

1. Title		Version 5, 2014
GES 13: Manufacture of Ni-containing catalysts from NiO-containing catalyst precursors		
Life cycle	Manufacture of Ni metal	
Free short title	Manufacture of Ni-containing catalysts from NiO-containing catalyst precursors	
Systematic title based on use descriptor	<p>SU: Not relevant</p> <p>PC: PC19 Intermediate PC20 Products such as pH-regulators, flocculants, precipitants, neutralizing agents</p> <p>ERC: ERC 1 Manufacture of substances ERC 3 Formulation in materials</p> <p>PROC: PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure 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 mixture (charging/ discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b Transfer of substance or mixture (charging/ discharging) from/to vessels/large containers at dedicated facilities PROC 9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC 14 Production of mixtures or articles by tableting, compression, extrusion, pelletisation</p>	
Processes, tasks, activities covered (environment)	Manufacture of Ni metal containing catalysts: Raw material delivery and handling, catalyst manufacture: dissolving, precipitating, filtrating, drying, mixing, forming, impregnation, calcination, reduction, stabilisation, coating and screening, catalyst packaging: filling operations, cleaning and maintenance and storage of final product	
Processes, tasks, activities covered (workers)	Contributing exposure scenario ES 13.1: Manufacture of powdered catalysts or production of shaped catalysts (<i>e.g.</i> encapsulated powders) from powdered precursors Contributing exposure scenario ES 13.2: Manufacture of shaped catalysts (<i>e.g.</i> extrudates, pellets, tablets, spheres) from shaped precursors	
2. Operational conditions and risk management measures		
2.1 Control of environmental exposure		
Environmental related free short title	Manufacture of Ni metal-containing catalysts from NiO-containing catalyst precursors	
Systematic title based on use descriptor (environment)	ERC 1 Manufacture of substances ERC 3 Formulation in materials	
Processes, tasks, activities covered (environment)	Manufacture of Ni metal containing catalysts: Raw material delivery and handling, catalyst manufacture: dissolving, precipitating, filtrating, drying, mixing, forming, impregnation, calcination, reduction, stabilisation, coating and screening, 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 Ni concentration ranging between 1 and 95 wt%.		
Amounts used		
Maximum daily use at a site	3.4 tonnes	
Maximum annual use at a site	ES 1, 2 & 3: 674 tonnes Ni (90 th percentile)	

Frequency and duration of use	
Pattern of release to the environment	Water: 200 days per year (median 50 th %) Air: 200 days per year
Environment factors not influenced by risk management	
Receiving surface water flow rate	ES 1: 18,000 (default) m ³ /d (Effluent STP: 2000 m ³ /d) ES 2: 61,005 m ³ /d (Effluent Site: 245 m ³ /d)
Dilution capacity, freshwater	ES 1 Freshwater STP discharge: 10 (default) ES 2 Freshwater direct discharge: 250
Dilution capacity, marine	ES 3 Marine discharge: 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 shall be implemented.	
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 (Efficiency: 95 to >99 %). And off-site wastewater treatment plant, municipal STP for ES 1 (Efficiency 40%). ES 1 Freshwater STP discharge: Release factor after on-site treatment: 40.7 g/T ES 2 Freshwater direct discharge: Release factor after on-site treatment: 40.7 g/T	
Air: Treatment of air emissions by filters (fabric, bag, HEPA, ceramic) and/or wet scrubbers. ES 1, 2 & 3: Release factor after on-site treatment: 97 g/T (90 th %)	
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
Discharge rate of the Municipal STP	2000 m ³ /d (default)
Incineration of the sludge of the Municipal STP	Yes
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: <ul style="list-style-type: none"> - 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 <ul style="list-style-type: none"> - 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 13.1	
Manufacture of powdered catalysts or production of shaped catalysts (e.g. encapsulated powders) from powdered catalyst precursors	
Workers related free short title	Manufacture of Ni-containing catalysts involving powder handling
Use descriptor covered	PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure 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 mixture (charging/ discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b Transfer of substance or mixture (charging/ discharging) from/to vessels/large containers at dedicated facilities PROC 9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC 14 Production of mixtures or articles by tableting, compression, extrusion, pelletisation
Processes, tasks, activities covered	Catalyst manufacture: <ul style="list-style-type: none"> - Mixing - Forming (e.g. preparation of encapsulated powders) - Reduction of NiO-containing catalyst precursor with H₂ - Stabilisation of Ni metal-containing catalyst - Screening and filling of catalyst into storage container - Handling of precursors, intermediates and products - Cleaning - Maintenance
Assessment Method	Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.
