1. Title GES 6 Production of nickel-containing enamel frits	Version 6, 2015
Life cycle	Industrial use – DU of NiO
Free short title	Production of nickel-containing enamel frits from NiO
Systematic title based on use descriptor	**SU:** SU 3 Industrial use SU 9 Manufacture of fine chemicals **PC:** PC 19 Intermediate **ERC:** ERC 6a: Industrial use resulting in manufacture of another substance (use of intermediates) SPERC: Production and formulation of metal compounds **PROC:** PROC 2 Use in closed, continuous process with occasional controlled exposure (*e.g.* sampling) PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities 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) PROC 22 Potentially closed processing operations with minerals/metals at elevated temperature PROC 24 High mechanical energy work-up of substances bound in materials and articles
Processes, tasks, activities covered (environment)	Production of enamel frits: Dosing, mixing and oven charging; Oven discharge; Drying (if water quenching); Milling (dry or wet); Drying (if milled wet); Mixing and/or packaging; Laboratory; Cleaning and maintenance
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 6.1 PROC 8a, PROC 8b: Raw materials handling Contributing exposure scenario ES 6.2 PROC 22: Dosing, mixing and oven charging Contributing exposure scenario ES 6.3 PROC 22: Kilning, Quenching and Drying Contributing exposure scenario ES 6.4 PROC 24: Milling and Drying Contributing exposure scenario ES 6.5 PROC 2, PROC9 :Blending and/or packaging Contributing exposure scenario ES 6.6 PROC 0: Cleaning and maintenance
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Production of nickel-containing enamel frits from NiO
Systematic title based on use descriptor (environment)	ERC6A: Industrial use resulting in manufacture of another substance (use of intermediates) SPERC: Production and formulation of metal compounds
Processes, tasks, activities covered (environment)	Production of enamel frits: Dosing, mixing and oven charging; Oven discharge; Drying (if water quenching); Milling (dry or wet); Drying (if milled wet); Mixing and/or packaging; Laboratory; Cleaning and maintenance
Environmental Assessment Method	SPERCs data for metal and metal compounds are used in order to estimate releases to wastewater for the generic ES. Estimates based on regional concentrations are used for calculation of PEC.
Product characteristics	
The tonnage is based on Ni originating from the use of NiO as well as other Ni compounds used at same sites.	
Amounts used	

Maximum daily use at a site	0.1 - 0.2 tonnes Ni (median 50th % emission days, max tonnage)
Maximum annual use at a site	ES 1 & 2: 72 tonnes Ni ES 3: 42.5 tonnes Ni
Frequency and duration of use	
Pattern of release to the environment	340 days per year per site (median 50th %)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1 Discharge to STP: 18,000 m^3/d (Effluent STP: 100 m^3/d) ES 2 Direct discharge: 24,900 m^3/d (Effluent Site: 100 m^3/d)
Dilution capacity, freshwater	ES 1 Discharge to STP: 10 ES 2 Direct discharge: 250
Dilution capacity, marine	ES 3: 100 (default)
Other given operational conditions affecting environmental exposure	
None	
Technical conditions and measures at process level (source) to prevent release	
None	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Waste water: On-site wastewater treatment. Off-site wastewater treatment plant, municipal STP for ES1. ES 1, 2 & 3: Release factor after on-site treatment based on SPERCs data for "Manufacture of metal compounds" are used (Eurometaux, 2012). 400 g Ni/T **Air:** Treatment of air emissions by fabric or bag filters. ES 1, 2 & 3: Release factor after on-site treatment based on SPERCs data for "Manufacture of metal compounds" are used (Eurometaux, 2012). 30 g Ni/T	
Organizational measures to prevent/limit release from site	
None	
Conditions and measures related to municipal sewage treatment plant	
Municipal Sewage Treatment Plant (STP)	Yes for ES 1 Discharge to STP
Discharge rate of the Municipal STP	2000 m^3/d (default)
Incineration of the sludge of the Municipal STP	The sludge is applied to agricultural soil
Conditions and measures related to external treatment of waste for disposal	
Hazardous wastes from onsite risk management measures and solid or liquid wastes from production, use and cleaning processes should be disposed of separately to hazardous waste incineration plants or hazardous waste landfills as hazardous waste. Releases to the floor, water and soil are to be prevented. If the nickel content of the waste is elevated enough, internal or external recovery/recycling might be considered. **Fraction of daily/annual use** expected in waste: - Nickel producers = 0.05 % - DU: stainless steel and alloy steels = 0.6 % - DU: nickel alloys, copper alloys, foundry, batteries, catalysts, chemicals, dyes and others = 0.5 % - DU: Plating = 3% **Appropriate waste codes:** 01 03 07*, 02 01 10*, 06 03 13*, 06 03 15*, 06 04 05*, 06 05 02*, 10 08 04, 10 08 08*, 10 08 09, 10 08 15*, 10 08 16, 10 10 03, 10 10 05*, 10 10 07*, 10 10 09*, 10 10 10, 10 10 11*, 11 02 07*, 12 01 03*, 12 01 04, 15 01 04*, 15 01 10*, 16 01 04*, 16 01 06*, 16 01 08*, 16 06 02*, 16 06 05, 16 08 02*, 16 08 03*, 17 04 07*, 17 04 09*, 19 09 04*, 19 10 02*, 19 12 03* **Suitable disposal:** Keep separate and dispose of to either - Hazardous waste incineration operated according to Council Directive 2008/98/EC on waste, Directive 2000/76/EC on the incineration of waste and the Reference Document on the Best Available Techniques for Waste Incineration of August 2006. - Hazardous landfill operated under Directive 1999/31/EC.	

