1. Title GES 22 Thin film deposition by evaporation technique	Version 6, 2015
Life cycle	End use - DU of Ni metal
Free short title	Evaporative processes in semi-conductor industry
Systematic title based on use descriptor	SU: SU 3 Industrial use PC: Not relevant ERC: ERC 7 Industrial use of substances in closed systems SPERC Industrial use: shaping PROC: PROC 1 Use in closed process, no likelihood of exposure PROC 0 Cleaning and maintenance
Processes, tasks, activities covered (environment)	Evaporative processes in semi-conductor and optics industry
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 20.1: PROC 1: Deposition of Ni Contributing exposure scenario ES 20.2: PROC 0: Cleaning and maintenance
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Thin film deposition by evaporation technique
Systematic title based on use descriptor (environment)	SPERC Industrial use: shaping
Processes, tasks, activities covered (environment)	Nickel is evaporated in a vacuum and re-deposited on the surface being coated
Environmental Assessment Method	Estimation of local concentrations based on the use of SPERC for Industrial use: shaping and measured regional concentrations are used for calculation of PEC for the terrestrial compartment
Product characteristics	
Solid, High purity metallic Ni (99.5%) Vapour during evaporation process in closed chamber	
Amounts used	
Maximum daily use at a site	Typically 100 g (range: 20-500g per coating equipment in a 7x24 operation; number of coating equipment per site using the same process: 1-10)
Maximum annual use at a site	Not given
Frequency and duration of use	
Pattern of release to the environment	
Environment factors not influenced by risk management	
Receiving surface water flow rate	Not relevant
Dilution capacity, freshwater	Not relevant
Dilution capacity, marine	Not relevant
Other given operational conditions affecting environmental exposure	
Process entirely enclosed. The quantities of Ni used are extremely small. No wastewater emissions. Possible releases to work environment expected to be <0.001 mgm^{-3}, thus possible releases to air is minimal. Release factor after on-site treatment for processing: 30 g/T (SPERC Industrial use: shaping)	
Technical conditions and measures at process level (source) to prevent release	
Process entirely enclosed	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Not given	
Organizational measures to prevent/limit release from site	
None	
Conditions and measures related to municipal sewage treatment plant	
Municipal Sewage Treatment Plant (STP)	Not relevant
Discharge rate of the Municipal STP	Not relevant
Incineration of the sludge of the Municipal STP	Not relevant

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

Fraction of daily/annual use expected in waste:

- Nickel producers = 0.05 %
- DU: stainless steel and alloy steels = 0.6 %
- DU: nickel alloys, copper alloys, foundry, batteries, catalysts, chemicals, dyes and others = 0.5 %
- DU: Plating = 3%

Appropriate waste codes:

01 03 07*, 02 01 10*, 06 03 13*, 06 03 15*, 06 04 05*, 06 05 02*, 10 08 04, 10 08 08*, 10 08 09, 10 08 15*, 10 08 16, 10 10 03, 10 10 05*, 10 10 07*, 10 10 09*, 10 10 10, 10 10 11*, 11 02 07*, 12 01 03*, 12 01 04, 15 01 04*, 15 01 10*, 16 01 04*, 16 01 06*, 16 01 08*, 16 06 02*, 16 06 05, 16 08 02*, 16 08 03*, 17 04 07*, 17 04 09*, 19 09 04*, 19 10 02*, 19 12 03*

Suitable disposal: Keep separate and dispose of to either

- Hazardous waste incineration operated according to Council Directive 2008/98/EC on waste, Directive 2000/76/EC on the incineration of waste and the Reference Document on the Best Available Techniques for Waste Incineration of August 2006.
- Hazardous landfill operated under Directive 1999/31/EC.

Conditions and measures related to external recovery of waste

Shredders pre-treating metal wastes should have a maximum release factors to air of 0.0015 after RMM and no releases to water and soil.

Qmax, local(shredding)=26kg Ni/day

(Note: This Qmax, local for shredders is based on the existing information at the moment of the update. It will be reviewed when new information is available from the BREF for shredding)

2.2 Control of workers exposure for contributing exposure scenario 22.1

Deposition of Nickel

Workers related free short title	Thin film deposition by evaporation technique
Use descriptor covered	PROC 1 Use in closed process, no likelihood of exposure
Processes, tasks, activities covered	Deposition of Ni
Assessment Method	Estimation of exposure based on qualitative assessment

Product characteristic

Solid, high purity metallic Ni (99.5%)
Vapour during evaporation process in closed chamber

Amounts used

A few to 100 g per shift per coating equipment (depends on specific equipment and process parameters)

Frequency and duration of use/exposure

8 hour shifts.

