

1. Title		Version 6, 2015
GES 12 Manufacturing of batteries using nickel electrodes		
Life cycle	End use – DU of Ni metal	
Free short title	Production of batteries	
Systematic title based on use descriptor	SU: SU 3: Industrial use SU 16 Manufacture of computer, electronic and optical products, electrical equipment PC: 0: Other: Battery products ERC: ERC 5 Industrial use resulting in inclusion into or onto a matrix PROC: PROC 8b Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 1 Use in closed process, no likelihood of exposure PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises PROC 13 Treatment of articles by dipping and pouring PROC 14 Production of preparations or articles by tableting, compression, extrusion, pelletisation PROC 22 Potentially closed processing operations with minerals / metals at elevated temperature PROC 26 Handling of solid inorganic substances at ambient temperature PROC 0 Cleaning and maintenance	
Processes, tasks, activities covered (environment)	Production of batteries using nickel electrodes	
Processes, tasks, activities covered (workers)	Production of batteries using nickel electrodes (nickel cadmium and nickel metal hydride): Ni metal is used in the form of Ni briquettes for making NiSO ₄ or Ni(NO ₃) ₂ solution further precipitated into Ni(OH) ₂ . Ni metal is used in the form of a electrolytic nickel squares & crowns; pellets or rounds (including S depolarised Ni) for use with anode baskets and as Durvanic or depolarised nickel pole anodes during electroplating of the substrate and is produced in the form of a continuous Ni plate on the surface of the pocket plate iron or steel electrode substrate. Ni metal powder is used in sinter coating of the nickel, iron or steel perforated electrode substrate. The electrodes are further processed and assembled into batteries Contributing exposure scenario ES 12.1: PROC 4, 8b: Raw materials handling Contributing exposure scenario ES 12.2: PROC 4, 8b: Manufacture of the NiSO ₄ solution Contributing exposure scenario ES 12.3: PROC 4, 8b, 13, 26: Nickel electroplating Contributing exposure scenario ES 12.4: PROC 1, 4, 8b : Preparation of Ni(NO ₃) ₂ solution Contributing exposure scenario ES 12.5: PROC 1, 13, 22: Preparation of the Ni sintered strip Contributing exposure scenario ES 12.6: 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 batteries using nickel electrodes	
Systematic title based on use descriptor (environment)	ERC5 Industrial use resulting in inclusion into or onto a matrix	
Processes, tasks, activities covered (environment)	Production of batteries using nickel electrodes	

Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC
Product characteristics	
Ni supplied in metallic form: Ni bars, Ni briquettes, Ni powder with a median size of 13µm or Ni powder with a median size of 2.5 µm	
Amounts used	
Maximum daily use at a site	ES 1, 2 & 3: 2.9 tonnes/day (median 50th % emission days, max tonnage)
Maximum annual use at a site	ES 1, 2 & 3: 796 (max)
Frequency and duration of use	
Pattern of release to the environment	276 days per year (median 50 th %)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1: 18,000 m3/d (Effluent STP: 2000 m3/d) ES 2: 52,272 m3/d (Effluent Site: 528 m3/d)
Dilution capacity, freshwater	ES 1 :10 (default) ES 2: 100
Dilution capacity, marine	ES 3: 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 by chemical precipitation with efficiency of 98% or a combination of methods and off-site wastewater treatment in municipal STP for ES 1 (Efficiency 40%)	
ES 1 Freshwater discharge to STP: Release factor after on-site treatment: 42.7 g/T	
ES 2 Freshwater direct discharge: Release factor after on-site treatment: 42.7 g/T	
ES 3 Marine direct discharge: Release factor after on-site treatment: 42.7 g/T	
Air:	
Treatment of air emissions by fabric or bag filters, ceramic filters and wet scrubbers	
Efficiency 99% removal	
ES1, 2 & 3: Release factor after on-site treatment: 25.4g/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)	No
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:	
<ul style="list-style-type: none"> - 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.

Q_{max}, local(shredding)=26kg Ni/day

(Note: This Q_{max}, 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 ES 12.1

Raw materials handling

Workers related free short title	Manufacturing of batteries using nickel electrodes
Use descriptor covered	PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Processes, tasks, activities covered	Raw materials handling – i) Ni briquettes, ii) Ni chips, ball or pole etc. anodes and ii) Ni metal powder
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.

Product characteristic

Ni supplied in metallic form: Ni bars, Ni briquettes, Ni powder with a median size of 13µm or Ni powder with a median size of 2.5 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

Apply ambient temperature and humidity.

Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.

