1. Title GES 3 Industrial use of NiO-containing catalyst precursors for the production of catalysts containing other nickel compounds	Version 6, 2015
Life cycle	Use at industrial sites of Ni oxide
Free short title	Industrial use of NiO-containing catalyst precursors for the production of catalysts containing other Ni compounds (B), for example nickel, nickel sulphide, nickel subsulphide
Systematic title based on use descriptor	**SU:** SU 3 Industrial use SU 8 manufacture of bulk, large scale chemicals (including petroleum products) SU 9 Manufacture of fine chemicals SU10 Formulation of preparations **PC:** PC 19 intermediate PC 20 Products such as pH-regulators, flocculants, precipitants, neutralization agents PC 21 Laboratory chemicals PC 0 Other, UCN P15500 - Catalysts **ERC:** ERC 4 industrial use of processing aids in processes and products, not becoming part of articles ERC 6a Industrial use of intermediates ERC 6b Industrial use of reactive processing aids **PROC:** PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure (*e.g.* sampling, cleaning and maintenance) PROC 3 Use in closed batch process (synthesis or formulation) PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises 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 14 Production of preparations or articles by tabletting, compression, extrusion, pelletisation
Processes, tasks, activities covered (environment)	Industrial use of Ni oxide catalysts: Raw material delivery and handling, catalyst manufacture: dissolving, precipitating, filtrating, drying, mixing, forming, impregnation, calcination, reduction, stabilisation, sulfiding, coating and screening, loading/unloading of reactor, catalyst packaging: filling operations, cleaning and maintenance and storage of final product.
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 3.1: Industrial use of powdered catalysts Contributing exposure scenario ES 3.2: Industrial use of shaped catalysts (extrudates, pellets, tablets, spheres, encapsulated powders)
2. Operational conditions and risk management measures	
2.1 Control of environmental exposure	
Environmental related free short title	Industrial use of NiO-containing catalyst precursors for the production of catalysts containing other Ni compounds
Systematic title based on use descriptor (environment)	ECR 4 industrial use of processing aids in processes and products, not becoming part of articles ERC 6a Industrial use of intermediates ERC 6b Industrial use of reactive processing aids
Processes, tasks, activities covered (environment)	Industrial use of Ni oxide catalyst precursors: Raw material delivery and handling, catalyst manufacture: dissolving,

	precipitating, filtrating, drying, mixing, forming, impregnation, calcination, reduction, stabilisation, sulfiding, coating and screening, loading/unloading of reactor, catalyst packaging: filling operations, cleaning and maintenance and storage of final product.
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC
Product characteristics	
Powdered and shaped catalysts with NiO concentration ranging between 1 and 90 wt%.	
Amounts used	
Maximum daily use at a site	2.5 tonnes (expressed as Ni; 90th % tonnage, 50th % emission days)
Annual use at a site	547 tonnes Ni (90th %)
Frequency and duration of use	
Pattern of release to the environment	216 days per year per site (50th %)
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1 Discharge to STP: 98,000 m^3/d (Effluent STP/Site: 2000 m^3/d) ES 2 Direct discharge: 101,864 m^3/d (Effluent Site: 136 m^3/d)
Dilution capacity, freshwater	ES 1 Discharge to STP: 50 ES 2 Direct discharge: 750
Dilution capacity, marine	ES 3 Marine: 100 (default)
Other given operational conditions affecting environmental exposure	
None	
Technical conditions and measures at process level (source) to prevent release	
Appropriate process control systems are implemented to prevent release	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Waste water: On-site wastewater treatment by chemical precipitation, filtration, distillation or ion-exchange and off-site wastewater treatment plant, municipal STP for ES 1 (Efficiency 40%) ES 1 Freshwater discharge to STP: Release factor after on-site treatment: 165 g/T (90P) ES 2 Freshwater direct discharge: Release factor after on-site treatment: 165 g/T (90P) ES 3 Marine direct discharge: Release factor after on-site treatment: 14.4 g/T (50P) **Air:** Treatment of air emissions by bag filters. ES 1, 2 & 3: Release factor after on-site treatment: 27.9 g/T (Max)	
Organizational measures to prevent/limit release from site	
Regular operator training.	
Conditions and measures related to municipal sewage treatment plant (if applicable)	
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	Incinerated in the case where it is applicable.
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 3.1

Industrial use of powdered catalysts

Workers related free short title	Production of catalysts involving handling of powders containing NiO
Use descriptor covered	PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure (*e.g.* sampling, cleaning and maintenance) PROC 3 Use in closed batch process (synthesis or formulation) PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises 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 14 Production of preparations or articles by tableting, compression, extrusion, pelletisation
Processes, tasks, activities covered	Catalyst manufacture: - Loading/unloading of reactor - Drying and calcination - Mixing - Forming (preparation of extrudates, pellets, tablets, spheres, encapsulated powders) - Screening and filling of catalyst into storage container - Handling of precursors, intermediates and product - Reduction and stabilisation - Sulfiding Cleaning Maintenance
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.

