

## GREEN NICKEL OXIDE

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**SECTION 1: Identification of the substance/mixture and of the company/undertaking****1.1. Product identifier**

Green Nickel Oxide – Type A  
Green Nickel Oxide – Type F  
Green Nickel Oxide - Standard

Registration Number: 01-2119467172-41-0036

**1.2. Relevant identified uses of the substance or mixture and uses advised against**

Production of Ni-containing electronic and thermally functioning ceramics (GES 5)  
Production of nickel-containing pigments (GES 7)

**Please refer to the Guidance to Downstream Users Annex I, exposure scenario Item 7.****1.3. Details of the supplier of the safety data sheet**

Novamet Specialty Products Corporation

681 Lawlins Road  
Wyckoff, NJ 07481  
United States

Phone : +1 201-891-7676  
Fax : +1 201 891 9467

Responsible person:

Mr. David Croan

E-Mail (competent person):

konrad.stoeber@ra-services.de

**1.4. Emergency phone No.:**

Chemtrec: outside USA call 0049 (761) 1 92 40  
(Poison-Information-Centre (Freiburg/Germany))

**SECTION 2: Hazards identification****2.1. Classification of the substance or mixture**

Acc. Regulation (EC) Nr. 1272/2008

Carc. (inhal.)	Cat. 1A	H350i
STOT RE inhalation	Cat. 1	H372
Skin Sens.	Cat. 1	H317
Aquatic Chronic	Cat. 4	H413

**Acc. Directive 67/548/EEEC**

T, 48/23

Karz. Kat 1; R49

R43

R53

for the full text of R-Phrases refer to section 16

**2.2. Label elements****Danger****Hazard statements:**

H350i May cause cancer if inhaled.

H372 Causes damage to organs through prolonged or repeated exposure

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H317 May cause an allergic skin reaction.  
H413 May cause long lasting harmful effects to aquatic life

**Precautionary statements:**

P201 Obtain special instructions before use.  
P281 Use personal protective equipment as required.  
P260 Do not breathe dust  
P308 + P313 IF exposed or concerned: Get medical advice/attention.  
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.  
P333 + P313 If skin irritation occurs: Get medical advice/attention.

**SECTION 3: Composition/information on ingredients****3.1. Substances**

*Name of Product:* Nickel oxide  
*IUPAC-Name:* oxonickel  
*CAS-No. :* 1313-99-1  
11099-02-8  
*EC-No.:* 215-215-7  
234-323-5  
*INDEX-No.:* 028-003-00-2  
*Purity:* 99.7% w/w  
*Synonym(s):* NICKEL(II) OXIDE  
Nickel monoxide  
*MW,* 74.6928  
*Formula:* NiO

**SECTION 4: First aid measures****4.1. Description of first aid measures***General information:*

In all cases of doubt call in a physician.

*In case of inhalation:*

Remove person to fresh air. Seek medical attention.

*In case of skin contact:*

Wash with plenty of water and soap and rinse thoroughly. If skin irritation or rash occurs: Get medical advice/attention.

*In case of eye contact:*

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses.

*In case of ingestion:*

Make the victim drink water. Never give anything by mouth to an unconscious person.

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*Self protection at first aid:*

Avoid substance contact

**4.2. Most important symptoms and effects, both acute and delayed**

no information available

**4.3. Indication of any immediate medical attention and special treatment needed**

no information available

**SECTION 5: Firefighting measures****5.1. Extinguishing media**

*Suitable extinguishing media:*

Extinguish surrounding fires with appropriate methods.

*Unsuitable extinguishing media:*

depending on surrounding fire

**5.2. Special hazards arising from the substance or mixture**

Not combustible. In case of fire toxic metal oxide smoke may occur.

**5.3. Advice for firefighters**

Wear a self-contained breathing apparatus and protective clothing in the dangerous zone.

Avoid fire fighting waters entering surface- or groundwater.

**SECTION 6: Accidental release measures****6.1. Personal precautions, protective equipment and emergency procedures**

*For non-emergency responders*

Avoid formation of dust. Avoid substance contact. Avoid inhalation of dust Provide sufficient ventilation

*For emergency responders*

Wear suitable protective equipment (refer to Section 8.)

**6.2. Environmental precautions**

Do not let enter drains.

**6.3. Methods and material for containment and cleaning up**

Collect spills by wet sweeping or vacuuming with the vacuum exhaust passing through a high efficiency particulate arresting (HEPA) filter if exhaust is discharged into the work place.