Oral: Good workplace hygiene practice

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

Inhalation: Automation but not complete enclosure of powder transfer operations are likely to give rise to significant exposures to inhalable Ni dust (tipping of >10 kg powders & breakages during transferring briquettes)

Dermal: Automation of processes should be used where possible to eliminate dermal contact.

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

LEV is required for processes not automated or enclosed involving powdered Ni raw material or dust emissions from friable or likely to give rise to Ni dust or fumes

Organisational measures to prevent /limit releases, dispersion and exposure

Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
<p><u>Inhalation:</u> Air-assisted filtering visor, masks or hood with P3 filter element (Assigned Protection Factor ~20 based on use of powered respirator meeting EN12492 requirement or FFP3 (EN149) or equivalent suitable respirator) is required for emergencies and non-routine tasks where exposure to Ni-containing dust is possible e.g. spills or leaks from breaches in transfer systems. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing aerosols.</p> <p><u>Dermal:</u> Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).</p>	
2.3 Control of workers exposure for contributing exposure scenario ES 12.2	
Manufacture of the NiSO ₄ solution	
Workers related free short title	Manufacturing of batteries using nickel electrodes
Use descriptor covered	<p>PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises</p> <p>PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities</p>
Processes, tasks, activities covered	Acid dissolution of Ni briquettes in sulphuric acid to give NiSO ₄ solution
Assessment Method	<p>Estimation of inhalation exposure based on measured data.</p> <p>Estimation of dermal exposure based on Tier 1 model.</p>
Product characteristic	
Ni supplied in metallic form: Ni briquettes	
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	
<p>Apply ambient temperature and humidity.</p> <p>Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.</p> <p>Oral: Good workplace hygiene practice</p>	
Technical conditions and measures at process level (source) to prevent release	
<p>Dissolution shall be enclosed</p> <p>Inhalation: Automation but not complete enclosure of reactor charge and briquette/acid mixing operations are likely to give rise to significant exposures to inhalable Ni dust and fumes</p> <p>Dermal: Automation of processes should be used where possible to eliminate dermal contact.</p>	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes not automated or enclosed or where Ni dust or fumes may be formed	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
<p><u>Inhalation:</u> Air-assisted filtering visor, masks or hood with P3 filter element (Assigned Protection Factor ~20 based on use of powered respirator meeting EN12492 requirement or FFP3 (EN149) or equivalent suitable respirator) is required for emergencies and non-routine tasks where exposure to Ni-containing dust is possible e.g. spills or leaks from breaches in transfer systems. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing aerosols.</p> <p><u>Dermal:</u> Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing</p>	

aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).	
2.4 Control of workers exposure for contributing exposure scenario ES 12.3	
Nickel electroplating {maintenance of NiSO ₄ electroplating solution & manufacture of electrode strip by nickel plating a steel strip}	
Workers related free short title	Manufacturing of batteries using nickel electrodes
Use descriptor covered	PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 26: Handling of solid inorganic substances at ambient temperature
Processes, tasks, activities covered	Nickel electroplating of 'jigged' strips and using a Watts electroplating solution where Ni metal-related tasks include: - Raw materials handling - Addition of Ni anode to tank solution - Rinsing coated items - Removal of coated items from jigs or barrels - Removal and treatment of spent solution and dirty rinse water from tanks - Testing solution composition
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Ni supplied in metallic form: Ni chips, balls, crowns, pellets or pole anodes	
Amounts used	
Not relevant	
Frequency and duration of use/exposure	
Electroplating is continuous over 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	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Anodes should be bagged where possible to prevent the release of Ni dust or chips into the tank solution. Dermal: Automation of processes should be used where possible to eliminate dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
Anodes should be bagged where possible to prevent the release of Ni dust or chips into the tank solution which are then contacted by worker during solution dumping, de-sludging or anode replacement. Anode stubs, removed from the tank solution during anode replacement, should not be left lying around the shop floor and RPE should be used if dust is released during the cutting of stubs for recycling as anodes in anode baskets. Oral: Good workplace hygiene practice.	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: Air-assisted filtering visor, masks or hood with P3 filter element (Assigned Protection Factor ~20 based on use of powered respirator meeting EN12492 requirement or FFP3 (EN149) or equivalent suitable respirator) is required for emergencies and non-routine tasks where exposure to Ni-containing dust is possible e.g. spills or leaks from breaches in transfer systems. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing aerosols. Dermal: Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).	