Product characteristic

NiO-containing powder (without forming step) or shaped material (including forming step)
Nickel oxide concentration 1 – 90 wt%.

Amounts used

220-1700 kg NiO/shift

Frequency and duration of use/exposure

8 – 11 hours/ day (37,5 hours/week)
80 – 360 days/year
Cleaning finds place in accordance to fixed cleaning plans for each production unit/area on regular and frequent basis.

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 (based on MEASE model. Considered a conservative estimate for this scenario)

Body weight	Not relevant
Other given operational conditions affecting workers exposure	
High level of workplace cleanliness and prevention of dust or powder accumulation on surfaces, including floors. Use of water or vacuum cleaner fitted with a HEPA filter to remove dusts and powders during cleaning. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Automation and partly enclosure of powder processing and transfer, handling and filling operations are not likely to give rise to significant exposures to inhalable NiO-containing powder or dust. Exposure is intermittent for (Semi-) automated process operated from control room or separate control area. Dermal: Automation of processes should be used where possible to eliminate dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required to avoid discharge of dust into workplace air Extraction of gases from high temperature processes is required to avoid discharge into workplace air. Extraction of gases from hot automated and enclosed processes are designed to remove gaseous side products (*e.g.* water vapour, carbon dioxide, nitric gases, sulphur dioxide) and applied to discharge points and transfer systems to prevent work place exposure. Vacuum or (pressure) washing with water are used during cleaning to remove dusts or powders containing NiO or other Ni compounds.	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (Particle filter with high efficiency for solid and liquid particles (*e.g.* EN 143 or 149, Type P3 or FFPE)) is required for cleaning and maintenance operations and where exposure to NiO dust or powder is possible. Air fed RPE may be used, if entry to the equipment used for production is required. Dermal: Containment of raw materials and product is required to prevent dermal contact. Where dermal contact is possible use protective suit conforming to EN13982-1 Type 5 and suitable chemical resistant safety gloves (EN 374) capable of providing protection during prolonged, direct contact (Recommended: Protective index 6, corresponding > 480 minutes of permeation time according to EN 374): *E.g.* nitrile rubber (0.4 mm), chloroprene rubber (0.5 mm), butyl rubber (0.7 mm) or other gloves meeting the required performance specifications. Other protective equipment: Should be chosen based on activities being undertaken, potential for exposure to airborne NiO and other relevant workplace hazards may include protective suit (with hood), safety shoes (*e.g.* according to EN 20346)	
2.3 Control of workers exposure for contributing exposure scenario ES 3.2	
Industrial use of shaped catalysts (extrudates, pellets, tablets, spheres, encapsulated powders)	
Workers related free short title	Production of catalysts from shaped precursors containing NiO
Use descriptor covered	PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure (*e.g.* sampling, cleaning and maintenance) PROC 3 Use in closed batch process (synthesis or formulation) PROC 4 Use in batch and other process (synthesis) where opportunity for exposure arises 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)
Processes, tasks, activities covered	Catalyst manufacture: - Loading/unloading of reactor - Drying and calcination - Impregnation - Mixing - Screening and filling of catalyst into storage container - Handling of precursors, intermediates and products - Reduction and stabilisation - Sulfiding Cleaning Maintenance
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.

