

1. Title		Version 5, 2015
<b>GES 10 Production of NiZn cores and solids from NiO powder</b>		
Life cycle	DU of NiO	
Free short title	Production of NiZn cores and solids from NiO-containing powders	
Systematic title based on use descriptor	<b>SU:</b> SU 3 Industrial use <b>PC:</b> PC 0: Other <b>ERC:</b> ERC 5 Industrial use resulting in inclusion into or onto a matrix <b>PROC:</b> PROC 2 Used in closed continuous processes with occasional controlled exposures PROC 8b Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises PROC 9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 23 Open processing and transfer operations with minerals/metals at elevated temperatures. PROC 27a Production of metal powders (hot processes) PROC 0 Cleaning and maintenance	
Processes, tasks, activities covered (environment)	Production of nickel-based powders: Powder mixing, smelting, atomisation; spraying, drying, sieving, filling in bags/drums, cleaning and maintenance	
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 10.1 PROC 8b, PROC 9: Raw materials handling Contributing exposure scenario ES 10.2 PROC 2, PROC 4, PROC 23, PROC 27a: Production of NiZn solids. Contributing exposure scenario ES 10.3 PROC 0: Cleaning and maintenance	
<b>2. Operational conditions and risk management measures</b>		
<b>2.1 Control of environmental exposure</b>		
Environmental related free short title	Use of Nickel oxide for the production of NiZn- ferrite powder	
Systematic title based on use descriptor (environment)	ERC 5 Industrial use resulting in inclusion into or onto a matrix	
Processes, tasks, activities covered (environment)	Blending of solids, preliminary process, milling, binders addition, spray drying, pressing and sintering	
Environmental Assessment Method	Estimates based on SPERC for Formulation of massive metal and metal powder in alloys (ARCHE/EUROMETAUX, SPERC fact sheet v1.1)	
<b>Product characteristics</b>		
Nickel oxide (powder), iron oxides (Fe <sub>2</sub> O <sub>3</sub> ) powder, and Zn oxides (ZnO)		
<b>Amounts used</b>		
Maximum daily use at a site	1.5 tonnes	
Maximum annual use at a site	ES 1, 2 & 3: 338 tonnes (2007)	
<b>Frequency and duration of use</b>		
Pattern of release to the environment	Water: 225 days per year per site (SPERC) Air: 225 days per year per site (SPERC)	
<b>Environment factors not influenced by risk management</b>		
Receiving surface water flow rate	ES 1 Discharge to STP: 18,000 m <sup>3</sup> /d (Effluent STP: 2000 m <sup>3</sup> /d) ES 2 Direct discharge: 18,000 m <sup>3</sup> /d (Effluent Site: 2000 m <sup>3</sup> /d)	
Dilution capacity, freshwater	ES 1 Discharge to STP: 10 ES 2 Direct discharge: 10	
Dilution capacity, marine	ES 3 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>		

<p>On-site wastewater treatment by chemical precipitation, sedimentation, filtration and/or electrolysis. (Efficiency 99.9 %)  Off-site wastewater treatment in municipal STP for ES 1 (Efficiency 40 %).  ES 1, 2 &amp; 3: Release factor after on-site treatment based on SPERC for Formulation of massive metal and metal powder in alloys: 50 g Ni/T</p>	
<p><b>Air:</b>  Treatment of air emission by use of fabric or bag filters, wet scrubbers (Efficiency 99 %).  ES 1, 2 &amp; 3: Release factor after on-site treatment based on SPERC for Formulation of massive metal and metal powder in alloys: 50 g Ni/T</p>	
<p><b>Organizational measures to prevent/limit release from site</b></p>	
<p>None</p>	
<p><b>Conditions and measures related to municipal sewage treatment plant</b></p>	
<p><b>Municipal Sewage Treatment Plant (STP)</b></p>	<p>Yes for ES 1 Discharge to STP</p>
<p><b>Discharge rate of the Municipal STP</b></p>	<p>2000 m<sup>3</sup>/d (default)</p>
<p><b>Incineration of the sludge of the Municipal STP</b></p>	<p>The sludge is applied to agricultural soil</p>
<p><b>Conditions and measures related to external treatment of waste for disposal</b></p>	
<p>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.</p>	
<p><b>Fraction of daily/annual use</b> expected in waste:</p> <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>	
<p><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*</p>	
<p><b>Suitable disposal:</b> Keep separate and dispose of to either</p> <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>	
<p><b>Conditions and measures related to external recovery of waste</b></p>	
<p>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, local</sub>(shredding)=26kg Ni/day  (Note: This Q<sub>max, local</sub> 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)</p>	
<p><b>2.2 Control of workers exposure for contributing exposure scenario ES 10.1</b></p>	
<p>Raw material handling</p>	
<p><b>Workers related free short title</b></p>	<p>Production of NiZn cores and solids from NiO-containing powders</p>
<p><b>Use descriptor covered</b></p>	<p>PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities  PROC 9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing)</p>
<p><b>Processes, tasks, activities covered</b></p>	<p>Raw material handling operations involve transfer of NiO powder to and from containers, sampling and weighing.</p>
<p><b>Assessment Method</b></p>	<p>Exposure estimated using a Tier 1 model</p>
<p><b>Product characteristic</b></p>	

