

1. Title		Version 6, 2015
<b>GES 4 Production of nickel based powders from nickel oxide</b>		
Life cycle	Industrial use – DU of NiO	
Free short title	Production of nickel based powders from NiO-containing materials	
Systematic title based on use descriptor	<p><b>SU:</b> SU 3 Industrial use</p> <p><b>PC:</b> PC 19 Intermediates</p> <p><b>ERC:</b> ERC 6a Industrial use resulting in manufacture of another substance (use of intermediates)</p> <p><b>PROC:</b></p> <p>PROC 2 Used in closed continuous processes with occasional controlled exposures</p> <p>PROC 8b Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities</p> <p>PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises</p> <p>PROC 9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing)</p> <p>PROC 22 Potentially closed processing operation with minerals/metals at elevated temperature</p> <p>PROC 24 High (mechanical) energy work-up of substance bound in materials</p> <p>PROC 27a Production of metal powders (hot processes)</p> <p>PROC 0 Cleaning and maintenance</p>	
Processes, tasks, activities covered (environment)	Production of nickel based powders: Powder mixing, smelting, atomisation; drying, sieving, filling in bags/drums, cleaning and maintenance	
Processes, tasks, activities covered (workers)	<p>Contributing exposure scenario ES 4.1</p> <p>PROC 8b: Raw materials handling</p> <p>Contributing exposure scenario ES 4.2</p> <p>PROC 22: Smelting</p> <p>Contributing exposure scenario ES 4.3</p> <p>PROC 4, PROC 24, PROC 27: Alloying &amp; Atomising</p> <p>Contributing exposure scenario ES 4.4</p> <p>PROC 2, PROC 4: Drying</p> <p>Contributing exposure scenario ES 4.5</p> <p>PROC 4: Blending &amp; Sieving</p> <p>Contributing exposure scenario ES 4.6</p> <p>PROC 9: Packaging</p> <p>Contributing exposure scenario ES 4.7</p> <p>PROC 0: Cleaning and maintenance</p>	
<b>2. Operational conditions and risk management measures</b>		
<b>2.1 Control of environmental exposure</b>		
Environmental related free short title	Production of nickel based powders from NiO-containing materials	
Systematic title based on use descriptor (environment)	ERC 6a Industrial use resulting in manufacture of another substance (use of intermediates)	
Processes, tasks, activities covered (environment)	Production of nickel based powders: Powder mixing, smelting, atomisation; drying, sieving, filling in bags/drums, cleaning and maintenance	
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC	
<b>Product characteristics</b>		
The tonnage is based on Ni originating from the use of NiO as well as other Ni compounds used at same sites.		
<b>Amounts used</b>		
Maximum daily use at a site	5.0 – 10 tonnes (expressed as Ni; median 50 <sup>th</sup> % emission days)	
Maximum annual use at a site	ES 1: 2056 tonnes Ni ES 2: 1048 tonnes Ni	
<b>Frequency and duration of use</b>		
Pattern of release to the environment	209 days per year per site (median 50 <sup>th</sup> %)	
<b>Environment factors not influenced by risk management</b>		