**6.4. Reference to other sections**

Refer to Sections 8 and 13

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## SECTION 7: Handling and storage

## 7.1. Precautions for safe handling

Avoid substance contact. Avoid formation of dust. Keep the containers tightly closed until discharge. Local exhaust ventilation required for all not enclosed processes. Any unavoidable deposit of dust must be regularly removed. For use associated RMM and operational conditions refer to Annex I - Exposure scenarios GES 5 and GES 7

## 7.2. Conditions for safe storage, including any incompatibilities

Store locked up. Keep container tightly closed and sealed until ready for use. Provide sufficient ventilation.

## 7.3. Specific end use(s)

refer to Section 1.2 and Annex I Exposure scenarios

## SECTION 8: Exposure controls/personal protection

## 8.1. Control parameters

DNEL/DMEL- Values: refer to Annex I - Exposure scenarios 5 and 7, each items 6.1.1 and 6.1.2

PNEC- Values: refer to Annex I - Exposure scenarios 5 and 7, each items 6.1.1 and 6.1.2

Air limit values in the EU are given as follows: Nickel, inorganic compound, water insoluble:

Country/Body	Status of Standard	Values of Standards <sup>1</sup> (mg Ni/m <sup>3</sup> )	
		Metallic Nickel and Insoluble Nickel species	Soluble Nickel Species
Austria	current	0.05 <sup>2</sup>	0.05
Belgium	current	1.0	0.1
Denmark	current	0.05	0.01
Finland	current	1.0	0.1
France	current	1 (VME) <sup>3</sup>	0.1 (VME)
Germany	current	0.5 (TRK) <sup>4</sup>	0.05 (TRK)
Ireland	current	1.0	0.1
Italy	current	1.0	0.1
Luxembourg	current	1.0	0.1
Netherlands	current	0.1	0.1
Norway	current	0.05	0.05
Portugal	current	1.0	0.1
Spain	current	1.0	0.1
Sweden	current	0.5 (metallic nickel) 0.1 (nickel oxide, carbonate) 0.01 (nickel subsulphide)	0.1
United Kingdom	current	0.5 (MEL) <sup>5,6</sup>	0.1 (MEL) <sup>6</sup>

<sup>1</sup> 8-hour TWA (Time-Weighted Average) unless otherwise noted. All values refer to 'total' nickel unless otherwise noted.

<sup>2</sup> This TLV applies to nickel metal and alloys, nickel sulfide, sulfidic ores, oxidic nickel, and nickel carbonate in inhalable dust, as well as any nickel compound in the form of inhalable droplets.

<sup>3</sup> VME = Valeur Moyenne d'Exposition. The value of 1 mg/m<sup>3</sup> applies to Ni carbonate, dihydroxide, subsulphide, monoxide, sulfide, trioxide and for other chemical forms non-otherwise specified such as 'insoluble Ni compounds' and Ni sulfide roasting fume and dust.

<sup>4</sup> TRK = Technische Richtkonzentrationen.

<sup>5</sup> MEL = Maximum Exposure Limit.

<sup>6</sup> This value is based on "total inhalable" aerosol as measured with the 7-hole sampler.

## 8.2. Exposure controls

*Appropriate engineering controls*

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Automation and enclosure of processes should be used where possible.

LEV system with filtration is required for process steps that are not fully enclosed and involve NiO powder or are other vice likely to give rise to Ni containing dust e.g. roll mill and dicing machine.

*Individual protection measures:*

Choose Suitable personal protection equipment dependant on substance concentration and amount specific for workplace. Resistance against chemicals should be clarified with the supplier.

*Eye/face protections*

Safety goggles with side protection

*Skin protection*

Gloves suitable for handling powders e.g. Nitrile rubber. suitable protective clothing is required where direct contact with NiO could occur.

*Respiratory protection*

Respiratory Protective equipment (FFP2) {approved with regard to EN 149} is required for unenclosed processes involving powders. Refer to the respective information in the attached exposure scenarios. Respiratory cartridges or canisters must be changed following the recommendations of the supplier.

*Environmental exposure controls:*

*Water:* On-site wastewater treatment - Efficiency > 90%

*Air:* Exhaust system fabric or bag filters.

