1. Title	Version 5, 2014
GES 2 Industrial use of NiO-containing catalysts and catalyst precursors	
Life cycle	Use at industrial sites of Ni oxide
Free short title	Industrial use of powdered and shaped NiO-containing catalysts and catalyst precursors (A)
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 PC: PC 19 intermediates 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 resulting in manufacture of another substance (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) 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
Processes, tasks, activities covered (environment)	Industrial use of powdered and shaped NiO-containing catalysts and catalyst precursors: Loading of reactor (transfer from big bags/drums/containers), use in closed reactor, unloading of reactor (transfer into drums /containers), cleaning and maintenance.
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 2.1: Industrial use of powdered catalysts Contributing exposure scenario ES 2.2: 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 powdered and shaped NiO-containing catalysts and catalyst precursors
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 powdered and shaped NiO-containing catalysts and catalyst precursors: Loading of reactor (transfer from big bags/drums/containers), use in closed reactor, unloading of reactor (transfer into drums /containers), cleaning and maintenance.
Environmental Assessment Method	Not relevant
Product characteristics	
Powdered and shaped catalysts with NiO concentration ranging between 1 and 90 wt%.	
Amounts used	
Maximum daily use at a site	43 tonnes (expressed as Ni) based on loading/unloading of 300 tonnes

	catalyst with a NiO content of 50% during one week, twice a year
Maximum annual use at a site	Powder catalysts: 0.5-75 tonnes Ni/year (1 - 150 tonnes catalyst/year) Shaped catalyst: 1.5-200 tonnes Ni/year (5 - 600 tonnes catalyst/year)
Frequency and duration of use	
Pattern of release to the environment	No appreciable release to the environment
Environment factors not influenced by risk management	
Receiving surface water flow rate	Not relevant
Dilution capacity, freshwater	Not relevant
Dilution capacity, marine	Not relevant
Other given operational conditions affecting environmental exposure	
None	
Technical conditions and measures at process level (source) to prevent release	
NiO-containing catalyst is practically entirely contained within reaction vessels and associated pipework. Transfer of catalyst between reactor and containers during loading and unloading are enclosed and may occur outdoors. Delivery of catalyst frequently occurs in big bags, drums or flow bins; big bags are equipped with dumping spouts that can be connected to a loading tube. Transfer also refers to tank cars or railroad cars, *i.e.* big containers that can be tightly connected to the reactor.	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Transfer of catalyst to reactor: semi-automated: catalyst transferred into hoppers and connected to loading tubes, or enclosed transfer from container to reactor.. Production equipment is not ventilated. The catalyst is installed in a reactor that is completely closed with no ventilation. Non involvement of water should take place except from in closed cycle..	
Organizational measures to prevent/limit release from site	
Regular operator training.	
Conditions and measures related to municipal sewage treatment plant	
Municipal Sewage Treatment Plant (STP)	Not relevant
Discharge rate of the Municipal STP	Not relevant
Incineration of the sludge of the Municipal STP	Not relevant
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 2.1	
Industrial use of powdered catalysts	
Workers related free short title	Industrial use of powdered NiO-containing catalysts
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) 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
Processes, tasks, activities covered	Charging and discharging of catalyst powder including piped transfer of catalyst from supply tank and return of spent catalyst to tank.
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
NiO-containing powder with nickel oxide concentration 1 – 90 %. Or as suspension in an inert liquid (*e.g.* water, alcohols, hydrocarbons).	
Amounts used	
0.5-75 tonnes Ni/year (1 - 150 tonnes catalyst/year)	
Frequency and duration of use/exposure	
8 – 11 hours/shift (37.5 hours/week) Loading and unloading operations for plant operators shall be no more than 5% of shifts. Special loading companies have up to full shift exposures. The exposure assessment is based on full shift data.	
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 The ES 2.1 excludes the handling of powdered catalyst materials in open workspace.	
Technical conditions and measures at process level (source) to prevent release	
Charging and discharging of catalyst powder takes place in a semi automated methods whereby the catalyst is transferred into hoppers and lifted up to the top of the reactor and transferred from the hopper to the reactor by manual assistance/control or enclosed transfer from container to reactor. During use NiO-containing catalyst powder is required to be entirely contained within reaction vessels and associated pipework.	
Technical conditions and measures to control dispersion from source towards the worker	
NONE	
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: Use of RPE (Particle filter with high efficiency for solid and liquid particles (*e.g.* EN 143 or 149, Type P3 or FFPE)) is required during loading and unloading of reactor and for cleaning and maintenance operations and where exposure to NiO containing dust or powder is possible. Use of air fed RPE is required if entry to the reactor is required Dermal:, Use of 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 is required during loading and unloading of reactor, during cleaning and maintenance and during any other operations where dermal contact is possible.	