Product characteristic	
Ni-containing powder (without forming step) or droplets (including forming step, where Ni powder is embedded/encapsulated in organic matrix). Ni concentration 1 – 95 % (powder) or 10 – 35% (droplets)	
Amounts used	
100-5000 kg/shift	
Frequency and duration of use/exposure	
8 - 11 hours/ day (37.5 hours/week) 80 – 360 days/year	
Frequent, regular cleaning of production areas	
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: During the reduction process, the NiO-containing catalyst precursor is placed in a closed reaction vessel and exposed to a H ₂ -containing atmosphere where NiO is converted partly or fully to nickel metal. Automation and complete enclosure of powder processing and transfer, handling and filling operations are designed to	

<p>minimize significant exposures to inhalable Ni-containing powder or dust. Exposure is intermittent for (semi) automated process operated from control room or separate control areas. Dust formation is unlikely for powders embedded in organic matrix. Dermal: Automation of processes should be used where possible to eliminate dermal contact.</p>	
Technical conditions and measures to control dispersion from source towards the worker	
<p>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 shall be designed to remove gaseous side products and applied to discharge points and transfer systems to prevent work place exposure. During cleaning, vacuum or (pressure) washing with water shall be used to remove dusts or powders containing Ni or other Ni compounds.</p>	
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	
<p>Inhalation: Use of RPE (Particle filter with high efficiency for solid and liquid particles (e.g. EN 143 or 149, Type P3 or FFPE)) for cleaning and maintenance operations and where exposure to Ni 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): <i>E.g.</i> 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 Ni and other relevant workplace hazards may include protective suit (with hood), safety shoes (<i>e.g.</i> according to EN 20346)</p>	
2.3 Control of workers exposure for contributing exposure scenario ES 13.2	
Manufacture of shaped catalysts (<i>e.g.</i> extrudates, pellets, tablets, spheres) from shaped precursors	
Workers related free short title	Manufacture of Ni-containing catalysts only involving handling of shaped materials
Use descriptor covered	<p>PROC 1 Use in closed process, no likelihood of exposure PROC 2 Use in closed, continuous process with occasional controlled exposure 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 mixture (charging/ discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b Transfer of substance or mixture (charging/ discharging) from/to vessels/large containers at dedicated facilities PROC 9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)</p>
Processes, tasks, activities covered	<p>Catalyst manufacture:</p> <ul style="list-style-type: none"> - Handling of precursors, intermediates and products - Reduction of NiO-containing catalyst precursor with H₂ - Stabilisation of Ni metal-containing catalyst - Screening and filling of catalyst into storage container - Maintenance - Cleaning
Assessment Method	<p>Estimation of inhalation exposure based on measured data. Estimation of dermal exposure based on Tier 1 model.</p>
Product characteristic	
Ni-containing shaped catalyst. Nickel concentration 1 – 70 wt%.	
