

1. Title	
GES 4 Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating	
Life cycle	End use – DU of Ni sulphate
Free short title	Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating
Systematic title based on use descriptor	SU: SU 3 Industrial use SU 15 Manufacture of fabricated metal products PC: PC 19 Intermediate use PC 14 Metal Surface Treatment Products ERC: ERC5: Industrial use resulting in inclusion into or onto a matrix PROC: PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 13: Treatment of articles by dipping and pouring PROC 0: Cleaning and maintenance
Processes, tasks, activities covered (environment)	Nickel electroplating without topcoat Nickel electroplating with chromium topcoat Nickel electroplating with other topcoats such as gold, silve, brass or organic compounds Nickel composite electroplating such as nickel plus silicon carbide Nickel electroforming Electroless nickel plating
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 4.1: Operations involving dry salts Contributing exposure scenario ES 4.2: Operations with salt solutions
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Metal surface treatment – Nickel electroplating, nickel electroforming and electroless nickel plating
Systematic title based on use descriptor (environment)	ERC5: Industrial use resulting in inclusion into or onto a matrix
Processes, tasks, activities covered (environment)	Nickel electroplating without topcoat Nickel electroplating with chromium topcoat Nickel electroplating with other topcoats such as gold, silver, brass or organic compounds Nickel composite electroplating such as nickel plus silicon carbide Nickel electroforming Electroless nickel plating
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC
Product characteristics	
Ni sulphate: Dry powder of approximately 100 %or solution of 25-50%	
Amounts used	
Maximum daily use at a site	ES 1: 0.05 tonnes/day (median 50 th % emission days, 50 th % tonnage) ES 2: 1.23 tonnes/day (median 50 th % emission days, 75 th % tonnage) ES 3: 0.02 tonnes/day (median 50 th % emission days, 25 th % tonnage)
Maximum annual use at a site	ES 1: 11 tonnes (median 50 th %, 2007); Discharge to STP ES 2: 271 tonnes (75 th %, 2007); Discharge to STP ES 3: 3.9 tonnes (25 th %, 2007); Direct discharge
Frequency and duration of use	
Pattern of release to the environment	220 days per year per site (median 50 th %)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1 discharge to STP: 1.8xE4 m ³ /d ES 2 discharge to STP: 2.0xE6 m ³ /d ES 3 direct discharge: 1.6xE2 m ³ /d
Dilution capacity, freshwater	ES 1: 10 (50 th %)

	ES 2: 1000 (max) ES 3: 10 (50 th %)
Dilution capacity, marine	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 wastewater treatment in a physico-chemical treatment plant by chemical precipitation, sedimentation, filtration or a combination.	
Efficiency: 95 - >99%	
Off-site waste water treatment plant, community sewer system	
Efficiency 40%	
ES 1 freshwater Discharge to STP and Marine: 131 g/T (median)	
ES2 freshwater Discharge to STP: 827 g/T (75%)	
ES 3 Direct discharge to freshwater: 63 g/T (25 th %)	
Air:	
Treatment of stack air emission by wet scrubbers.	
Efficiency 99%	
Release factor after on-site treatment: 80 g/T (max)	
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	No – sludge is applied to agricultural soil
Conditions and measures related to external treatment of waste for disposal	
Ni bearing waste shall be recovered or recycled if possible. Ni bearing waste shall be considered hazardous if the Ni content is above the generic cutoffs (for mixtures) as stated in regulation (EC) No. 1272/2008. Ni bearing waste mixtures may be assessed as substances according to regulation (EC) No. 1272/2008 criteria. Disposal of Ni bearing waste shall comply with local, state or national waste legislation and remains the responsibility of the waste treatment operator.	
Conditions and measures related to external recovery of waste	
Not applicable	
2.2 Control of workers exposure for contributing exposure scenario ES 4.1	
Operations involving dry salts	
Workers related free short title	Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating
Use descriptor covered	PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 0: Cleaning and maintenance
Processes, tasks, activities covered	Raw material handling Preparation of Ni sulphate solution Cleaning and maintenance
Assessment Method	Estimation of exposure based on measured data and a Tier 1 model
Product characteristic	
Ni sulphate: Dry powder of approximately 100 % or solution of 25-50%	
Amounts used	
Not relevant	
Frequency and duration of use/exposure	
Addition of Ni sulphate to tank ranging from once per shift to once every 2 or 3 weeks	
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 sulphate is supplied and handled in dry form. Ambient temperature and humidity should apply. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Use of water or vacuum fitted with HEPA filter to clear spilled material or accumulations of dust within the work area. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Automation and enclosure of processes where possible	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for operations involving handling powder in open workspace such as ripping and tipping sacks, weighing, mixing, adding powders to solution	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: Use of RPE (FP3; APF = 20) is required for cleaning and maintenance operations involving dusts and powders. Dermal: Gloves and other suitable protective clothing are required to minimise dermal contact with powder	
2.3 Control of workers exposure for contributing exposure scenario ES 4.2	
Operations with salt solutions	
Workers related free short title	Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating
Use descriptor covered	PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 13: Treatment of articles by dipping and pouring PROC 0: Cleaning and maintenance
Processes, tasks, activities covered	Addition Ni sulphate to tank Dipping of items to be coated Removal of coated items Rinsing of coated items Removal of spent solution/rinse water from tank Wastewater handling – rinse water Cleaning and maintenance
Assessment Method	Estimation of exposure based on measured data
Product characteristic	
Ni sulphate: Solution of 25-50%	
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	
Ni sulphate is added to the plating bath in solution. Plating process involves immersion of piece into plating tank followed by immersion of piece into rinse tanks. Temperature of plating baths is typically 25-75°C. Plating bath is agitated by bubbling air through the electrolyte solution to ensure even availability of Ni salt to piece being plated. Maintain a clean workplace. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Automation and enclosure of processes should be used where possible	
Plating is either manual, semi-automated or automated: Manual plating - parts are placed on racks or hangers and manually transferred from tank to tank	