<b>Receiving surface water flow rate</b>	ES 1 Direct discharge: 9,960 m <sup>3</sup> /d (Effluent Site: 40 m <sup>3</sup> /d)
<b>Dilution capacity, freshwater</b>	ES 1 Direct discharge: 250
<b>Dilution capacity, marine</b>	ES 2 Marine discharge:100 (default)
<b>Other given operational conditions affecting environmental exposure</b>	
None	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
None	
<b>Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil</b>	
<b>Waste water:</b>	
On-site wastewater treatment by sand filtration.	
ES 1 Freshwater direct discharge: Release factor after on-site treatment: 3.3 g/T (90P)	
ES 2 Marine direct discharge: Release factor after on-site treatment: 3.3 g/T (90P)	
<b>Air:</b>	
Treatment of air emissions by fabric or bag filters.(Efficiency >98%).	
ES 1 & 2: Release factor after on-site treatment: 50.5 g/T	
<b>Organizational measures to prevent/limit release from site</b>	
None	
<b>Conditions and measures related to municipal sewage treatment plant</b>	
<b>Municipal Sewage Treatment Plant (STP)</b>	No
<b>Discharge rate of the Municipal STP</b>	Not relevant
<b>Incineration of the sludge of the Municipal STP</b>	Not relevant
<b>Conditions and measures related to external treatment of waste for disposal</b>	
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.	
<b>Fraction of daily/annual use</b> expected in waste:	
<ul style="list-style-type: none"> <li>- Nickel producers = 0.05 %</li> <li>- DU: stainless steel and alloy steels = 0.6 %</li> <li>- DU: nickel alloys, copper alloys, foundry, batteries, catalysts, chemicals, dyes and others = 0.5 %</li> <li>- DU: Plating = 3%</li> </ul>	
<b>Appropriate waste codes:</b>	
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*	
<b>Suitable disposal:</b> Keep separate and dispose of to either	
<ul style="list-style-type: none"> <li>- 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.</li> <li>- Hazardous landfill operated under Directive 1999/31/EC.</li> </ul>	
<b>Conditions and measures related to external recovery of waste</b>	
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 <sub>max</sub> , local(shredding)=26kg Ni/day	
(Note: This Q <sub>max</sub> , 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)	
<b>2.2 Control of workers exposure for contributing exposure scenario ES 4.1</b>	
Raw material handling	
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials
<b>Use descriptor covered</b>	PROC 8b: Transfer of substance or preparation (charging/discharging)

	from/to vessels/large containers at dedicated facilities	
<b>Processes, tasks, activities covered</b>	Raw material handling for receiving smelter feedstock	
<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.	
<b>Product characteristic</b>		
Ni supplied as NiO in concentrate/pellet/briquette/ferronickel form		
<b>Amounts used</b>		
Not relevant		
<b>Frequency and duration of use/exposure</b>		
8 hour shifts		
<b>Human factors not influenced by risk management</b>		
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	480 cm <sup>2</sup>	
Body weight	Not relevant	
<b>Other given operational conditions affecting workers exposure</b>		
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice.		
<b>Technical conditions and measures at process level (source) to prevent release</b>		
<u>Inhalation</u> : Partly enclosed powder transfer operations are likely to give rise to significant exposures to inhalable Ni (tipping of NiO concentrate, briquettes or pellets) <u>Dermal</u> : Automation of processes should be used where possible to eliminate dermal contact.		
<b>Technical conditions and measures to control dispersion from source towards the worker</b>		
LEV is required for process steps that are not fully enclosed and involve NiO concentrate, briquettes or pellets and operations that are likely to give rise to NiO dust or fumes		
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>		
None		
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>		
<u>Inhalation</u> : RPE (FFP3, APF 20) {approved to EN 149 (half-mask disposable respirators)} is required at process steps that are not fully enclosed and involve NiO concentrate, briquettes or pellets. <u>Dermal</u> : Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with NiO could occur.		
<b>2.3 Control of workers exposure for contributing exposure scenario ES 4.2</b>		
Smelting		
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials	
<b>Use descriptor covered</b>	PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature	
<b>Processes, tasks, activities covered</b>	Smelting of NiO	
<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.	
<b>Product characteristic</b>		
Ni supplied as NiO in concentrate/pellet/briquette/ferronickel form		
<b>Amounts used</b>		
Not relevant		
<b>Frequency and duration of use/exposure</b>		
8 hour shifts		
<b>Human factors not influenced by risk management</b>		
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	1980 cm <sup>2</sup>	
Body weight	Not relevant	
<b>Other given operational conditions affecting workers exposure</b>		
Smelting is carried under reducing conditions e.g. by addition of reducing agent such as carbon. NiO is reduced to Ni metal under the reducing conditions. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice		