NiO is in powder form. NiO is present at > 25%	
<b>Amounts used</b>	
Not relevant	
<b>Frequency and duration of use/exposure</b>	
8 hour shifts, task duration up to 8 hrs/day	
<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	960 cm <sup>2</sup>
Body weight	70 kg
<b>Other given operational conditions affecting workers exposure</b>	
Transfer of NiO powder occurs through open vessels in automated processes.	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<u>Inhalation</u> : Open powder transfer operations are likely to give rise to significant exposures to inhalable NiO powder.	
<u>Dermal</u> : Automation of process limits 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 operations that are likely to give rise to NiO dust or fumes	
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>	
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.	
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>	
<u>Inhalation</u> : Use of RPE (FFP3, APF 40) is required.	
<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 10.2</b>	
Production of NiZn solids.	
<b>Workers related free short title</b>	Production of NiZn cores and solids from NiO-containing powders
<b>Use descriptor covered</b>	PROC 2 Used in closed continuous processes with occasional controlled exposures PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises PROC 23 Open processing and transfer operations with minerals/metals at elevated temperatures. PROC 27a Production of metal powders (hot processes)
<b>Processes, tasks, activities covered</b>	Milling, spray, drying, pressing and sintering processes.
<b>Assessment Method</b>	Exposure estimated using a Tier 1 model
<b>Product characteristic</b>	
NiO is in powder form. NiO is present at > 25% in concentration.	
<b>Amounts used</b>	
Not relevant	
<b>Frequency and duration of use/exposure</b>	
8 hour shifts; task duration maximum 4 hrs/shift	
<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	1980 cm <sup>2</sup>
Body weight	70 kg
<b>Other given operational conditions affecting workers exposure</b>	
Milling involves producing powder from solid materials. Pressing and sintering operations involve making solid objects from metal powders at elevated temperature conditions.	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
<u>Inhalation</u> : Open transfer operations are likely to give rise to significant exposures to inhalable Ni oxide fumes 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 involve NiO operations that are likely to give rise to NiO	

