1. Title GES 16 Production of nickel-containing products (electronics)	Version 6, 2015
Life cycle	End use - DU of Ni metal
Free short title	Production of nickel-containing products (electronics)
Systematic title based on use descriptor	SU: SU 3 Industrial use SU 16 Manufacture of computer, electronic and optical products, electrical equipment PC: Not relevant ERC: ERC5: Industrial use resulting in inclusion into or onto a matrix SPERC Industrial use in metallic coating PROC: PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) PROC 0: Cleaning and maintenance
Processes, tasks, activities covered (environment)	Production of nickel-containing products (electronics)
Processes, tasks, activities covered (workers)	Production of ceramic-based electronic components containing Ni Contributing exposure scenario ES 16.1: PROC 8a: Raw material handling /powder handling Contributing exposure scenario ES 16.2: PROC 5: Production and handling of finished product Contributing exposure scenario ES 16.3: PROC 0: Cleaning and maintenance
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Production of nickel-containing products (electronics)
Systematic title based on use descriptor (environment)	SPERC: Industrial use in metallic coating
Processes, tasks, activities covered (environment)	Production of electronics
Environmental Assessment Method	Estimation of local concentrations based on the use of SPERC for Industrial use in metallic coating and measured regional concentrations are used for calculation of PEC
Product characteristics	
Ni metal: Particle size ranges from 0.2-0.4 µm	
Amounts used	
Maximum daily use at a site	58 kg/day
Maximum annual use at a site	ES 1 & 2: 14 tonnes Ni (2007)
Frequency and duration of use	
Pattern of release to the environment	240 days per year (median values)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1 Discharge to STP: 18,000 m3/d (Effluent STP: 2000 m3/d)
Dilution capacity, freshwater	ES 1: 10 (default)
Dilution capacity, marine	ES 2: 100 (default)
Other given operational conditions affecting environmental exposure	
None	
Technical conditions and measures at process level (source) to prevent release	
None	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Waste water: On-site waste water treatment plant where process effluent is subject to settling tanks prior to discharge. Off site waste water treatment in municipal STP for ES 1. ES 1 Freshwater discharge to STP: Release factor after on-site treatment: 2000 g/T (Sperc for industrial use in metallic coating)	

ES 2 Marine direct discharge: Release factor after on-site treatment: 2000 g/T (Sperc for industrial use in metallic coating)

Air:
Treatment of air emissions by fabric or bag filters.
ES 1 & 2: Release factor to air after on-site treatment: 5000 g/T (Sperc for industrial use in metallic coating)

Organizational measures to prevent/limit release from site	
None	
Conditions and measures related to municipal sewage treatment plant	
Municipal Sewage Treatment Plant (STP)	Yes
Discharge rate of the Municipal STP	2000 m^3/d (default)
Incineration of the sludge of the Municipal STP	The sludge is applied to agricultural soil

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 16.1	
Raw material handling/powder handling	
Workers related free short title	Production of nickel-containing products (electronics)
Use descriptor covered	PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities
Processes, tasks, activities covered	Powder handling
Assessment Method	Estimation of exposure based on measured data
Product characteristic	
Ni metal: Particle size ranges from 0.2-0.4 µm	
Amounts used	

Not relevant	
Frequency and duration of use/exposure	
Max. 1 hour , 1 – 3 times per day	
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	
Ni powder is dispersed into an organic solvent and added to ceramic slurry, then thickened by further organic additives, until paste consistency. The paste is decanted and stored in 1 kg polyethylene jars in a temperature controlled storage area. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Mixing in covered vessel. Water vacuum cleaner with HEPA filter to remove dust from workplace during cleaning and maintenance.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required at points where Ni powders is handled and mixed	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (APF 10) is required when handling nickel powder Dermal: Gloves are required for any direct contact with raw materials and for cleaning and maintenance operations	
2.3 Control of workers exposure for contributing exposure scenario 16.2	
Production and handling of finished product	
Workers related free short title	Production of nickel-containing products (electronics)
Use descriptor covered	PROC 5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)
Processes, tasks, activities covered	Production and handling of finished product: Working with paste prior to firing Firing Handling of finished product
Assessment Method	Estimation of exposure based on measured data
Product characteristic	
Paste containing Ni metal powder with a particle size ranges from 0.2-0.4 µm	
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	
The paste is screen printed onto a ceramic substrate, and after firing becomes the electrode of the component. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
The use of the paste end the following firing is enclosed and emissions extracted from the firing process should not be discharged into workplace air.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV shall be an integrated part of the production equipment	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	

Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (APF 10) is required when handling nickel powder Dermal: Gloves are required for any direct contact with raw materials and for cleaning and maintenance operations	
2.5 Control of workers exposure for contributing exposure scenario 16.3	
Cleaning and maintenance	
Workers related free short title	Production of nickel-containing products (electronics)
Use descriptor covered	PROC 0: Cleaning and maintenance
Processes, tasks, activities covered	Cleaning and maintenance
Assessment Method	Estimation of exposure based on measured data
Product characteristic	
Ni metal: Particle size ranges from 0.2-0.4 µm	
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	
Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Collection of spills and cleaning is done by using water or a vacuum cleaner with HEPA filter to remove dust from workplace	
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	
Inhalation: RPE (APF 10) is required when handling of nickel powder. Dermal: Gloves are required for cleaning and maintenance operations	
3. Exposure and risk estimation	

Environment

SPERC Industrial use in metallic coating
Production of nickel-containing products (electronics)

Compartment	Unit	PNEC	$PEC_{Regional}$	C_{local}	PEC	RCR	Methods for calculation of environmental concentrations
ES 1: Freshwater STP discharge							Metal SPERC for metallic coating is used for estimation of environmental concentrations
Freshwater	µg Ni/L	7.1	2.9	2.51	5.41	0.76	
STP	mg Ni/L	0.33	-	--	0.035	0.11	
Sediment	mg Ni/kg	136	33.5	66.0	99.5	0.73	
Terrestrial	mg Ni/kg	29.9	16.2	1.11	17.31	0.58	
ES 2: Marine direct discharge							
Marine water	µg Ni/L	8.6	0.3	4.18	4.48	0.52	
Sediment	mg Ni/kg	136	16.1	110.0	126.1	0.93	
Terrestrial	mg Ni/kg	29.9	16.2	0.02	16.22	0.54	

Workers

ES 16.1
PROC 8a: Raw material handling/powder handling

	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm^2/day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm^2/day	0.035	0.009	0.257	Estimated 75th percentile for dermal exposure to insoluble Ni
Inhalation					
Acute local	mgNi/m^3	4.0	1.0	0.25	10 x 75th percentile long-term estimate. A factor of 10 was used to take account of the extreme variability in exposure concentration through time that arises during powder handling operations.
Long-term systemic and local	mgNi/m^3	0.05	0.1	2 excl. RPE By use of RPE (P2, APF=10): 0.2	75th percentile long-term exposure estimate based on expert judgement in the absence of measurement data. Assumes LEV in open workplaces

ES 16.2
PROC 5: Production and handling of finished product

	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm^2/day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm^2/day	0.035	0.009	0.257	Estimated 75th percentile for dermal exposure to insoluble Ni
Inhalation					
Acute local	mgNi/m^3	4.0	0.0015	<0.001	3 x long-term exposure estimate
Long-term systemic and local	mgNi/m^3	0.05	0.0005	0.01	No significant exposure is expected provided that firing process is enclosed.

					Estimate based on expert judgement in the absence of measurement data.
ES 16.3 PROC 0: Cleaning and maintenance					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm²/day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm²/day	0.035	0.009	0.257	Estimated 75th percentile for dermal exposure to insoluble Ni
Inhalation					
Acute local	mgNi/m³	4.0	0.5	0.13	10 x long-term exposure estimate. A factor of 10 was used to take account of the extreme variability in exposure concentration through time that arises during powder handling operations.
Long-term systemic and local	mgNi/m³	0.05	0.05	1 excl. RPE By use of RPE (P2, APF 10): 0.1	Long-term mean exposure for cleaning in areas where powder has been handled. Estimated as half of that associated with raw materials/powder handling, based on expert judgement.
NR: Not Relevant <u>Acute local inhalation</u> 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 the production of nickel-containing products (electronics)

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