plant
<ul style="list-style-type: none"> Biological STP: None [Effectiveness Water: 0%]
Conditions and measures related to external treatment of waste (including article waste)
<ul style="list-style-type: none"> Particular considerations on the waste treatment operations: No (low concentration) <p><i>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.</i></p> <p><i>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</i></p> <p><i>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%</i></p> <p><i>A detailed assessment has been performed on modelled and measured data and is reported in the Waste report (ARCHE, 2013)</i></p>
Other conditions affecting environmental exposure
<ul style="list-style-type: none"> Receiving surface water flow rate: $\geq 1.8E4$ m³/day Discharge rate of effluent: $\geq 2E3$ m³/day

9.6.1.2. 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 9.25. Local releases to the environment

Release	Assessment entity	Release estimation method	Explanations
Water	Silver in powder form	Estimated release factor	<p>Release factor before on site RMM: 0.018%</p> <p>Release factor after on site RMM: 0.018%</p> <p>Local release rate: 8.28E-4 kg/day</p> <p>Explanation:</p> <p>3 companies reported no emissions to water, another 3 reported emissions to water. The maximum value from these emissions was selected.</p>
Air	Silver in powder form	Estimated release factor	<p>Release factor before on site RMM: 0%</p> <p>Release factor after on site RMM: 0%</p> <p>Local release rate: 0 kg/day</p>



Release	Assessment entity	Release estimation method	Explanations
			Explanation: 5 out of 7 companies reported no release to air, as silver is bonded in electroplating bath or silver is in finished component. The other two companies have provided no data.
Non agricultural soil	Silver in powder form	Estimated release factor	Release factor after on site RMM: 0% Explanation: No direct release to soil.

Releases to waste

Release factor to external waste: 0 %

A detailed assessment has been performed on modelled and measured data and is reported in the Waste report (ARCHE, 2013)

9.6.1.3. 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 9.26. Exposure concentrations and risks for the environment and man via the environment

Protection target	Assessment entity	Exposure concentration	Risk quantification
Fresh water	Silver in powder form	Local PEC: 1.68E-5 mg/L RCR = 0.42	Final RCR = 0.42
Sediment (freshwater)	Silver in powder form	Local PEC: 3.199 mg/kg dw RCR = 7.3E-3	Final RCR < 0.01
Marine water	Silver in powder form	Local PEC: 2.98E-6 mg/L RCR = 3.47E-3	Final RCR < 0.01
Sediment (marine water)	Silver in powder form	Local PEC: 0.568 mg/kg dw RCR = 1.3E-3	Final RCR < 0.01
Sewage Treatment Plant	Silver in powder form	Local PEC: 0 mg/L RCR = 0	Final RCR < 0.01
Agricultural soil	Silver in powder form	Local PEC: 0.096 mg/kg dw RCR = 0.068	Final RCR = 0.068

9.6.2. Worker CS 2: Raw material handling (PROC 3, PROC 26, PROC 4, PROC 5, PROC 8a, PROC 8b, PROC 9)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.3. Worker CS 3: Handling of solutions/suspensions (PROC 8b, PROC 15, PROC 9)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.4. Worker CS 4: Processes in closed systems (PROC 1, PROC 2)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).



9.6.5. Worker CS 5: Mechanical treatment (PROC 14, PROC 21, PROC 24)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.6. Worker CS 6: Hot processes (PROC 22, PROC 23, PROC 25)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.7. Worker CS 7: Wet processes (PROC 2, PROC 13, PROC 27b, PROC 3, PROC 4)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.8. Worker CS 8: Finishing (PROC 14, PROC 10, PROC 21, PROC 24)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.9. Worker CS 9: Production and handling of powders (PROC 26, PROC 27a, PROC 27b)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.10. Worker CS 10: Packaging of massive objects (PROC 21)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).

9.6.11. Worker CS 11: Cleaning and maintenance (PROC 8a, PROC 26, PROC 28)

Assessment entity group used for the assessment of this contributing scenario: Silver in powder form
Exposure assessment and risk characterisation are not required (see scope under 9.0.4).