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 2.2	
Industrial use of shaped catalysts	
Workers related free short title	Industrial use of shaped NiO-containing catalysts
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) 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
Processes, tasks, activities covered	Loading of reactor (transfer from big bags/drums/containers), use in closed reactor, unloading of reactor (transfer into drums /containers), cleaning and 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 – 65 wt%.	
Amounts used	
1.5-200 tonnes Ni/year (5 - 600 tonnes catalyst/year)	
Frequency and duration of use/exposure	
Loading/unloading frequency: During 1 week once every 6 months or less frequently. Cleaning frequency: From twice a year to once in 8 years. 8 – 11 hours/shift (37,5 hours/week) Loading and unloading operations for plant operators shall be no more than 5% of shifts. Special loading companies have up to full shift exposures. The exposure assessment is based on full shift data.	
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	
Batch loading and unloading. Cleaning is normally undertaken by vacuuming fitted with a HEPA filter with control measures in place to prevent the release of dust into workplace air. Oral: Good workplace hygiene practice	
Technical conditions and measures at process level (source) to prevent release	
Loading: Enclosed transfer system are used to prevent the release of dust into workplace air or a semi-automated operation are used for outdoor transfer. Use: A closed reactor is required. Unloading: Enclosed transfer from reactor to container or operation may occur outdoors.	
Technical conditions and measures to control dispersion from source towards the worker	
None	
Organisational measures to prevent /limit releases, dispersion and exposure	
Regular operator training.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Inhalation: Use of RPE (Particle filter with high efficiency for solid and liquid particles (*e.g.* EN 143 or 149, Type P3 or FFPE)) is required during loading and unloading of reactor and for cleaning and maintenance operations where exposure to NiO containing dust or powder is possible; use of air fed RPE is required, if entry to the reactor is required Dermal: Use of 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 is required during loading and unloading of reactor, during cleaning and maintenance and during any other operations where dermal contact is possible.	

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 powdered and shaped NiO-containing catalysts and catalyst precursors

Compartment	Unit	PNEC	$PEC_{Regional}$	C_{local}	PEC	RCR	Methods for calculation of environmental concentrations
Freshwater	µg Ni/L	3.55	2.9	-	-	-	Not relevant
Marine	µg Ni/L	8.6	0.3	-	-	-	
Sediment	mg Ni/kg	136	33.5	-	-	-	
Terrestrial	mg Ni/kg	29.9	16.2	-	-	-	
STP	mg Ni/kg	0.33	-	-	-	-	

*Exposure to the environment is considered not relevant

Workers

ES 2.1
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 material.
Inhalation					
Acute systemic	mg Ni /m^3	520	0.04	0.00008	4 x 75th percentile for filling operations in NiO powdered catalyst production.
Acute local	mg Ni /m^3	3.9	0.04	0.0 1	
Long-term systemic and local	mg Ni /m^3	0.05	0.01	0.2	Calculated 75th percentile for filling operations (full shift) in NiO powdered catalyst production.

ES 2.2
Industrial use of shaped catalysts

	Unit	DNEL	Exposure concentration	RCR	Methods for calculati n 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 systemic	mg Ni /m³	520	0.06	0.0001	3 x calculated 75th percentile for filling operations in NiO shaped catalyst production.
Acute local	mg Ni /m³	3.9	0.06	0.02	
Long-term systemic and local	mg Ni /m³	0.05	0.02	0.4	Calculated 75th percentile for filling operations (full shift) in NiO shaped catalyst production.

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 NiO-containing catalysts and catalyst precursors

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 13.8 ng Ni/m^3. The value of 13.8 is derived from the difference between the DNEL of 20 ng Ni/m^3 and the EU regional background concentration ($C_{regional}$) of 6.2 ng Ni/m^3 (P90 annual concentration for 2007-200).

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	<13.8	6.2*	<20	<1

**: EU average of country P90 annual Ni concentrations (2007-2009)*

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.