Semi-automated plating - parts are manually loaded on to jigs that are moved between the baths using an overhead hoist
Automated plating – as semi-automated process except jigs moved electronically

If no LEV, automation and enclosure of the following processes: Addition of solutions to plating tanks, dipping and removal of pieces to be plated (plating and rinsing tanks) are required (fluids may directly pumped in and out of tanks, dipping process may be entirely automated and enclosed)

Tank should be covered if not enclosed (e.g. by use of floating cover). Storage vessels used for electroplating solutions should be capped.

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

LEV is required for operations where mists may be created including addition of solutions to plating tanks, dipping and removal of pieces to be plated (plating and rinsing tanks)

Organisational measures to prevent /limit releases, dispersion and exposure

None

Conditions and measures related to personal protection, hygiene and health evaluation

Inhalation: Use of RPE is required for cleaning and maintenance operations.

Dermal: Gloves and other suitable protective clothing are required to minimise dermal contact with solution (acid resistant)

3. Exposure and risk estimation

Environment

ERC 5: Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating							
Compartment	Unit	PNEC	PEC _{Regional}	C _{local}	PEC	RCR	Methods for calculation of environmental concentrations and PNEC
Freshwater ES 1	µg Ni/L	3.55	2.9	0.14	3.04	0.86	Measured values, Tier 3-RWC
Freshwater ES 2	µg Ni/L	3.55	2.9	0.22	3.12	0.88	Measured values, Tier 3-RWC
Freshwater ES 3	µg Ni/L	3.55	2.9	0.44	3.34	0.94	Measured values, Tier 3-RWC
Marine	µg Ni/L	8.6	0.3	6.43	6.73	0.78	Measured values, Tier 3-RWC
Terrestrial ES 2 - sludge application	mg Ni/kg	29.9	16.2	9.56	25.76	0.86	Measured values, Tier 3-RWC
Terrestrial ES 2 – no sludge application	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	Measured values, Tier 3-RWC

Workers

ES 4.1 PROC 8a, PROC 0: Operations involving dry salts					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm ² /day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm ² /day	0.00044	0.00003	0.068	Exposure estimated using MEASE for PROC 8a (> 25% concentration, non-direct handling, intermittent exposure for 60-240 minutes, and use of gloves)
Inhalation					

Acute systemic	mg Ni/m ³	16	0.5	0.031	Estimated 75 th percentile short term exposure for handling of dry NiSO ₄ powder with LEV in place
Acute local	mg Ni/m ³	0.7	0.5	0.714 excl. RPE By use of RPE (P3, APF 20): 0.09	
Long-term systemic	mg Ni/m ³	0.05	0.033	0.66	Exposure estimated using MEASE for PROC 8a (>25% concentration, solid, medium dustiness, Use of LEV, RPE (APE 20))
Long-term local	mg Ni/m ³	0.05	0.033	0.66	

ES 4.2

PROC 8a, PROC 13, PROC 0: Operations with salt solutions

	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm ² /day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm ² /day	0.00044	7x10 ⁻⁵	0.16	Estimated 75 th percentile exposure to soluble nickel associated with electroplating based on the EU RAR (2008-2009). Assumes suitable protective clothing employed
Inhalation					
Acute systemic	mg Ni/m ³	16	0.06	0.004	3 x the estimated 75 th percentile exposure to airborne soluble Ni
Acute local	mg Ni/m ³	0.7	0.06	0.086	
Long-term systemic	mg Ni/m ³	0.05	0.02	0.4	Estimated 75 th percentile exposure to airborne soluble Ni assuming manual plating process with effective LEV in place
Long-term local	mg Ni/m ³	0.05	0.02	0.4	

Notes

Collect process monitoring data. Respirable fraction exposure levels should be kept below 0.01 mg Ni/m³. Use speciation to ensure that the appropriate inhalable DNEL is used (e.g., if only Ni metal and Ni oxide are present, an inhalable exposure of 0.2 mg Ni/m³ could be reasonably assumed to be safe).

Acute local inhalation

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 occupational exposure monitoring data. Use aerosol particle size information, when available, to confirm the appropriate use of an inhalable

Summary of Man via Environment exposure and risk characterisation assessments for metal surface treatment

For each sector, an overview of the range of operational conditions (OCs) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared to 11.5 ng Ni/m^3 or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m^3 .

Sector overview

	tonnage (T Ni/year)	daily emissions to air (kg Ni/d)	release factor to air (g Ni/T)	Emission days to air per site (d/y)	$C_{local, air}^*$ (ng Ni/m ³)	PEC air [§] (ng Ni/m ³)
min	4	<0.01	15	220	<1	9
max	1500	0.24	4000	336	43	52
median	14	0.08	2032	235	12	12

*: based on EUSES air model

§: based on C_{local} predicted + regional background depending on available information.

For two companies calculations were based on a SPERC with a release factor of 4000 g/T.