<b>Technical conditions and measures at process level (source) to prevent release</b>	
<u>Inhalation</u> : Partial enclosure of furnace (melting) and partly enclosed molten metal transfer operations are likely to give rise to significant exposures to inhalable Ni oxide and Ni metal fume and dust.	
<u>Dermal</u> : Automation of processes should be used where possible to eliminate dermal contact.	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required at process steps that are not fully enclosed and are likely to give rise to Ni oxide or Ni metal fumes or dust	
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
None	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<u>Inhalation</u> : RPE (FFP3, APF 20) {approved to EN 149 (half-mask disposable respirators)} is required at process steps that are not fully enclosed and are likely to give rise to Ni oxide or Ni metal fumes or dust.	
<u>Dermal</u> : Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with NiO or Ni metal could occur.	
<b>2.4 Control of workers exposure for contributing exposure scenario ES 4.3</b>	
Alloying & Atomising	
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials
<b>Use descriptor covered</b>	PROC 4: use in batch and other processes where opportunity for considerable exposure arises PROC 24: High (mechanical) energy work-up of substance bound in materials PROC 27 Production of metal powders (hot processes)
<b>Processes, tasks, activities covered</b>	Mixing solid nickel substrate pellets or powder with minor alloying ingredients, melting this mixture and gas atomisation of the melt.
<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
<b>Product characteristic</b>	
Ni supplied: Metallic pellet or powder form Reduced molten nickel metal	
<b>Amounts used</b>	
Not relevant	
<b>Frequency and duration of use/exposure</b>	
8 hour shifts	
<b>Human factors not influenced by risk management</b>	
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	480 cm <sup>2</sup>
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
Nickel pellets and powder are made by atomisation of reduced molten nickel metal. The melt feed stock for the furnace is prepared by weighing out Ni pellets and Ni based powder into a bin and adding prescribed alloying ingredients to the bin. This is called 'granulating'. The contents of the bin are emptied into the belt furnace and heated to produce a nickel based melt. A stream of this molten nickel, released from the furnace, is broken into droplets by gas atomisation. A high energy jet of nitrogen or argon is injected through an atomising nozzle on to the stream of molten metal. This breaks the stream into droplets which are cooled and solidify to a powder before they can deposit on each other or on a surface. The powder is likely to be wetted in the atomisation process <i>i.e.</i> by cooling or quenching. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice.	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<u>Inhalation</u> : Manually operated loading /unloading of bins with furnace feedstock and emptying dust filter on local exhaust ventilation system are not fully enclosed operations and likely to give rise to significant exposures to Ni dust. Partial enclosure of atomisation operations is likely to give rise to significant exposures to Ni powder, fumes or dust. Automation and wet collection of moist powder product is likely to give rise to significant exposures to Ni powder and dust.	
<u>Dermal</u> : Automation of processes should be used where possible to eliminate dermal contact.	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required for process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes	

<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
None	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<u>Inhalation</u> : RPE (FFP3, APF 20) {approved to EN 149} is required for process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes. If powders with > 10% of the particle in the respirable size range, <i>i.e.</i> < 10 µm, is being handled, use RPE approved to EN 136 mask and EN 143 filter (APF 40).	
<u>Dermal</u> : Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with NiO or Ni metal could occur.	
<b>2.5 Control of workers exposure for contributing exposure scenario ES 4.4</b>	
Drying	
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials
<b>Use descriptor covered</b>	PROC4: use in batch and other processes where opportunity for considerable exposure arises PROC 2: Used in closed continuous processes with occasional controlled exposures
<b>Processes, tasks, activities covered</b>	Damp powder exiting the furnace is released into a container, transferred to an intermediate container and then to the feed hopper on the rotating drier. The dried powder is collected in a receiving hopper.
<b>Assessment Method</b>	Estimation of inhalation exposure and dermal exposure based on Tier 1 model.
<b>Product characteristic</b>	
Ni supplied as moist NiO powder	
<b>Amounts used</b>	
Not relevant	
<b>Frequency and duration of use/exposure</b>	
8 hour shifts	
<b>Human factors not influenced by risk management</b>	
Respiration volume under conditions of use	Light to medium level work, 10 m <sup>3</sup> /d
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	480 cm <sup>2</sup>
Body weight	70 kg
<b>Other given operational conditions affecting workers exposure</b>	
A chute/pipe/belt/screw conveyor delivers the damp powder from the furnace into the receiving container. Manual or vehicular (FLT) shovelling of the damp powder from furnace receiving container into an intermediate container which is driven to and tipped into the feed hopper for the rotary drier. The water is removed from the damp powder in the rotary drier (at ~125°C) and collected in a hopper. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice.	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<u>Inhalation</u> : Shovelling, driving and tipping of damp powder is likely to give rise to significant exposures to Ni dust. Partly enclosure of dry powder discharging into receiving hopper is likely to give rise to significant exposures to Ni dust. <u>Dermal</u> : Automation of processes should be used where possible to eliminate dermal contact.	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required at process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes.	
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
None	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<u>Inhalation</u> : RPE (FFP3, APF 20) {approved to EN 149} is required for process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes.	
<u>Dermal</u> : Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with Ni metal could occur.	
<b>2.6 Control of workers exposure for contributing exposure scenario ES 4.5</b>	
Blending and Sieving	
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials
<b>Use descriptor covered</b>	PROC 4: use in batch and other processes where opportunity for considerable exposure arises
<b>Processes, tasks, activities covered</b>	Dried powder(s) are mixed and returned to the hopper. The powder is sieved into different size fractions before and after mixing.