dust or fumes							
<b>Organisational measures to prevent /limit releases, dispersion and exposure</b>							
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces							
<b>Conditions and measures related to personal protection, hygiene and health evaluation</b>							
Inhalation: Use of RPE (FFP3, APF 20 or APF 40) dust filter masks are required.							
Dermal: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with NiO could occur.							
<b>2.4 Control of workers exposure for contributing exposure scenario ES 10.3</b>							
Cleaning and maintenance							
<b>Workers related free short title</b>				Production of NiZn cores and solids from NiO-containing powders			
<b>Use descriptor covered</b>				PROC 0: Cleaning and maintenance			
<b>Processes, tasks, activities covered</b>				Cleaning and maintenance			
<b>Assessment Method</b>				Exposure estimated using a Tier 1 model			
<b>Product characteristic</b>							
NiO is present in the form of powder. NiO is present more than 25% in concentration.							
<b>Amounts used</b>							
Not relevant							
<b>Frequency and duration of use/exposure</b>							
8 hour shifts. Task duration maximum 4 hrs/shift							
<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				960 cm <sup>2</sup>			
Body weight				70 kg			
<b>Other given operational conditions affecting workers exposure</b>							
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							
<b>Technical conditions and measures at process level (source) to prevent release</b>							
None.							
<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>							
Inhalation: Use of RPE (FFP3, APF 20 or APF 40) is required							
Dermal: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with NiO could occur.							
<b>3. Exposure and risk estimation</b>							
<b>Environment</b>							
ERC 5							
Use of Nickel oxide for the production of NiZn- ferrite powder							
Compartment	Unit	PNEC	PEC <sub>Regional</sub>	C <sub>local</sub>	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	1.61	4.51	0.64	
STP	mg Ni/L	0.33	-	-	0.023	0.07	
Sediment	mg Ni/kg	136	33.5	42.4	75.9	0.56	
Terrestrial	mg Ni/kg	29.9	16.2	0.71	16.91	0.57	
ES 2: Freshwater direct discharge							Measured values, Tier 3-RWC
Freshwater	µg Ni/L	7.1	2.9	2.69	5.59	0.79	
Sediment	mg Ni/kg	136	33.5	70.7	104.2	0.77	
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	0.27	0.57	0.07	
Sediment	mg Ni/kg	136	16.1	7.1	23.2	0.17	
Terrestrial	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	

### Workers

#### ES 10.1

PROC 8b, PROC 9: Raw materials handling

	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	Exposure estimated using MEASE for PROC 9 (medium dustiness solid, NiO present in higher than 25% concentration, industrial use, greater than 4 hours of operation, non-dispersive use, non-direct handling, intermittent exposure, and properly designed gloves).
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	11	2.8 Excluding RPE  By use of RPE (APF 20): 0.14	10 X the long-term exposure estimate.
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	1.1	22 Excluding RPE  1.1 with APF=20  By use of RPE (APF 40): 0.55	Exposure estimated using MEASE for PROC 9 (medium dustiness solid, NiO present in higher than 25% concentration, industrial use, greater than 4 hours of operation, non-dispersive use, non-direct handling, intermittent exposure, use of LEV assumed

#### ES10.2

PROC 2, PROC 4, PROC 23, PROC 27a: Production of NiZn solids.

	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	0.00003	0.0025	Exposure estimated using MEASE for PROC 27a

					(medium dustiness solid, NiO present in higher than 25% concentration, industrial use, less than 4 hours of operation, non-dispersive use, non-direct handling, intermittent exposure, and properly designed gloves).
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	6.6	1.70 excluding RPE By use of RPE (APE 20): 0.09	10 X the long-term exposure estimate.
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.66	13.2 excluding RPE By use of RPE (APF 20): 0.66	Exposure estimated using MEASE for PROC 27a (medium dustiness solid, NiO present in higher than 25% concentration, Industrial use, less than 4 hours of operation, non-dispersive use, non-direct handling, intermittent exposure. LEV is assumed.
<b>ES 10.3</b>					
PROC 0: Cleaning and maintenance					
	<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	0.00005	0.004	Exposure estimated using MEASE for PROC 10 (Medium dustiness solid, NiO present in higher than 25% concentration, Industrial use, greater than 4 hours of operation, non-dispersive use, non-direct handling, intermittent exposure, and properly designed gloves).
<b>Inhalation</b>					
Acute local	mg Ni/m <sup>3</sup>	3.9	1.98	0.5 excluding RPE	3 X the long-term exposure estimate.
Long-term systemic and local	mg Ni/m <sup>3</sup>	0.05	0.66	13.2 Excluding RPE By use of RPE (APF 20): 0.66	Exposure estimated using MEASE for PROC 10 (Medium dustiness solid, NiO present in higher than 25% concentration, Industrial use, less than 4 hours of

					operation, non-dispersive use, non-direct handling, intermittent exposure, use of LEV assumed.
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					
<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 ( $C_{local}$ approach).					
Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration ( $C_{local}$ 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 NiZn cores and solids from NiO powder

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 ( $C_{local}$ ) 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 ( $C_{regional}$ ) 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)	$C_{local}$ (ng/m <sup>3</sup> )	$C_{regional}$ (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