9.4 Industrial use of silver chloride emulsion in the photographic industry

Exposure Scenario Format (1) addressing uses carried out by workers				
1. Title				
Free short title	Industrial use of silver chloride emulsion in the photographic industry			
Systematic title based on use descriptor	SU6b (appropriate PROCs and ERCs are given in Section 2 below)			
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described in Section 2 below.			
Assessment Method	The assessment of occupational exposure is based on the exposure assessment tool MEASE.			
2. Operational conditions and risk management measures				
Process category (PROC)	**REACH definition**	**Involved tasks**	**ERC**	**REACH description**
PROC 1	Use in closed process, no likelihood of exposure	Processes for which the exposure potential is driven by the level of containment rather than the process itself.	5	Industrial use resulting in inclusion into or onto a matrix
PROC 3	Use in closed batch process (synthesis or formulation)			
PROC 4	Use in batch and other process (synthesis) where opportunity for exposure arises			
PROC 5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)	mixing		
PROC 8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities	cleaning (i.e. removal of splashes)		
PROC 8b	Transfer of substance or preparation (charging/ discharging) from/to vessels/large containers at dedicated facilities	handling of substances		
PROC 9	Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	handling of substances		
PROC 13	Treatment of articles by dipping and pouring	immersion operations, dipping, coating		
PROC 21	Low energy manipulation of substances bound in materials and/or articles	manual cutting, handling		

2.1 Control of workers exposure

Product characteristics

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. To determine the dustiness of a substance, a dustiness test may be performed. The rotating drum (modified Heubach) method can be used, to reflect potential dustiness during handling of a substance. In hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. Although handling of aqueous solutions is usually associated with a very low emission potential, the spraying of aqueous solutions is assumed to be involved with medium emission. Further information can be found in the glossary of the MEASE tool (www.ebrc.de/mease.html).

Process category (PROC)	Use in preparation	Content in preparation	Physical form*	Emission potential
PROC 1	not restricted		aqueous solution	very low
PROC 3	not restricted		aqueous solution	very low
PROC 4	not restricted		aqueous solution	very low
PROC 5	not restricted		aqueous solution	very low
PROC 8a	not restricted		aqueous solution	very low
PROC 8b	not restricted		aqueous solution	very low
PROC 9	not restricted		aqueous solution	very low
PROC 13	not restricted		aqueous solution	very low
PROC 21	not restricted		massive object	very low

*The physical forms “aqueous solution” and “massive object” are used as surrogates to reflect the very low exposure potential of the crystals in the gelatine solution (“aqueous solution”) and the coated paper/film articles (“massive object”).

Amounts used

The actual tonnage handled/used per shift is not explicitly considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Process category (PROC)	Duration of exposure (per shift/day)
All nominated processes	not restricted (480 minutes)

Human factors not influenced by risk management

The shift breathing volume covering all process steps is assumed to be 10 m^3/shift (8 hours).

Technical conditions and measures at process level (source) to prevent release

Process category (PROC)	Level of containment	Level of segregation
PROC 1	closed process	not required
PROC 3	closed batch process	not required
All other nominated processes	Risk management measures at the process level (e.g. containment or segregation of the emission source) are generally not required in these processes.	

Technical conditions and measures to control dispersion from source towards the worker

Process category (PROC)	Level of separation	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
All nominated processes	no separation required	not required	na	-

Organisational measures to prevent /limit releases, dispersion and exposure

General good occupational hygiene practices are required to ensure safe handling of the substance. These include (i) measures to avoid any contamination of private households via the work-home-interface (e.g. shower and change clothes at end of work shift), (ii) good housekeeping practices in the workplace (i.e. regular cleaning with suitable cleaning devices and immediate cleaning in case of splashes and overspill), and (iii) measures to minimise inadvertent ingestion exposure (e.g. no eating and smoking in the workplace). In general, inhalation and ingestion of the substance should be avoided. Certified working clothing and shoes should be worn during work. In addition, the following principles should be followed: (i) ensure good general ventilation in the workplace, and (ii) do not blow dust (including dust remaining from dried splashes) off with compressed air. Regular training of workers in workplace hygiene practice and proper use of personal protective equipment is required.