Conditions and measures related to external recovery of waste	
Shredders pre-treating metal wastes should have a maximum release factors to air of 0.0015 after RMM and no releases to water and soil. 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)	
2.2 Control of workers exposure for contributing exposure scenario ES 6.1	
Raw materials handling	
Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Processes, tasks, activities covered	1) NiO powder is automatically fed into an intermediate storage silo from a delivery tanker and automatically introduced into the process with no contact with operator. 2) NiO received in bags
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Nickel oxide powder with particle size quoted as 1) 100 % < 100 µm and 50 % > 10 µm and as 2) 95 % < 45 µm	
Amounts used	
Approximately 13 tonnes of nickel compounds annually (calculated as Ni)	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	480 cm^2
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
NiO is received either as NiO powder automatically (no operator contact) fed into an intermediate storage silo from a delivery tanker or received in bags. NiO powder is automatically introduced into the process with no contact with operator. Oral: Good workplace hygiene practice.	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Both manual and automated operations that are partly enclosed are likely to give rise to significant exposures to NiO powder and dust. Automatic enclosed operations are unlikely to give rise to significant exposure. Dermal: Automation of processes should be used where possible to reduce dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes that are not enclosed or other process steps that are likely to give rise to NiO dust	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (TH2 (APF 20) or FFP3) {powered mask approved with regard EN12941 *e.g.* SATA Vision 2000/CE 0299} is required at process steps that are not fully enclosed and are likely to give rise to Ni dust. Dermal: Suitable gloves *e.g.* leather gloves type "108 Super KM En 363, EN 420", goggles and special safety clothing are required where direct contact with NiO could occur.	
2.3 Control of workers exposure for contributing exposure scenario ES 6.2	
Dosing, mixing and oven charging	
Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 22 Potentially closed processing operations with minerals/metals at elevated temperature
Processes, tasks, activities covered	There are automated and manual options for dosing, mixing with other ingredients and charging the kiln. 1) NiO powder is transferred from the silo by screw or (open) belt conveyor