## SECTION 9: Physical and chemical properties

### 9.1. Information on basic physical and chemical properties

Appearance::	solid, powder - green
Odour:	odourless
Odour threshold:	n/a
pH:	not applicable
Melting point/freezing point;	>1984 °C
Initial boiling point	not applicable
Flash point;	not applicable
Evaporation rate;	not applicable
Flammability;	not highly flammable
Upper/lower flammability or explosive limits;	not applicable
Vapour pressure;	not applicable
Vapour density;	not applicable
Relative density;	6,75 g/cm <sup>3</sup>
Solubility(ies); in water	2.71 x 10 <sup>-3</sup> mg/L at 20°C
Partition coefficient: n-octanol/water;	not applicable
Auto-ignition temperature;	>400°C (CSR)
Decomposition temperature;	not applicable
Viscosity	not applicable
Explosive properties;	not explosive (structural reasons)
Oxidising properties.	not applicable

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## 9.2. Other information

not available

## SECTION 10: Stability and reactivity

## 10.1. Reactivity

no information available

## 10.2. Chemical stability

The product is stable under normal conditions

## 10.3. Possibility of hazardous reactions

no information available

## 10.4. Conditions to avoid

The product is stable under normal conditions

## 10.5. Incompatible materials

Strong acids

## 10.6. Hazardous decomposition products

please refer to section 5

## 11. SECTION 11: Toxicological information

## 11.1. Information on toxicological effects

*(a) acute toxicity;*

	<i>Value</i>	<i>Unit</i>	<i>Species</i>
<i>LD50 (oral.)</i>	> 11 000	mg/kg bw	rat
<i>LD50 (dermal)</i>	not available		waiving
<i>LD50 (inhal)</i>	>5,08	mg/l	rat

*b) skin corrosion/irritation;*

Rabbit: slight irritation, 24 h semioclusiv (clipping) OECD 404 - not classified

*c) serious eye damage/irritation;*

Rabbit: mildly irritating 4d OECD 405 - not classified

*d) respiratory or skin sensitisation;*

Inhalation: No data obtained from animal tests available.

skin: tests with guinea pigs - OECD 406 - no positive reactions

Classification as skin sensitizer not covered by experimental results

*e) germ cell mutagenicity;*

tests in vitro and in vivo - negative - not classified as mutagenic

*f) carcinogenicity;*

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Inhalation: classified as carcinogenic Category 1A

g) *reproductive toxicity*;

not classified as toxic to reproduction

h) *STOT-single exposure*;

not classified

i) *STOT-repeated exposure*;

Target organs - respiratory tract (lung, nose) - classified

j) *aspiration hazard*.

*not classified*

*Other information*

Further hazardous properties cannot be excluded. The product should be handled with the care usual when dealing with chemicals.

## SECTION 12: Ecological information

### 12.1. Toxicity

Data selected from a large number of high quality tests on several soluble Nickel compounds e.g. Nickelchloride and nickel sulphate are used for read across.

<i>short term toxicity</i>	<i>Value (range)</i>	<i>Duration</i>	<i>Species</i>
<i>LC<sub>50</sub> Fish</i>	0.23 mg Ni/L	96h	Pimephales promelas
<i>EC<sub>50</sub> invertebrates</i>	0.013 mg Ni/L	48h	Ceriodaphnia dubia
<i>EC<sub>10</sub> algae</i>	>25.3 - <362 µg/L	72h	Pseudokirchnerella subcapitata
<i>EC<sub>10</sub> algae</i>	>41.2 - < 51.8 µ/L	72h	Coelastrum microporum
<i>long term toxicity</i>			
Fish			
NOEC	40 µg/L	8 d	Brachydanio rerio
NOEC	57 µg/L	32 d	Pimephales promelas
NOEC	134 µg/L	32 d	Oncorhynchus mykiss
Invertebrates			
NOEC	8.8 µg/L	21 d	Daphnia magna
NOEC	90 µg/L	21 d	Daphnia magna

### 12.2. Persistence and degradability

not applicable

### 12.3. Bioaccumulative potential

BCFs for Fish and phytoplankton are generally less than 100. Higher values are reported for Crustacea and brown macroalgae. Significant higher values are reported for marine bivalves.

### 12.4. Mobility in soil

not applicable

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**12.5. Results of PBT and vPvB assessment**

PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances

**12.6. Other adverse effects** not known

**SECTION 13: Disposal considerations****13.1. Waste treatment methods**

Chemicals and packages must be disposed of in compliance with the respective national and local regulations. Ni-bearing wastes shall be handled as hazardous waste and shall be removed by licensed waste removal company, incinerated or recycled.

Contact an approved waste management company.

