

1. Title		Version 6, 2015
<b>GES 15 Production of magnets (powder use)</b>		
Life cycle	End use – DU of Ni metal	
Free short title	Production of magnets (powder use)	
Systematic title based on use descriptor	SU: SU 3 Industrial use SU15 Manufacture of fabricated metal products, except machinery and equipment PC: PC7: Base metals and alloys 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 5: Mixing or blending in batch process for formulation of preparations and articles (multi stage and/or significant contact) PROC 14: Production of preparations or articles by tableting, compression, extrusion, pelettisation PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature PROC 23: Open processing and transfer operations with metals at elevated temperature PROC 24: High (mechanical) energy work-up of substance bound in materials PROC 26: Handling of solid inorganic substances at ambient temperature PROC 0: Cleaning and maintenance	
Processes, tasks, activities covered (environment)	Production of magnets (powder use)	
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 15.1: PROC 8a: Raw material handling Contributing exposure scenario ES 15.2 PROC 5: Mixing and blending Contributing exposure scenario ES 15.3 PROC 14: Compacting and Pressing Contributing exposure scenario ES 15.4: PROC 22, 23: Smelting and sintering Contributing exposure scenario ES 15.5: PROC 24: Processing of cast product Contributing exposure scenario ES 15.6: PROC 26: Packing Contributing exposure scenario ES 15.7: 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	Production of magnets (powder use)	
Systematic title based on use descriptor (environment)	ERC 5: Industrial use resulting in inclusion into or onto a matrix	
Processes, tasks, activities covered (environment)	Production of magnets (powder use)	
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC	
<b>Product characteristics</b>		
Raw material: Ni briquettes, granules 30-60 mm in size. powder 0.001-0.15mm in size		
<b>Amounts used</b>		
Maximum daily use at a site	ES 1, 2 & 3: 180 kg Ni/day	
Maximum annual use at a site	ES 1, 2 & 3: 45 tonnes Ni (2007)	

<b>Frequency and duration of use</b>	
<b>Pattern of release to the environment</b>	250 days per year per site
<b>Environment factors not influenced by risk management</b>	
<b>Receiving surface water flow rate</b>	ES 1 Discharge to STP: 18,000 m3/d (Effluent STP: 2000 m3/d) ES 2 Direct discharge: 99 m3/d (Effluent Site: 1 m3/d)
<b>Dilution capacity, freshwater</b>	ES 1: Discharge to STP: 10 (default) ES 2: Direct discharge: 100
<b>Dilution capacity, marine</b>	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>	
ES 1 Discharge to STP: On-site wastewater treatment 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: 2.14 g/T ES 2 Freshwater direct discharge: Release factor after on-site treatment: 2.14 g/T ES 3 Marine direct discharge: Release factor after on-site treatment: 2.14 g/T	
<b>Air:</b>	
Treatment of stack air emission (fabric or bag filters). ES 1, 2 & 3: Release factor after on-site treatment: 170 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>	Yes for ES 1 Discharge to STP
<b>Discharge rate of the Municipal STP</b>	2000 m <sup>3</sup> /d (default)
<b>Incineration of the sludge of the Municipal STP</b>	The sludge is applied to agricultural soil
<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> </ul>	

- Hazardous landfill operated under Directive 1999/31/EC.	
<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. Qmax, local(shredding)=26kg Ni/day (Note: This Qmax, local for shredders is based on the existing information at the moment of the update. It will be reviewed when new information is available from the BREF for shredding)	
<b>2.2 Control of workers exposure for contributing exposure scenario ES 15.1</b>	
Raw material handling (nickel powder and granules)	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities
<b>Processes, tasks, activities covered</b>	Raw material handling including loading, weighing, filling, pouring, bagging etc
<b>Assessment Method</b>	Estimation of exposure based on measured data
<b>Product characteristic</b>	
Nickel (electrodes, briquettes etc) 30-60 mm in size or powder 75 µm<particle size<150 µm and 1 µm - 15 µm supplied in drums or big bags. Ni powder: Concentration of Ni: > 95% in Ni powders or 30% Ni in powdered alloys	
<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	Not relevant
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Dermal: Design workplace and work processes to minimise direct contact with the materials. 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 of LEV is required for operations such as transfer, weighing and mixing where dust release is likely.	
<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 (FP3, APF 20) is required for cleaning and maintenance operations where exposure to Ni dust or powder is possible. Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations.	
<b>2.2 Control of workers exposure for contributing exposure scenario ES 15.2</b>	
Mixing and blending (nickel powder)	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 5: Mixing or blending in batch