2.5 Control of workers exposure for contributing exposure scenario ES 12.4	
Preparation of Ni(NO ₃) ₂ solution	
Workers related free short title	Manufacturing of batteries using nickel electrodes
Use descriptor covered	PROC 1: Use in closed process, no likelihood of exposure PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Processes, tasks, activities covered	Acid dissolution of Ni briquettes in sulphuric acid to give NiSO ₄ solution
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Ni supplied in metallic form: Ni briquettes	
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	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Dissolution shall be enclosed Inhalation: Automation but not complete enclosure of reactor charge and briquette/acid mixing operations are likely to give rise to significant exposures to inhalable Ni dust and fumes Dermal: Automation of processes should be used where possible to eliminate dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes not automated or enclosed or where Ni dust or fumes may be formed	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: Air-assisted filtering visor, masks or hood with P3 filter element (Assigned Protection Factor ~20 based on use of powered respirator meeting EN12492 requirement or FFP3 (EN149) or equivalent suitable respirator) is required for emergencies and non-routine tasks where exposure to Ni-containing dust is possible e.g. spills or leaks from breaches in transfer systems. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing aerosols. Dermal: Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).	
2.6 Control of workers exposure for contributing exposure scenario ES 12.5	
Preparation of the Ni sintered strip	
Workers related free short title	Manufacturing of batteries using nickel electrodes
Use descriptor covered	PROC 1: Use in closed process, no likelihood of exposure PROC 13: Treatment of articles by dipping and pouring PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature
Processes, tasks, activities covered	A Ni/water slurry is prepared and loaded into a bath through with the bare nickel, iron or steel strip passes for coating and the coated strip is then sintered.

Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model (MEASE)
Product characteristic	
Ni supplied in metallic form: Ni powder	
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	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Coating and sintering shall be enclosed Inhalation: Automation but not complete enclosure of coating and sintering operations are likely to give rise to significant exposures to inhalable Ni dust and fumes. Slurry make-up is likely to be a manual operation and will require LEV and/or containment to be applied during weighing out and mixing of the powder. Dermal: Automation of processes should be used where possible to eliminate dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes not automated or enclosed or where Ni dust or fumes may be formed	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: Air-assisted filtering visor, masks or hood with P3 filter element (Assigned Protection Factor ~20 based on use of powered respirator meeting EN12492 requirement or FFP3 (EN149) or equivalent suitable respirator) is required for emergencies and non-routine tasks where exposure to Ni-containing dust is possible e.g. spills or leaks from breaches in transfer systems. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing aerosols. Dermal: Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).	
2.7 Control of workers exposure for contributing exposure scenario ES 12.6	
Cleaning and maintenance	
Workers related free short title	Manufacturing of batteries using nickel electrodes
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 materials include Ni chips, Ni crowns, Ni pellets, Ni briquettes, Ni powder with a median size of 13µm or Ni powder with a median size of 2.5 µm and Ni-containing dust and fume	
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							
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice							
Technical conditions and measures at process level (source) to prevent release							
None							
Technical conditions and measures to control dispersion from source towards the worker							
Use of water or vacuum fitted with a HEPA filter to remove dusts and powders during cleaning.							
Organisational measures to prevent /limit releases, dispersion and exposure							
Regular training in work hygiene practices and proper use of PPE.							
Conditions and measures related to personal protection, hygiene and health evaluation							
Inhalation to mists and particulates and skin exposure to mists, liquids splashes and particulates shall be controlled by RPE and gloves when undertaking maintenance and cleaning work. Inhalation: Use of air-assisted filtering visor, masks or hood with P3 filter element for plant or premises heavily contaminated with nickel-containing dust or spills {APF 20 or 40 based on use of powered respirator meeting EN12492 or EN12941 requirement or FFP3 (EN136) or equivalent suitable respirator}. RPE with a lower APF of 10 {air-assisted filtering visor, masks or hood with P2 filter element including powered respirators meeting the EN12492 TM1 or EN 12941 TH1 requirement or the FFP2 (EN149) or equivalent suitable respirator} may be used for cleaning and maintenance work where the plant or premises is less heavily contaminated with nickel-containing dust or spills. It is important to note that the disposable mask FFP1 (with APF = 4) is not recommended for use with Ni-containing dust. Dermal: Suitable gloves (EN 374, protection level 6, PVC or equivalent), and goggles. Other protective equipment e.g. special safety clothing should be chosen based on activities being undertaken, potential for exposure to airborne nickel-containing aerosols and other relevant workplace hazards may include protective suit with hood (conforming to EN13982-1 Type 5) and safety shoes (e.g. according to EN 20346).							
3. Exposure and risk estimation							
Environment							
ERC 5 Production of batteries							
Compartment	Unit	PNEC	PEC _{Regional}	C _{local}	PEC	RCR	Methods for calculation of environmental concentrations
ES 1: Freshwater STP discharge							Measured values, Tier 3-RWC
Freshwater	µg Ni/L	7.1	2.9	2.65	5.55	0.78	
STP	mg Ni/L	0.33	-	-	0.037	0.11	
Sediment	mg Ni/kg	136	33.5	69.7	103.2	0.76	
Terrestrial	mg Ni/kg	29.9	16.2	1.16	17.36	0.58	
ES 2: Freshwater direct discharge							
Freshwater	µg Ni/L	7.1	2.9	1.67	4.57	0.64	
Sediment	mg Ni/kg	136	33.5	44.0	77.5	0.57	
Terrestrial	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	
ES 3: Marine direct discharge							
Marine water	µg Ni/L	8.6	0.3	1.67	1.97	0.23	
Sediment	mg Ni/kg	136	16.1	44.0	60.1	0.44	
Terrestrial	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	
Workers							
ES 12.1 PROC 4 & 8b: Raw materials 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				