<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.	
<b>Product characteristic</b>		
Dry Ni powder		
<b>Amounts used</b>		
Not relevant		
<b>Frequency and duration of use/exposure</b>		
8 hour shifts		
<b>Human factors not influenced by risk management</b>		
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	480 cm <sup>2</sup>	
Body weight	Not relevant	
<b>Other given operational conditions affecting workers exposure</b>		
Dried powder(s) are emptied from the hopper into a double cone mixer, and after complete mixing is returned to the hopper. The powder is sieved into different size fractions before and after mixing. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice.		
<b>Technical conditions and measures at process level (source) to prevent release</b>		
Inhalation: Manually operated loading /unloading of dried powder(s) into a sieve/double cone mixer system is likely to give rise to significant exposures to Ni dust. Dermal: Automation of processes should be used where possible to eliminate dermal contact.		
<b>Technical conditions and measures to control dispersion from source towards the worker</b>		
LEV is required at process steps that are not fully enclosed and are likely to give rise to Ni dust		
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>		
None		
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>		
Inhalation: RPE (FFP3, APF 20) {approved to EN 149 (half-mask disposable respirators)} is required at process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes. If powders with > 10% of the particle in the respirable size range, i.e. < 10 µm, is being handled, use RPE approved to EN 136 mask and EN 143 filter (APF 40). Dermal: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with Ni metal could occur.		
<b>2.7 Control of workers exposure for contributing exposure scenario ES 4.6</b>		
Packaging		
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials	
<b>Use descriptor covered</b>	PROC 9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	
<b>Processes, tasks, activities covered</b>	Bagging and drumming Ni powder product at filling station.	
<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on read across from similar process for Ni metal.	
<b>Product characteristic</b>		
Dry Ni powder		
<b>Amounts used</b>		
Not relevant		
<b>Frequency and duration of use/exposure</b>		
8 hour shifts		
<b>Human factors not influenced by risk management</b>		
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	420 cm <sup>2</sup>	
Body weight	Not relevant	
<b>Other given operational conditions affecting workers exposure</b>		
Discharging from the mixer storage bin into filling station for packaging in big bag or drums. Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.		