	process for formulation of preparations and articles (multi stage and/or significant contact)
<b>Processes, tasks, activities covered</b>	Nickel powder is mixed with other powders in closed vessels.
<b>Assessment Method</b>	Exposure estimated using Tier 1 model
<b>Product characteristic</b>	
Raw material: Ni Powder: 0.001-0.15mm in size supplied in metallic drums. Ni powder: Concentration of Ni: > 95% in Ni powders or 30% Ni in powdered alloys	
<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>	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Dermal: Design workplace and work processes to minimize direct contact with the materials. Oral: Good workplace hygiene practice	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
Mixing and blending shall be carried out in closed system.	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
Use of LEV is required for operations such as weighing and mixing where dust release is likely.	
<b>Organizational 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 (FP3, APF 20) is required for cleaning and maintenance operations where exposure to Ni dust or powder is possible. Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations.	
<b>2.2 Control of workers exposure for contributing exposure scenario ES 15.3</b>	
Compacting and Pressing	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 14: Production of preparations or articles by tableting, compression, extrusion, or pelettisation
<b>Processes, tasks, activities covered</b>	Powder mixture containing Nickel is manually loaded into compacting machines where it is compacted into certain form. After compacting, parts are loaded into containers for heat treatment.
<b>Assessment Method</b>	Exposure estimated using Tier 1 model
<b>Product characteristic</b>	
Powder: 0.001-0.15mm in size supplied in metallic drums. Ni powder alloys: Concentration of Ni: > 30% in 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>	
Apply ambient temperature and humidity. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Dermal: Design workplace and work processes to minimize direct contact with the materials. Oral: Good workplace hygiene practice	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
Compacting and pressings shall be carried out in closed system	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
Use of LEV is required for operations such as weighing, mixing, and transfer where dust release is likely.	
<b>Organizational 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 (FP3, APF 20) is required for cleaning and maintenance operations where exposure to Ni dust or powder is possible. Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations.	
<b>2.3 Control of workers exposure for contributing exposure scenario ES 15.4</b>	
Smelting and sintering	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 22: Potentially closed processing operations with metals at elevated temperature PROC 23: Open processing and transfer operations with metals at elevated temperature
<b>Processes, tasks, activities covered</b>	Smelting and sintering including pouring melt into casts and cooling melt in casts
<b>Assessment Method</b>	Estimation of exposure based on measured data
<b>Product characteristic</b>	
Raw material: granules 30-60 mm in size supplied in drums or big bags. Ni-powder: Concentration of Ni: > 95% or 30% Ni in powdered alloys	
<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	Not relevant
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
Smelting: Conducted in open induction furnaces operated and supervised on a semi-automated basis at temperatures of 1500-1600 C. LEV systems for removing gasses are in place. Melted alloy is poured into sand moulds and they are removed into closed cooling chamber with its own ventilation system. During melting and casting process people are present in vicinity all the time.  Sintering: Carried out in closed vacuum furnaces at temperatures of about 1200 - 1380 C. , Furnaces for thermo-magnetic and thermal treatments ~550 - 1380°C. Nickel powder is mixed with iron powder, titanium hydride powder, proprietary pre-alloy powders  Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Dermal: Design workplace and work processes to minimize direct contact with the materials. Smelting and sintering shall be partly or fully automated	

Oral: Good workplace hygiene practice	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
Extraction of furnace gases to prevent discharge of metal fume into workplace air.	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required at the smelter as well as in cooling chambers.	
<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: Sintering RPE (FP3, APF 20) for manual loading and unloading of furnaces. Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations.	
<b>2.4 Control of workers exposure for contributing exposure scenario ES 15.5</b>	
Processing of cast product	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 24: High (mechanical) energy work-up of substance bound in materials
<b>Processes, tasks, activities covered</b>	Processing of cast product including cleaning in a sandblasting machine, grinding, thermal treatments at elevated temperatures and pre-alloy powder production for internal use
<b>Assessment Method</b>	Estimation of exposure based on measured data
<b>Product characteristic</b>	
Cast parts: 10-100 g of Ni alloys Concentration of Ni: > 95% or 30% Ni in powdered alloys	
<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	Not relevant
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
Post-casting treatments: Sandblasting: enclosed process Cleaning and grinding: ambient temperature, pressure, humidity Thermal treatments: elevated temperatures (not specified) Pre-alloy powder: ambient temperature, pressure, humidity; hammer crusher enclosed.	
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Dermal: Design workplace and work processes to minimize direct contact with the materials. Grinding operations shall be automated. Oral: Good workplace hygiene practice	
<b>Technical conditions and measures at process level (source) to prevent release</b>	
Total enclosure is required for sandblasting and automated grinding and cutting operations. Use of water or vacuum fitted with a HEPA filter to remove dusts and powders during cleaning	
<b>Technical conditions and measures to control dispersion from source towards the worker</b>	
LEV is required for operations such as weighing and mixing where dust release is likely, for grinding and cutting where direct handling of product required and on crusher, mills and sieves used in powder production.	
<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 (FP3, APF 20) is required for cleaning and maintenance operations where exposure to Ni dust or powder is possible.

Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations.

### 2.5 Control of workers exposure for contributing exposure scenario ES 15.6

Packing	
<b>Workers related free short title</b>	Production of magnets (powder use)
<b>Use descriptor covered</b>	PROC 26: Handling of solid inorganic substances at ambient temperature
<b>Processes, tasks, activities covered</b>	Packing and shipping
<b>Assessment Method</b>	Estimation of exposure based on measured data
<b>Product characteristic</b>	
Cast parts: 10-100 g of Ni alloys	
<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	Not relevant
Body weight	Not relevant
<b>Other given operational conditions affecting workers exposure</b>	
Packing: Products are manually packed in various types of packaging: PVC bags or vacuum packing in PA/PE bags or plastic tubes and put into corrugated cardboard boxes, directly into corrugated cardboard boxes into blister plates and plastic containers.	
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.	
Dermal: Design workplace and work processes to minimise direct contact with the materials.	
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>	
None	
<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>	
Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations	
<b>2.5 Control of workers exposure for contributing exposure scenario ES 15.7</b>	
Cleaning and maintenance	
<b>Workers related free short title</b>	Production of magnets (powder use)
<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 exposure based on measured data
<b>Product characteristic</b>	
Raw material: granules 30-60 mm in size supplied in drums or big bags.	
Cast parts: 10-100 g of Ni alloys	
Ni powder: Concentration of Ni: > 95% in Ni powders or 30% Ni in powdered alloys	
<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	Not relevant						
Body weight	Not relevant						
<b>Other given operational conditions affecting workers exposure</b>							
Smelting furnace is cleaned manually with hand tools, metal residues are gathered and stored for recycling. Manual cleaning of filters at sandblasting machine, cleaning of grinding machines and removal and storing of the grinding sludge for recycling or selling.							
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.							
Dermal: Design workplace and work processes to minimise direct contact with the materials.							
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 of water or vacuum fitted with a HEPA filter to remove dusts and powders 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 (FP3, APF 20) is required for cleaning and maintenance operations where exposure to Ni dust or powder is possible.							
Dermal: Gloves and other appropriate protective clothing are required for operations where direct contact is possible, such as handling raw materials or finished product and for cleaning and maintenance operations							
<b>3. Exposure and risk estimation</b>							
<b>Environment</b>							
ERC 5: Production of magnets (powder use)							
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	0.01	2.91	0.41	
STP	mg Ni/L	0.33	-	-	<0.001	<0.01	
Sediment	mg Ni/kg	136	33.5	0.2	33.7	0.25	
Terrestrial	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	
ES 2: Freshwater direct discharge							
Freshwater	µg Ni/L	7.1	2.9	2.94	5.84	0.82	
Sediment	mg Ni/kg	136	33.5	77.3	110.8	0.82	
Terrestrial	mg Ni/kg	29.9	16.2	<0.01	16.20	0.54	
ES 3: Marine direct discharge							
Marine water	µg Ni/L	8.6	0.3	2.94	3.24	0.38	
Sediment	mg Ni/kg	136	16.1	77.3	93.4	0.69	
Terrestrial	mg Ni/kg	29.9	16.2	<0.01	16.20	0.54	
<b>Workers</b>							
<b>ES 15.1</b>							
PROC 8a: Raw material handling							
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure		
Dermal							
Acute systemic	mgNi/kg/day	-	NR				
Acute local	mgNi/cm <sup>2</sup> /day	-	NR				
Long-term systemic	mgNi/kg/day	-	NR				
Long-term local	mgNi/cm <sup>2</sup> /day	0.035	0.009	0.257	Estimated 75 <sup>th</sup> percentile for dermal exposure to		