	to the balance cone where a charge is automatically weighed, then mixed with other ingredients and sent to the kiln. 2) NiO in bags are manually fed directly into the kiln
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Nickel oxide powder with particle size quoted as 1) 100 % < 100 µm and 50 % > 10 µm and as 2) 95 % < 45 µm	
Amounts used	
Approximately 13 tonnes of nickel compounds annually (calculated as Ni)	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	1980 cm^2
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
The raw materials are weighed out, mixed and transferred to the kiln for melting. Oral: Good workplace hygiene practice.	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Both manual and automated operations that are partly enclosed are likely to give rise to significant exposures to NiO powder and dust. Dermal: Automation of processes should be used where possible to reduce dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes that are not fully enclosed, such as manually tipping NiO from a bag into the kiln, or transfer of NiO powder between the silo, balance and kiln and other process steps that are likely to give rise to NiO dust	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (TH2 (APF 20) or FFP3) {powered mask approved with regard EN12941 *e.g.* SATA Vision 2000/CE 0299} is required at process steps that are not fully enclosed and are likely to give rise to Ni dust. Dermal: Suitable gloves *e.g.* leather gloves type "108 Super KM En 363, EN 420", goggles and special safety clothing are required where direct contact with NiO could occur..	
2.4 Control of workers exposure for contributing exposure scenario ES 6.3	
Kilning, quenching and drying	
Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 22 Potentially closed processing operations with minerals/metals at elevated temperature
Processes, tasks, activities covered	Heating NiO with other ingredients and quenching the melt in water or air. After water quenching the wet product is dried and may be transferred to packaging.
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Nickel oxide powder with particle size quoted as 1) 100 % < 100 µm and 50 % > 10 µm and as 2) 95 % < 45 µm and molten mixture of NiO and sodium oxide, calcium oxide, silica, diboron trioxide	
Amounts used	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	1980 cm^2

Body weight	Not relevant
Other given operational conditions affecting workers exposure	
The feed is heated to 1150 – 1250 °C in the kiln. The melt is usually quenched, by passing it through water cooled rollers or pouring it into a water bath, then either dried and packaged as a final product (see ES 3.4), sent (conveyor belt) to intermediate storage or transferred directly to milling. Oral: Good workplace hygiene practice.	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Both manual and automated operations that are not fully enclosed are likely to give rise to significant exposures to NiO-containing frit dust. Dermal: Automation of processes should be used where possible to reduce dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes not fully enclosed and likely to give rise to NiO-containing dust	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (FFP3) {approved with regard to EN 149 } *e.g.* Moldex 3305 FFP 2D/CE 0121/EN 149:2001 is required at process steps that are not fully enclosed and are likely to give rise to Ni containing dust Dermal: Suitable gloves *e.g.* leather gloves type 108 Super KM En 363, EN 420 are required where direct contact with NiO could occur.	
2.5 Control of workers exposure for contributing exposure scenario ES 6.4	
Milling and Drying	
Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 24 High mechanical energy work-up of substances bound in materials and articles
Processes, tasks, activities covered	Frits along with other raw materials are (wet or dry) milled and dried after wet milling.
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Dry or wet frits	
Amounts used	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	1980 cm^2
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
Frits are milled in a ball mill to the powder product and dried in a hot air drier after wet-milling. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Both manual and automated operations that are not fully enclosured are likely to give rise to significant exposures to NiO-containing frit powder and dust. Dermal: Automation of processes should be used where possible to reduce dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required for processes not fully enclosed and likely to give rise to NiO-containing dust	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (P3, APF 20) is required at process steps that are not fully enclosed and are likely to give rise to Ni containing dust. Dermal: Suitable gloves *e.g.* leather gloves type 108 Super KM En 363, EN 420 are required where direct contact with NiO-containing frits could occur.	
2.6 Control of workers exposure for contributing exposure scenario ES 6.5	
Blending and/or packaging	

Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 2 Use in closed, continuous process with occasional controlled exposure (*e.g.* sampling) PROC9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing)
Processes, tasks, activities covered	In some cases, frits are automatically extracted from the quenching bath and dried and then packed into bags or big bags. Once filled, big bags are decoupled from the feeder, closed by hand and transferred to the storage area. Bags are closed automatically.
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on read across from similar process for Ni metal.
Product characteristic	
NiO-containing powdered frit of unknown median diameter and frit recovered after quenching	
Amounts used	
Frequency and duration of use/exposure	
8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Not relevant
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	420 cm^2
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
The powder and 'quenched-only' frits are conveyed, directly or via intermediate storage, to the bagging line and big-bagging unit. The big-bagging of powder or 'quenched-only' frits into bulk container bags (1000 kg) is manually operated (hanging the empty bag in the unit, securing the bag sock or spout to the fill point, initiating/terminating the automatic filling of the bag, manually closing the full bag and driving it to the warehouse). Powder and 'quenched-only' frits are packed smaller (200 kg) using an automated line. Oral: Good workplace hygiene practice.	
Technical conditions and measures at process level (source) to prevent release	
Complete enclosure and automation of processes and should be used where possible to reduce inhalation and dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
General ventilation and LEV are required at processes that are not fully enclosed and likely to give rise to NiO-containing dust	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (P3, APF 20) is required at process steps that are not fully enclosed and are likely to give rise to Ni containing dust. Dermal: Suitable gloves *e.g.* leather gloves type 108 Super KM En 363, EN 420 are required where direct contact with NiO-containing frits could occur.	
2.7 Control of workers exposure for contributing exposure scenario ES 6.6	
Cleaning and maintenance	
Workers related free short title	Production of nickel-containing enamel frits from NiO
Use descriptor covered	PROC 0 Cleaning and maintenance
Processes, tasks, activities covered	Cleaning and maintenance operations are regularly performed on-site of equipment and installations used for handling of raw materials and final product
Assessment Method	Estimation of inhalation exposure and dermal exposure based on Tier 1 model.
Product characteristic	
Dust and powder from NiO-containing frits	
Amounts used	
Frequency and duration of use/exposure	

8 hour shifts	
Human factors not influenced by risk management	
Respiration volume under conditions of use	Light to medium level work, 10 m^3/d
Room size and ventilation rate	Not relevant
Area of skin contact with the substance under conditions of use	1500 cm^2
Body weight	70 kg
Other given operational conditions affecting workers exposure	
Dry vacuuming of spills and settled dust followed by wet power washing. Oral: Good workplace hygiene practice.	
Technical conditions and measures at process level (source) to prevent release	
None	
Technical conditions and measures to control dispersion from source towards the worker	
None	
Organisational measures to prevent /limit releases, dispersion and exposure	
None	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (FFP3, APF 20) {approved with regard to EN 149 } is required *e.g.* Moldex 3305 FFP 2D/CE 0121/EN 149:2001 Dermal: Suitable gloves are required *e.g.* leather gloves type 108 Super KM En 363, EN 420.	

3. Exposure and risk estimation

Environment

ERC6A: Industrial use resulting in manufacture of another substance (use of intermediates)
SPERC: Production and formulation of metal compounds
Production of nickel-containing enamel frits from NiO

Compartment	Unit	PNEC	$PEC_{Regional}$	C_{local}	PEC	RCR	Methods for calculation of environmental concentrations
ES 1: Freshwater STP discharge							Measured values, Tier 3-RWC
Freshwater	µg Ni/L	7.1	2.9	1.82	4.72	0.67	
STP	mg Ni/L	0.33	-	-	0.025	0.08	
Sediment	mg Ni/kg	136	33.5	47.9	81.4	0.60	
Terrestrial	mg Ni/kg	29.9	16.2	0.79	16.99	0.57	
ES 2: Freshwater direct discharge							
Freshwater	µg Ni/L	7.1	2.9	2.43	5.33	0.75	
Sediment	mg Ni/kg	136	33.5	63.9	97.4	0.72	
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	3.59	3.89	0.45	
Sediment	mg Ni/kg	136	16.1	63.9	97.4	0.72	
Terrestrial	mg Ni/kg	29.9	16.2	<0.01	16.20	0.54	

Workers

ES 6.1
PROC 8a, PROC 8b: Raw material 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^2/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm^2/day	0.012	0.0005	0.041	90th percentile from MEASE modelling (PROC8a, 8b, partly enclosed, gloves)
Inhalation					
Acute local	mg Ni/m^3	3.9	0.03	0.008	Estimated as 3x the long-term value