Oral: Good workplace hygiene practice.	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<p><u>Inhalation</u>: Manually operated mechanised filling of big bags (1 m<sup>3</sup>) with powder may give rise to significant exposures to Ni dust where there is incomplete sealing of (bag's) spout around discharge pipe and during closing of bag. Automated drum filling with some manual interventions (such as loading empty /unloading full drums, closing lids and manually adding/ removing pellets to achieve the correct mass) during filling drums with Ni powder are likely to give rise to significant exposures to Ni powder and dust.</p> <p><u>Dermal</u>: Automation of processes should be used where possible to eliminate dermal contact.</p>	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required for process steps that are not fully enclosed and are likely to give rise to Ni dust	
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
None	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<p><u>Inhalation</u>: RPE (APF 20){approved with regard to EN 149 (half-mask disposable respirators)} is required. If powders with &gt; 10% of the particle in the respirable size range, <i>i.e.</i> &lt; 10 µm, is being handled, use RPE approved to EN 136 mask and EN 143 filter (APF 40)</p> <p><u>Dermal</u>: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with Ni dust could occur.</p>	
<b>2.8 Control of workers exposure for contributing exposure scenario ES 4.7</b>	
Cleaning and maintenance	
<b>Workers related free short title</b>	Production of nickel based powders from NiO-containing materials
<b>Use descriptor covered</b>	PROC 0: Cleaning and maintenance
<b>Processes, tasks, activities covered</b>	Cleaning and maintenance
<b>Assessment Method</b>	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
<b>Product characteristic</b>	
Dust from moist or dry Ni powder	
<b>Amounts used</b>	
Not relevant	
<b>Frequency and duration of use/exposure</b>	
8 hour shifts	
<b>Human factors not influenced by risk management</b>	
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	1500 cm <sup>2</sup>
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
<p>Cleaning and maintenance work of plant and premises can include scheduled regular and intermittent/occasional tasks of long and short duration which lead to high exposure to dust. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice</p>	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
Use vacuum and pressure washing with water to remove Ni powder and dust during cleaning.	
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
None	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<p><u>Inhalation</u>: RPE (APF 20) {approved with regard to EN 149 (half-mask disposable respirators)} is required. If powders with &gt; 10% of the particle in the respirable size range, <i>i.e.</i> &lt; 10 µm, is being handled, use RPE approved to EN 136 mask and EN 143 filter (APF 40)</p> <p><u>Dermal</u>: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with Ni dust could occur.</p>	
<b>3. Exposure and risk estimation</b>	
<b>Environment</b>	
<p>ERC 6a Production of nickel based powders</p>	

Compartment	Unit	PNEC	PEC <sub>Regional</sub>	C <sub>local</sub>	PEC	RCR	Methods for calculation of environmental concentrations
ES 2: Freshwater direct discharge							Measured values, Tier 3-RWC
Freshwater	µg Ni/L	7.1	2.9	2.31	5.21	0.73	
Sediment	mg Ni/kg	136	33.5	60.9	94.4	0.69	
Terrestrial	mg Ni/kg	29.9	16.2	0.03	16.23	0.54	
ES 3: Marine direct discharge							
Marine water	µg Ni/L	8.6	0.3	2.95	3.25	0.38	
Sediment	mg Ni/kg	136	16.1	77.6	93.7	0.69	
Terrestrial	mg Ni/kg	29.9	16.2	0.02	16.22	0.54	

### Workers

ES 4.1 PROC 8b: Raw materials handling						
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure	
Dermal						
Acute systemic	mg Ni /kg/day	-	NR	-		
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-		
Long-term systemic	mg Ni /kg/day	-	NR	-		
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.0005	0.041	90 <sup>th</sup> percentile from MEASE modelling (PROC8b, gloves)	
Inhalation						
Acute local	mg Ni/m <sup>3</sup>	3.9	0.220	0.06	Estimated as 3x the long-term value	
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.073	1.5 excl RPE By use of RPE (P3, APF 20): 0.0734	Highest of 2 personal exposure measurements for 'adding materials'; inhalable fraction	
ES 4.2 PROC 22: Smelting						
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure	
Dermal						
Acute systemic	mg Ni /kg/day	-	NR	-		
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-		
Long-term systemic	mg Ni /kg/day	-	NR	-		
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.0005	0.041	90 <sup>th</sup> percentile from MEASE modelling (PROC22, automated, enclosed)	
Inhalation						
Acute local	mg Ni/m <sup>3</sup>	3.9	0.6	0.15	Estimated as 3x the long-term value	
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.2	4 excl. RPE By use of RPE (P3, APF 20): 0.2	Single personal exposure measurement for 'smelting'; assumed to be inhalable fraction	