					insoluble Ni
Inhalation					
Acute local	mgNi/m <sup>3</sup>	4.0	1	0.25	10 x 75 <sup>th</sup> percentile of long-term average for weighing and mixing. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.1	2 excl. RPE  By use of RPE (P3, APF 20): 0.1	Reasonable estimate of the 75 <sup>th</sup> percentile long-term mean exposure assuming LEV. The estimate was derived using data from powder metallurgy sector described in EU RAR (2008-2009), Hughson (2010) and limited data from the magnet sector.
<b>ES 15.2</b>					
PROC 5: Mixing and Blending					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm <sup>2</sup> /day	0.035	<0.001	<0.001	Exposure calculated using MEASE, a Tier 1 model for PROC 5. The process is assumed to be carried out in a closed system without breaches, with direct handling. It is assumed that workers wear gloves and only incidental exposure occurs.
Inhalation					
Acute local	mgNi/m <sup>3</sup>	4.0	0.33	0.083	10 x long-term exposure estimate. A factor of 10

					allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.033	0.66	Exposure calculated using MEASE, a Tier 1 model for PROC 5. The process is assumed to be carried out in a closed system without breaches, with direct handling. It is assumed that RPE is used (APF=20) and only incidental exposure occurs
<b>ES 15.3</b>					
PROC 14: Compacting and pressing					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm <sup>2</sup> /day	0.035	0.002	0.057	Exposure calculated using MEASE, a Tier 1 model. The process is assumed to be carried out in a closed system without breaches, with direct handling. It is assumed that workers wear gloves and only incidental exposure occurs.
Inhalation					
Acute local	mgNi/m <sup>3</sup>	4.0	0.33	0.083	10 x long-term exposure estimate. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a

					result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.033	0.66	Exposure calculated using MEASE, a Tier 1 model for PROC 14. The process is assumed to be carried out in a closed system without breaches, with direct handling. It is assumed that RPE is used (APF=20) and only incidental exposure occurs.
<b>ES 15.4</b>					
PROC 22, PROC 23: Smelting and sintering					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm <sup>2</sup> /day	0.035	0.009	0.257	Estimated 75 <sup>th</sup> percentile for dermal exposure to insoluble Ni
Inhalation					
Acute local	mgNi/m <sup>3</sup>	4.0	0.25	0.0625	10 x 75 <sup>th</sup> percentile long-term exposure estimate for furnace loading. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
Long-term	mgNi/m <sup>3</sup>	0.05	0.02	0.4	Estimated for furnace

systemic and local					loading partly or wholly automated. This estimate was derived using data from powder metallurgy sector described in EU RAR (2008-2009), and limited data from the magnet sector.
<b>ES 15.5</b>					
PROC 24: Processing of cast product					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mgNi/kg/day	-	NR		
Long-term local	mgNi/cm <sup>2</sup> /day	0.035	0.009	0.257	Estimated 75 <sup>th</sup> percentile for dermal exposure to insoluble Ni
Inhalation					
Acute local	mgNi/m <sup>3</sup>	4.0	0.1	0.025	10 x 75 <sup>th</sup> percentile of long-term average for processing of cast product. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.01	0.2	Estimated for automation and enclosure of grinding. This estimate was derived using data from powder metallurgy sector described in EU RAR (2008-2009), and limited data from the magnet sector.
<b>ES 15.6</b>					
PROC 26: Packing					
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mgNi/cm <sup>2</sup> /day	-	NR		

systemic	Long-term	mgNi/kg/day	-	NR		
local	Long-term	mgNi/cm <sup>2</sup> /day	0.035	0.009	0.257	Estimated 75 <sup>th</sup> percentile for dermal exposure to insoluble Ni
Inhalation						
	Acute local	mgNi/m <sup>3</sup>	4.0	0.1	0.025	10 x 75 <sup>th</sup> percentile of long-term average for packing. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also the material is in powdered form and would have considerable potential to release dust.
	Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.01	0.2	Estimate based on expert judgment and low dustiness of product
<b>ES 15.7</b>						
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 <sup>2</sup> /day	-	NR		
	Long-term systemic	mgNi/kg/day	-	NR		
	Long-term local	mgNi/cm <sup>2</sup> /day	0.035	0.009	0.257	Estimated 75 <sup>th</sup> percentile for dermal exposure to insoluble Ni
Inhalation						
	Acute local	mgNi/m <sup>3</sup>	4.0	0.1	0.025	10 x 75 <sup>th</sup> percentile of long-term average for Cleaning and Maintenance. A factor of 10 allows for the variability in exposure concentration through time that would be expected to arise as a result of the intermittent nature of the more dusty tasks involved in the initial stages of weighing and mixing and during finishing operations. Also

					the material is in powdered form and would have considerable potential to release dust.
Long-term systemic and local	mgNi/m <sup>3</sup>	0.05	0.01	0.2	Estimate based on low dustiness of process residues. This estimate was derived using expert judgment and limited data from the magnet sector.
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 magnets

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> )
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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