Conditions and measures related to personal protection, hygiene and health evaluation				
Process category (PROC)	**Specification of respiratory protective equipment (RPE)**	**RPE efficiency (assigned protection factor, APF)**	**Specification of gloves**	**Further personal protective equipment (PPE)**
All nominated processes	not required	na	According to SCOEL, local dermal effects were not observed if workers operated in compliance with the inhalation OEL and direct contact with the substance was omitted. The use of gloves is obligatory if direct dermal contact with the substance cannot be excluded. In this case, protective gloves according to EN 374 should be worn and have to be changed according to manufacturer's information or when damaged, whatever is the earlier.	standard working clothes (overall) and safety shoes

2.2 Control of environmental exposure

Product characteristics

Photographic emulsion

Amounts used

Maximum site tonnage 61 tpa (as Ag)

Frequency and duration of use

Continuous use, 365 days/year

Monitored Emissions

Yes

Annual measured tonnage emitted to air/water

Not applicable

Environment factors not influenced by risk management

Default data for receiving water and for the municipal sewage treatment plant are 18 000 m3/d and 2000 m3/d, respectively (resulting dilution factor to the receiving water 10).

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Assumed waste water goes to sewage treatment works in local freshwater assessment.

Modelled release factors to air 0.06%, water 0.0055% before STP, soil 0%.

Conditions and measures related to municipal sewage treatment plant

EUSES default STP with primary settler with effluent discharge rate 2000m3/d, serving 10000 inhabitants. Zero degradation assumed. Partitioning: 80.1% to sludge, 19.9 % to water calculated based on measured partition coefficients. Sludge assumed to be spread to agricultural land.

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 silver content of the waste is elevated enough, internal or external recovery/recycling might be considered.

Fraction of daily/annual use *expected in waste: 0%*

Appropriate waste codes: *09 01 04*, 09 01 05*, 09 01 06*, 09 01 07, 09 01 08, 19 08 11**

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, 2012)

Conditions and measures related to external recovery of waste

Waste generated should be recycled into the manufacturing system.

The focus of the silver industry is on the minimisation of waste by optimising the process and by utilizing residues and wastes as far as possible. The residues arising from different stages of the production process are therefore used as raw materials for other processes and an extensive network of metallurgical operators has been established for many years to increase the recovery of metals and eliminate the quantities of waste for disposal.

With regards to the end of life, silver is fully recyclable and the silver content in the end of life material often determines the value of the waste.

3. Exposure estimation and reference to its source

Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For inhalation exposure, the RCR is based on a DNEL (long-term, local effects and systemic effects) for silver chloride of 0.13 mg/m^3 (corresponding to 0.1 mg Ag/m³). This DNEL reflects the available indicative Occupational Exposure Limit (OEL) for poorly soluble silver compounds. A dermal DNEL was not derived as a threshold could not be derived for local effects. However, according to SCOEL, local dermal effects were not observed if workers operated in compliance with the inhalation OEL and direct contact with the substance was omitted. Thus, workers are sufficiently protected if operating in compliance with the inhalation DNEL of the substance and direct contact of the substance is omitted (protection against deposition of airborne dust on skin). The use of gloves is obligatory if direct dermal contact with the substance cannot be excluded (including protection against contaminated surfaces).

Process category (PROC)	Method used for inhalation exposure assessment (refer to introduction)	Inhalation exposure estimate (RCR)
PROC 1	MEASE	0.001 mg/m³ (0.008)
PROC 3	MEASE	0.01 mg/m³ (0.08)
PROC 4	MEASE	0.05 mg/m³ (0.38)
PROC 5	MEASE	0.05 mg/m³ (0.38)
PROC 8a	MEASE	0.05 mg/m³ (0.38)
PROC 8b	MEASE	0.01 mg/m³ (0.08)
PROC 9	MEASE	0.01 mg/m³ (0.08)
PROC 13	MEASE	0.01 mg/m³ (0.08)
PROC 21	MEASE	0.05 mg/m³ (0.38)

Environmental emissions

Environmental modelling was carried out using equations in ECHA R.16

Local PEC

Air mg/m^3 (RCR)	Fresh water mg/L (RCR)	Sediment freshwater mg/kg wwt (RCR)	Soil mg/kg wwt (RCR)	STP mg/L (RCR)
2.79E-05 (NA)	2.98E-05 (0.745)	5.071 (0.053)	0.0903 (0.072)	9.1E-04 (0.037)