Product characteristic	
NiO-containing shaped catalyst. Nickel oxide concentration 1 – 90 wt%.	
Amounts used	
220-1700 kg NiO/shift	
Frequency and duration of use/exposure	
8 - 11 hours/ day (37,5 hours/week) Maintenance and cleaning, one day 10-50 times a year (according to cleaning schedules for each production units/areas) on regular and frequent basis.	
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 (based on MEASE model. Considered a conservative estimate for this scenario)
Body weight	Not relevant
Other given operational conditions affecting workers exposure	
High level of workplace cleanliness and prevention of dust or powder accumulation on surfaces, including floors. Use of water or vacuum cleaner fitted with a HEPA filter to remove dusts and powders during cleaning. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Inhalation: Automation and complete enclosure of thermal processing and mechanised transfer operations are designed to minimize significant exposures to inhalable NiO-containing dust. Exposure is intermittent for (Semi-) automated process operated from control room or separate control areas. Dust formation is unlikely for wet impregnated support materials to be fed into the drier. Semiautomatic filling line specially designed for the filling of catalysts are used for screening and filling of shaped catalyst into storage container. Dermal: Automation of processes should be used where possible to prevent dermal contact.	
Technical conditions and measures to control dispersion from source towards the worker	
LEV is required to avoid discharge of dust into workplace air. Extraction of gases from high temperature processes is required to avoid discharge into workplace air. Extraction of gases from hot automated and enclosed processes are designed to remove gaseous side products (*e.g.* water vapour, carbon dioxide, nitric gases) and applied to discharge points and transfer systems to prevent work place exposure. Vacuum or (pressure) washing with water are used during cleaning to remove dusts or powders containing NiO or other Ni compounds.	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular training in work hygiene practices and proper use of PPE.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: RPE (Particle filter with high efficiency for solid and liquid particles (*e.g.* EN 143 or 149, Type P3 or FFPE)) is required for cleaning and maintenance operations and where exposure to NiO dust or powder is possible. Air fed RPE may be used, if entry to the equipment used for production is required. Dermal: Containment of raw materials and product is required to prevent dermal contact. Where dermal contact is possible use protective suit conforming to EN13982-1 Type 5 and suitable chemical resistant safety gloves (EN 374) capable of providing protection during prolonged, direct contact (Recommended: Protective index 6, corresponding > 480 minutes of permeation time according to EN 374): *E.g.* nitrile rubber (0.4 mm), chloroprene rubber (0.5 mm), butyl rubber (0.7 mm) or other gloves meeting the required performance specifications. Other protective equipment: Should be chosen based on activities being undertaken, potential for exposure to airborne NiO and other relevant workplace hazards may include protective suit with hood, safety shoes (*e.g.* according to EN 20346).	

3. Exposure and risk estimation

Environment

ERC 4, 6a and 6b
Industrial use of NiO-containing catalyst precursors for the production of catalysts containing other Ni compounds

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	1.80	4.70	0.66	
STP	mg Ni/L	0.33	-	-	0.125	0.38	
Sediment	mg Ni/kg	136	33.5	47.3	80.8	0.59	
Terrestrial	mg Ni/kg	29.9	16.2	3.96	20.16	0.67	
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	0.05	16.25	0.54	
ES 3: Marine direct discharge							
Marine water	µg Ni/L	8.6	0.3	1.92	2.22	0.26	
Sediment	mg Ni/kg	136	16.1	50.6	66.7	0.49	
Terrestrial	mg Ni/kg	29.9	16.2	0.05	16.25	0.54	

Workers

ES 3.1 Industrial use of powdered catalysts

	Unit	DNEL	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 (PROC 8b, automated, contained transfer operations, gloves) for handling powdered raw material and product.
Inhalation					
Acute local	mg Ni /m^3	3.9	0.18	0.05	4 x calculated 75th percentile of maximum exposure concentrations measured for manufacturing processes relevant to industrial use of powdered nickel oxide catalysts for the production of catalysts containing other Ni compounds.
Long-term systemic and local	mg Ni /m^3	0.05	0.045	0.9	Calculated 75th percentile of maximum exposure concentrations measured for manufacturing processes relevant to industrial use of powdered nickel oxide catalysts for the production of catalysts containing other Ni compounds.

ES 3.2 Industrial use of shaped catalysts (extrudates, pellets, tablets, spheres, encapsulated powders)

	Unit	DNEL	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 (PROC 8b, automated, contained transfer operations, gloves).
Inhalation					
Acute local	mg Ni	3.9	0.078	0.02	3 x calculated 75th percentile of

	/m³				maximum exposure concentrations measured for manufacturing processes relevant to industrial use of shaped nickel oxide catalysts for the production of catalysts containing other Ni compounds.
Long-term systemic and local	mg Ni /m³	0.05	0.026	0.52	Calculated 75th percentile of maximum exposure concentrations measured for manufacturing processes relevant to industrial use of shaped nickel oxide catalysts for the production of catalysts containing other Ni compounds.
NR: Not Relevant Acute local inhalation DNEL based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher					

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

Environment

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

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

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

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

Workers

Scaling considering duration and frequency of use.
Collect process monitoring data with an inhalable sampler. The simultaneous use of a respirable sampler is encouraged. Use aerosol particle size information, when available, to confirm the appropriate use of the inhalable DNEL of 0.05 mg Ni/m³. Respirable fraction exposure levels should be kept below 0.01 mg Ni/m³.

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 use of nickel oxide containing catalyst precursors for the produciton of catalysts containing other nickel compounds

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