Long-term systemic and local	mg Ni/m^3	0.05	0.01	0.2	Highest of 3personal exposure measurement reported for dosing, mixing and oven charging[1]
ES 6.2 PROC 22: Dosing, mixing and oven charging					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm^2/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm^2/day	0.012	0.0005	0.041	90th percentile from MEASE modelling (PROC22, automated, enclosed)
Inhalation					
Acute local	mg Ni/m^3	3.9	0.03	0.008	Estimated as 3x the long-term value
Long-term systemic and local	mg Ni/m^3	0.05	0.01	0.2	Highest of 3 personal exposure measurement reported for dosing, mixing and oven charging expressed as Ni[1]
ES 6.3 PROC 22: Kilning, quenching and drying					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm^2/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm^2/day	0.012	0.0005	0.041	90th percentile from MEASE modelling (PROC22, automated with manual intervention, partly enclosed)
Inhalation					
Acute local	mg Ni/m^3	3.9	0.024	0.006	Estimated as 3x the long-term value. A factor of 3 was considered sufficient to account for the limited dataset.
Long-term systemic and local	mg Ni/m^3	0.05	0.008	0.16	Personal drying measurement used
ES 6.4 PROC 24: Milling					
	Unit	DNEL NiO	Exposure concentration	RCR	Methods fo calculation of exposure

Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm²/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm²/day	0.012	0. 00005	0.004	90th percentile from MEASE modelling (PROC24, automated, partly enclosed)
Inhalation					
Acute local	mg Ni/m³	3.9	0.0018	<0.001	Estimated as 3x the long-term value. A factor of 3 was considered sufficient to account for the limited dataset.
Long-term systemic and local	mg Ni/m³	0.05	0.0006	0.01	Single personal exposure measurement reported for milling (dry or wet) expressed as Ni[1]

ES 6.5
PROC 2, PROC 9: Blending and/or packaging

	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm²/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm²/day	0.012	0.011	0.91	Read across from dermal exposure to insoluble Ni for packing Ni Metal Powder
Inhalation					
Acute local	mg Ni/m³	3.9	0.21	0.05	Estimated as 10 x the long-term value for handling of powders during packing. A factor of 10 was considered sufficient to account for the limited dataset.
Long-term systemic and local	mg Ni/m³	0.05	0.021	0.42	Single personal exposure measurement reported for mixing and/or packaging expressed as Ni[1]

ES 6.6
PROC 0: Cleaning and maintenance

	Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm²/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm²/day	0.012	0.00003	0.0025	90th percentile from MEASE modelling (PROC10, no direct

					handling, non dispersive techniques, no more than 4 hours, gloves)
Inhalation					
Acute local	mg Ni/m^3	3.9	1.026	0.26	3 x modelled exposure value
Long-term systemic and local	mg Ni/m^3	0.05	0.342	6.84 excl. RPE By use of RPE (P3, APF 20): 0.34	90th percentile from MEASE modeling (PROC10, no direct handling, non dispersive techniques, no more than 4 hours)

NR: Not Relevant

Acute local inhalation
DNEL based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher

[1]This GES is based on a nickel content in total dust of 0.5%. This value is considered an over estimation based on information from frits manufacturing industry; if nickel in total dust should be present at concentrations higher that 0.5% then the risk characterisation should be re-calculated to confirm safe use.

4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment
Scaling tool: Metals EUSES IT tool (free download: http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool)

Scaling of the release to air and water environment includes:
Refining of the release factor to air and waste water and/or and the efficiency of the air filter and wastewater treatment facility.

Scaling of the PNEC for aquatic environment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach).

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach).

Workers
Scaling considering duration and frequency of use
Collect process monitoring data with an inhalable sampler. The simultaneous use of a respirable sampler is encouraged. Use aerosol particle size information, when available, to confirm the appropriate use of the inhalable DNEL of 0.05 mg Ni/m^3. Respirable fraction exposure levels should be kept below 0.01 mg Ni/m^3.

For further information and guidance on exposure scenarios, available tools, and scaling options, please visit the Nickel Consortia exposure scenario library at the following link: http://www.nickelconsortia.eu/exposure-scenario-library.html

Man via Environment exposure and risk characterisation assessments for the production of nickel-containing frits

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^3 as annual average in PM_{10} 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^3. The value of 15.5 is derived from the difference between the DNEL of 20 ng Ni/m^3 and the EU regional background concentration ($C_{regional}$) of 4.5 ng Ni/m^3 (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/m³)	$C_{regional}$ (ng/m³)	PEC_{local} (ng/m³)	RCR = PEC/DNEL (DNEL= 20 ng/m³)
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