Human factors not influenced by risk management

Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	Not relevant
Body weight	Not relevant

Other given operational conditions affecting workers exposure

Working in shifts
Quantities of Ni used are extremely small
Good workplace hygiene practice

Technical conditions and measures at process level (source) to prevent release	
Processes shall be entirely enclosed	
Technical conditions and measures to control dispersion from source towards the worker	
None	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Dermal: appropriate gloves are required during loading and unloading operations	
2.3 Control of workers exposure for contributing exposure scenario 22.2	
Cleaning and maintenance	
Workers related free short title	Thin film deposition by evaporation technique
Use descriptor covered	PROC 0 Cleaning and maintenance
Processes, tasks, activities covered	Cleaning and maintenance
Assessment Method	Estimation of exposure based on qualitative assessment
Product characteristic	
Solid, high purity metallic Ni (99.5%)	
Amounts used	
Not relevant	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	Not relevant
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
Vapour deposition chamber cleaned manually (protective shields (coated with the respective materials during the process) are removed and cleaned by sandblasting techniques)	
Technical conditions and measures at process level (source) to prevent release	
Processes shall be entirely enclosed	
Technical conditions and measures to control dispersion from source towards the worker	
None	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
RPE and appropriate gloves are required during cleaning and maintenance operations.	
3. Exposure and risk estimation	

Environment

SPERC Industrial use: shaping
Thin film deposition by evaporation technique

Compartment	Unit	PNEC	$PEC_{Regional}$	C_{local}	PEC	RCR	Methods for calculation of environmental concentrations
Freshwater	µg Ni/L	7.1	2.9				No wastewater emission
Sediment	mg Ni/kg	136	33.5				No wastewater emission
Terrestrial	mg Ni/kg	29.9	16.2	<0.01	16.20	0.54	esimated values, Tier 3-RWC

Workers

ES 22.1
PROC 1: Deposition of Ni

	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					

Acute systemic	mg Ni /kg/day	-	NR		
Acute local	mg Ni /cm²/day	-	NR		
Long-term systemic	mg Ni /kg/day	-	NR		
Long-term local	mg Ni /cm²/day	0.035	$5*10^{-6}$	0.001	Estimated for specialist clean room, no direct dermal contact with Ni, the dermal exposure was estimated as being close to the limit of detection
Inhalation					
Acute local	mg Ni /m³	4.0	0.01	0.0025	Estimated as 10 x 75th percentile long-term average exposure to allow for the uncertainty in the estimate of shift mean exposure
Long-term systemic and local	mg Ni /m³	0.05	0.001	0.02	Estimated 75th percentile long-term exposure based on expert judgement in the absence of measurement data, the exposure estimates take account of the clean room standards of cleanliness associated with this process
ES 22.2 PROC 0: Cleaning and maintenance					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni /kg/day	-	NR		
Acute local	mg Ni /cm²/day	-	NR		
Long-term systemic	mg Ni /kg/day	-	NR		
Long-term local	mg Ni /cm²/day	0.035	$5*10^{-6}$	0.001	Estimated for specialist clean room, no direct dermal contact with Ni, the dermal exposure was estimated as being close to the limit of detection
Inhalation					
Acute local	mg Ni /m³	4.0	0.01	0.0025	Estimated as 10 x 75th percentile long-term average exposure to allow for the uncertainty in the estimate of shift mean exposure
Long-term systemic and local	mg Ni /m³	0.05	0.001	0.02	Estimated 75th percentile long-term exposure based on expert judgement in the absence of measurement data, the exposure estimates take account of the clean room standards of cleanliness

					associated with this process

NR: Not Relevant

Acute local inhalation
DNEL based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher

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.

Scaling of the PNEC for aquatic environment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach).

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach).

Workers

Scaling considering duration and frequency of use
Collect process monitoring data with an inhalable sampler. The simultaneous use of a respirable sampler is encouraged. Use aerosol particle size information, when available, to confirm the appropriate use of the inhalable DNEL of 0.05 mg Ni/m^3. Respirable fraction exposure levels should be kept below 0.01 mg Ni/m^3.

For further information and guidance on exposure scenarios, available tools, and scaling options, please visit the Nickel Consortia exposure scenario library at the following link: http://www.nickelconsortia.eu/exposure-scenario-library.html

Man via Environment exposure and risk characterisation assessments for thin film deposition by evaporation technique

Inhalation is the critical exposure pathway for humans via the environment. The PEC for air at site neighbouring residential areas should be lower than the chronic inhalation DNEL for the general public of 20 ng Ni/m^3 as annual average in PM_{10} in order to demonstrate adequate control of risk (RCR < 1) for Man via the Environment (MvE).

Hereto a Generic safe use Exposure Scenario for MvE was developed based on the EUSES model. The MvE GES is defined as the product of tonnage (T) and emission factor to air (EF) being lower than 18000 g Ni/year. The value of 18000 g Ni/year is derived by using EUSES model to back-calculate the product of T and EF that results in a local air concentration (C_{local}) of 15.5 ng Ni/m^3. The value of 15.5 is derived from the difference between the DNEL of 20 ng Ni/m^3 and the EU regional background concentration ($C_{regional}$) of 4.5 ng Ni/m^3 (P90 annual concentration for 2012).

Generic safe use ES for all sectors according to Tier 1 (EUSES model)

Sector	Tonnage (Ni T /year)	Emission factor (g Ni/T)	Tonnage × emission factor (g /year)	C_{local} (ng/m^3)	$C_{regional}$ (ng/m^3)	PEC_{local} (ng/m^3)	RCR = PEC/DNEL (DNEL= 20 ng/m^3)
All	T	EF	T × EF < 18000	<15.5	4.5*	<20	<1

**: EU average of country P90 annual Ni concentrations (2012)*

If a site is not compliant with these conditions, meaning that the product of tonnage and emission factor is above 18000 g Ni/year, a tiered approach including site-specific modelling can be applied to demonstrate safe use