<b>ES 4.3</b> PROC 4, PROC 24, PROC 27: Alloying and Atomising					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
<b>Dermal</b>					
Acute systemic	mg Ni /kg/day	-	NR	-	
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-	
Long-term systemic	mg Ni /kg/day	-	NR	-	
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.00005	0.004	90 <sup>th</sup> percentile from MEASE modelling (PROC27, automated with manual intervention, gloves)
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	1.35	0.35	Estimated as 3x the long-term value
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.45	9 excl. RPE  By use of RPE (P3, APF 20): 0.45	Highest of 2 measurements associated with 'granulating'
<b>ES 4.4</b> PROC 4, PROC 2: Drying					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
<b>Dermal</b>					
Acute systemic	mg Ni /kg/day	-	NR	-	
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-	
Long-term systemic	mg Ni /kg/day	-	NR	-	
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.00005	0.004	90 <sup>th</sup> percentile from MEASE modelling (PROC2, 4, automated with manual intervention, gloves)
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	0.039	0.01	Estimated as 3x the long-term value
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.013	0.26	90 <sup>th</sup> percentile from MEASE modelling
<b>ES 4.5</b> PROC 4: Blending and Sieving					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
<b>Dermal</b>					
Acute systemic	mg Ni /kg/day	-	NR		
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mg Ni /kg/day	-	NR		
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.00005	0.004	90 <sup>th</sup> percentile from MEASE modelling (PROC4,

					mechanised, gloves)
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	0.66	0.17	Estimated as 3x the long-term value
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.22	4.4 excl. RPE By use of RPE (P3, APF 20): 0.22	Highest of 3 measurements associated with blending and sieving
<b>ES 4.6 PROC 9: Packaging</b>					
	<b>Unit</b>	<b>DNEL NiO</b>	<b>Exposure concentration</b>	<b>RCR</b>	<b>Methods for calculation of exposure</b>
<b>Dermal</b>					
Acute systemic	mg Ni /kg/day	-	NR	-	
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-	
Long-term systemic	mg Ni /kg/day	-	NR	-	
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.011	0.91	Read across from dermal exposure to insoluble Ni for packing Ni Metal Powder
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	1.93	0.5	Estimated as 10 x the long-term value for operations involving handling of powdered product
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.193	3.86 excl. RPE By use of RPE (P3, APF 20): 0.193	Highest of four measurements (3 personal, 1 static) associated with filling big bags and small containers
<b>ES 4.7 PROC 0: Maintenance and Cleaning</b>					
	<b>Unit</b>	<b>DNEL NiO</b>	<b>Exposure concentration</b>	<b>RCR</b>	<b>Methods for calculation of exposure</b>
<b>Dermal</b>					
Acute systemic	mg Ni /kg/day	-	NR	-	
Acute local	mg Ni/cm <sup>2</sup> /day	-	NR	-	
Long-term systemic	mg Ni /kg/day	-	NR	-	
Long-term local	mg Ni/cm <sup>2</sup> /day	0.012	0.00003	0.0025	90 <sup>th</sup> percentile from MEASE modelling (PROC10, no direct handling, non dispersive techniques, no more than 4 hours, gloves)
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	0.087	0.022	Estimated as 3x the long-term

					value
local	Long-term systemic and	mg Ni/m <sup>3</sup>	0.05	0.029	0.58 excl. RPE By use of RPE (P3, APF 20): 0.029
Single exposure measurement – please verify if covers general heavy duty maintenance and cleaning					
NR: Not Relevant					
Acute local inhalation DNEL based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher					
<b>4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES</b>					
<b>Environment</b>					
Scaling tool: Metals EUSES IT tool (free download: <a href="http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool">http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool</a> )					
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 <sub>local</sub> approach).					
Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C <sub>local</sub> approach).					
<b>Workers</b>					
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 <sup>3</sup> . Respirable fraction exposure levels should be kept below 0.01 mg Ni/m <sup>3</sup> .					
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: <a href="http://www.nickelconsortia.eu/exposure-scenario-library.html">http://www.nickelconsortia.eu/exposure-scenario-library.html</a>					

## Man via Environment exposure and risk characterisation assessments for the production of nickel-based powders from nickel oxide

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<sup>3</sup> as annual average in PM<sub>10</sub> 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<sub>local</sub>) of 15.5 ng Ni/m<sup>3</sup>. The value of 15.5 is derived from the difference between the DNEL of 20 ng Ni/m<sup>3</sup> and the EU regional background concentration (C<sub>regional</sub>) of 4.5 ng Ni/m<sup>3</sup> (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 <sub>local</sub> (ng/m <sup>3</sup> )	C <sub>regional</sub> (ng/m <sup>3</sup> )	PEC <sub>local</sub> (ng/m <sup>3</sup> )	RCR = PEC/DNEL (DNEL= 20 ng/m <sup>3</sup> )
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