systemic	Long-term	mgNi/kg/day	-	NR		
local	Long-term	mgNi/cm ² /day	0.035	0.000003	8.6x10 ⁻⁵	90 th percentile MEASE modelling (PROC 8b, no direct handling, solid, medium dustiness, <15 min, 5-25% Ni content, LEV, gloves)
Inhalation						
	Acute local	mgNi /m ³	4.0	0.082	0.0205	Higher of two measurements for unbagging NiSO ₄ 6H ₂ O
	Long-term systemic and local	mgNi/m ³	0.05	NR	NR	This operation is not of long term duration
ES 12.2						
PROC 4 & 8b: Manufacture of the NiSO ₄ solution						
		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	0.00003	8.6x10 ⁻⁴	90 th percentile MEASE modelling (PROC 4, no direct handling, solid, medium dustiness, 8h, 5-25% Ni content, enclosed, gloves)
Inhalation						
	Acute local	mgNi/m ³	4.0	0.066	0.0167	3x long term exposure estimate
	Long-term systemic and local	mgNi/m ³	0.05	0.022	0.44	Maximum of 7 personal exposure measurements
ES 12.3						
PROC 4, 8b & 26: Nickel electroplating						
		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	0.00003	8.6x10 ⁻⁴	90 th percentile MEASE modelling (PROC 4, solid, medium dustiness, 8h, 5-25% Ni content, enclosed, gloves)
Inhalation						
	Acute local	mgNi/m ³	4.0	0.0426	0.011	3x long term exposure estimate
	Long-term systemic and local	mgNi/m ³	0.05	0.0142	0.3	The highest of 5 static measurements for nickel electroplating from a NiSO ₄ rich solution
ES 12.4						
PROC 1, 4 & 8b: Preparation of Ni(NO ₃) ₂ solution						
		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	0.00003	8.6x10 ⁻⁴	90 th percentile MEASE modelling (PROC 4, 8b, no direct handling, aqueous solution, 1-4h, >25% Ni content, inclusion into matrix, intermittent contact, gloves)
Inhalation						
	Acute local	mgNi/m ³	4.0	0.114	0.0285	3x long term exposure estimate
	Long-term systemic and local	mgNi/m ³	0.05	0.038	0.76	75 th percentile value from 14 long-term exposure measurements
ES 12.5						
PROC 1, 13, 22: Preparation of the Ni sintered strip						
		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	0.00005	1.43x10 ⁻³	90 th percentile MEASE modelling (PROC 22, no direct handling, aqueous solution, >4h, >25% Ni content, intermittent contact, gloves)
Inhalation						
	Acute local	mgNi/m ³	4.0	0.132	0.033	3x long term exposure estimate
	Long-term systemic and local	mgNi/m ³	0.05	0.044	0.88	75 th percentile value from 73 exposure measurements
ES 12.6						
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/cm ² /day	-	NR		
	Long-term systemic	mgNi/kg/day	-	NR		
	Long-term local	mgNi/cm ² /day	0.035	0.000018	5.1x10 ⁻⁴	90 th percentile MEASE modelling (PROC 0, no direct handling, solid, medium dustiness, 5-25% Ni content, non-direct handling, incidental contact, gloves, 4h of max duration of operation, then hands must be washed before continuing work)
Inhalation						
	Acute local	mgNi/m ³	4.0	1.026	0.26	3x long term exposure estimate
	Long-term systemic and local	mgNi/m ³	0.05	0.342 excl. RPE 0.0171 by use of RPE (APF 20)	6.84 excl. RPE 0.34 By use of RPE (P3, APF 20)	Read-across based on 3 measurements from powder handling operations in the catalyst industry
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 the production of batteries using nickel electrodes

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/m³ as annual average in PM₁₀ 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/m³. The value of 15.5 is derived from the difference between the DNEL of 20 ng Ni/m³ and the EU regional background concentration ($C_{regional}$) of 4.5 ng Ni/m³ (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