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

Occupational exposure

The downstream user (DU) works inside the boundaries set by the ES if the proposed operational conditions (OCs) and risk management measures (RMMs) as described in the exposure scenario (ES) are met (including substance/product characteristics). If the DU's conditions slightly deviate (such deviations are specified below) from the conditions as described in the ES, the DU may either inform the supplier of the substance to reflect the DU's conditions in a modified exposure scenario or has to ensure his slightly modified OCs and implemented RMMs are adequate. Depending on the basis for the exposure assessment (EA) conducted for the ES, this needs to be done in different ways:

Use of measured data as basis for assessment: If the EA in the ES is based on measured data, the same approach can be used at DU level. Please note that 6 measurements per workplace are required for an EA as a minimum. Depending on the variability of the data sets (expressed as the geometric standard deviation) and the level of the resulting risk characterisation ratio (RCR), additional measurements may be required. Only measurements of personal exposure of the inhalable fraction of airborne dust (according to EN 481) should be used. The exposure data shall either be applicable to the length of a specific task to be assessed or to a full-shift (i.e. sampled over a duration of at least 120 min) if the task to be assessed is conducted for a significant portion of the work shift. From the exposure data set the 90th percentile is to be used as a reasonable worst case (RWC) estimate for comparison with the relevant DNEL. RPE may be taken into account by applying the assigned protection factor applicable to the equipment used as given in EN 529:2005.

It is noted that deviations from the ES are only allowed for the efficacy of installed RMMs (but not the type of RMM), exposure duration and personal protective equipment used.

Use of exposure models: If the EA in the ES is based on modelled data, the same model can be used to justify specific slight deviations from the conditions as described. All parameters needed to run the exposure estimation tool MEASE (available on www.ebrc.de/mease.html) can be found in the ES. It is noted that the installation of the described RMMs is mandatory and that exclusively the modification of the used PPE is allowed as deviation. The only parameters which may therefore be modified in the MEASE-calculation are consequently exposure duration, efficacy of the installed RMMs and PPE.

Generic to both assessment bases: Safe use is demonstrated, if the calculated exposure level is below the relevant DNEL (RCR <1). It is noted that smaller RCRs provide additional margin of safety and should therefore be envisaged.

$DNEL_{inhalation}$: 0.13 mg/m³ (as silver chloride, corresponding to 0.1 mg Ag/m³)

Environmental emissions

The manufacturer works inside the boundaries set by the ES if:
A) Either the proposed risk management measures as described above are met or
B) The manufacturer can demonstrate on his own that his operational conditions and implemented risk management measures are adequate. In case the conditions changed (e.g. increase in production volume) he needs to demonstrate safe use by showing that they limit the environmental exposure to a level below one of the following options:

1. *In case the manufacturer has measured ambient data in the receiving environment in accordance to the REACH guidance on monitoring data*

   PNECfreshwater: 0.04 µg Ag/L (Soluble Ag)
   PNECsediment freshwater: 438 mg Ag/kg dwt
   PNECsoil: 1.24 mg Ag/kg wwt
   PNECSTP: 0.025 mg Ag/L (Soluble Ag)

2. *In the event the manufacturer has measured data available but not exactly those required as per REACH guidance, the manufacturer can still compare effluent concentrations with the following default emissions calculated for the default ES described above:*

   Concentration in untreated waste water released to freshwater STP must be < 5 µg Ag/l to ensure that the risk characterisation ratio does not exceed 1.

   The manufacturer may make use of an appropriate scaling tool such as MetalEUSES (free download: http://www.arche-consulting.be/Metal-CSA-toolbox/duscaling-tool) to estimate the associated exposure for other parameters than the default ones included here above to demonstrate safe use under this specific scenario or situation.

3. *In case no safe use can be demonstrated under 1 or 2 above based on monitoring data, but the manufacturer has knowledge on emitted annual or daily loads, he can compare its emission to water to the emission ratio listed below:*

   The RCR will be equal to or lower than those stated above if they emit less than 0.009 kg Ag/day to on site or off site waste water treatment works (equivalent to 0.0018 kg Ag/day to the receiving water).

4. *In case the manufacturer does not have emission or ambient measured info he can use the Metal EUSES scaling tool (free download: http://www.arche-consulting.be/Metal-CSA-toolbox/duscaling-tool) to estimate the associated exposure for other parameters than those included here above to demonstrate safe use under this specific scenario or situation.*