Amounts used	
100-5000 kg/shift	
Frequency and duration of use/exposure	
<p>8 - 11 hours/day (37.5 hours/week) 80 – 360 days/year Frequent, regular cleaning of production areas</p>	
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							
<u>Inhalation:</u> During the reduction process the NiO-containing catalyst precursor is placed in a closed reaction vessel and exposed to a H ₂ -containing atmosphere where NiO is converted partly or fully to nickel metal. Automation and complete enclosure of thermal processing and mechanised transfer operations are designed to minimize significant exposures to inhalable Ni-containing powder or dust. Exposure is intermittent for (semi) automated process operated from control room or separate control areas. <u>Dermal:</u> 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 shall be designed to remove gaseous side products and applied to discharge points and transfer systems to prevent work place exposure. During cleaning, vacuum or (pressure) washing with water shall be used to remove dusts or powders containing Ni 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							
<u>Inhalation:</u> Use of RPE (Particle filter with high efficiency for solid and liquid particles (e.g. EN 143 or 149, Type P3 or FFPE)) for cleaning and maintenance operations and where exposure to Ni containing dust or powder is possible. Air fed RPE may be used, if entry to the equipment used for production is required. <u>Dermal:</u> 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): <i>E.g.</i> 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 Ni and other relevant workplace hazards may include protective suit (with hood), safety shoes (<i>e.g.</i> according to EN 20346)							
3. Exposure and risk estimation							
Environment							
ERC 1, 3 Manufacture of Ni-containing catalysts from NiO-containing catalyst precursors							
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	2.95	5.85	0.82	
STP	mg Ni/L	0.33	-	-	0.041	0.13	
Sediment	mg Ni/kg	136	33.5	77.6	111.1	0.82	
Terrestrial	mg Ni/kg	29.9	16.2	1.30	17.50	0.59	
ES 2: Freshwater direct discharge							
Freshwater	µg Ni/L	7.1	2.9	1.61	4.51	0.64	
Sediment	mg Ni/kg	136	33.5	42.2	75.7	0.56	
Terrestrial	mg Ni/kg	29.9	16.2	0.02	16.22	0.54	
ES 3: Marine direct discharge							
Marine water	µg Ni/L	8.4	0.3	4.01	4.31	0.50	
Sediment	mg Ni/kg	136	16.1	105.1	121.7	0.89	
Terrestrial	mg Ni/kg	29.9	16.2	0.02	16.22	0.54	
Workers							

ES 13.1 Manufacture of powdered catalysts or production of shaped catalysts (<i>e.g.</i> encapsulated powders) from powdered catalyst precursors					
	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	0.035	0.0005	0.014	90 th percentile from MEASE modelling (PROC 8b, automated, contained transfer operations, gloves) for handling raw material and product.
Inhalation					
Acute systemic	mg Ni /m ³	680	0.16	<0.001	4 x estimated 75 th percentile of maximum exposure concentrations measured for manufacturing processes relevant to the production of nickel metal catalyst involving powdered raw materials or products. assumes processes are enclosed and effective LEV is in place
Acute local	mg Ni /m ³	4	0.16	0.04	
Long-term systemic and local	mg Ni /m ³	0.05	0.04	0.8	
ES 13.2 Manufacture of shaped catalysts (<i>e.g.</i> extrudates, pellets, tablets, spheres) from shaped catalyst precursors					
	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	0.035	0.0005	0.014	90 th percentile from MEASE modelling (PROC 8b, automated, contained transfer operations, gloves) for handling raw material and product.
Inhalation					
Acute systemic	mg Ni /m ³	680	0.06	<0.001	3 x estimated 75 th percentile shift mean exposure concentration; Assumes automation and complete enclosure of thermal processing and mechanized transfer operations.
Acute local	mg Ni /m ³	4	0.06	0.015	
Long-term systemic and local	mg Ni /m ³	0.05	0.02	0.4	
NR: Not Relevant					
<u>Acute local inhalation</u> DNEL based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher					
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 manufacture of Ni-containing catalysts from NiO-containing 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/m³ as annual average in PM₁₀ 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/m³. The value of 13.8 is derived from the difference between the DNEL of 20 ng Ni/m³ and the EU regional background concentration (C_{regional}) of 6.2 ng Ni/m³ (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/m ³)	C _{regional} (ng/m ³)	PEC _{local} (ng/m ³)	RCR = PEC/DNEL (DNEL= 20 ng/m ³)
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.