Do not contaminate ground or surface waters via drainage, by cleaning of equipment or disposal of wastes

**SECTION 14: Transport information**

	ADR/RID	AND/ADNR	IMDG	IATA
<b>14.1. UN number</b>	not classified as dangerous good			
<b>14.2. UN proper shipping name</b>				
<b>14.3. Transport hazard class(es)</b>				
<b>14.4. Packing group</b>				
<b>14.5. Environmental hazards</b>				
<b>14.6. Special precautions for user</b>				

**14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code**

not applicable

**SECTION 15: Regulatory information****15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture***EU regulations:*

Directive on Major accident hazard 96/82/EC: 9.a Dangerous for the environment - -/1 t  
refer to Directive 92/85/EC on improvements in the safety and health at work of pregnant workers...  
refer to Directive 94/33/EC on the protection of young people at work

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Authorisations and/or restrictions on use:

refer to Regulation 552/2009/EC amending Regulation 1907/2006/EC: Annex XVII point 28/29/30

National regulations: (Germany)

GERMAN ORDINANCE OF FAILURE, Annex I, 1 t / 1 t

occupational restrictions

refer to regulations on occupational restrictions as:

to adolescent persons according to § 22 ArbSchG

to pregnant and nursing women acc. to §§ 4 and 5 MuSchRiV

water hazard class: WGK 1 - low hazard to waters Substance No.: 5368 Classification according to Annex 3 of the Administrative Regulation of Substances Hazardous to Water (VwVwS)

**15.2. Chemical safety assessment** available

**SECTION 16: Other information**

Changes: Version 1.1 general revision, corrections

*Main sources for data:* Nickel-Consortium Chemical safety report for Nickel oxide

*Abbreviations used:* refer to Annex II

*Relevant*

*R-Phrases*

R49 May cause cancer by inhalation.

R43 May cause sensitisation by skin contact.

R48/23 Toxic: danger of serious damage to health by prolonged exposure through inhalation.

R53 May cause long-term adverse effects in the aquatic environment.

*Hazard Statements*

H350i May cause cancer if inhaled.

H372 Causes damage to organs through prolonged or repeated exposure

H317 May cause an allergic skin reaction.

H413 May cause long lasting harmful effects to aquatic life

*Precautionary statements*

P201 Obtain special instructions before use.

P281 Use personal protective equipment as required.

P260 Do not breathe dust

P308 + P313 IF exposed or concerned: Get medical advice/attention.

P302 + P352 IF ON SKIN: Wash with plenty of soap and water.

P333 + P313 If skin irritation occurs: Get medical advice/attention.

Training: Operators should be trained regularly on safe handling and emergency response.

*Further information:*

*MSDS issued by:*

Chemieservice Dr. Stöber  
Kefersteinstr. 6

Phone: ++49(0)345/ 2909 777  
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D-06110 Halle

Contact Person: Dr. Konrad Stöber

Date of issue: 28.03.2011

These data are based on our present knowledge. However, they shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

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## Annex I

## GES 5 Production of Nickel-containing electronics and thermally functioning ceramics

1	<b>Exposure scenario identification</b>
	Short title of the exposure scenario
	GES 5 Production of Nickel-containing electronics and thermally functioning ceramics
2	Processes and activities covered by the exposure scenario - workers
	<p>PROC 0, PROC1, PROC 3, PROC 4, PROC 5, PROC 22, PROC 24</p> <p>Thermistor production NiO powder from a production batch is measured out using manually operated balances. The NiO is milled and then mixed with other ingredients including cobalt oxide and manganese oxide. This intermediate product is transferred to a furnace and calcined. The calcined powder is then mixed with deionised water and additives, formed and sintered to produce the semiconducting ceramic. This ceramic slab is cut into 'chips' of sintered ceramic. The thermistors are then assembled into the temperature sensing probe and packed into individual boxes by hand. Mixing and forming machines are wet washed and cleaned on a daily and twice weekly basis respectively. All extraction equipment is under a planned maintenance schedule.</p> <p>Fuel cell production: Anodes for solid oxide fuel cells (SOFC) are made of either a nickel/yttria-stabilised zirconia (Ni-YSZ) or of nickel oxide/yttria-stabilised zirconia (NiO-YSZ). These anodes are produced by using powder technology methods in one of three ways namely</p> <ol style="list-style-type: none"> <li>1) a Ni slurry is applied to the cell substrate and yttria-stabilised zirconia is deposited by electrochemical vapour deposition and sintered</li> <li>2) Ni-YSZ slurry is applied to the cell substrate and sintered or</li> <li>3) NiO-YSZ paste is applied to the cell Substrate by Screen-printing and sintered. During cell application in stack environment NiO is reduced to particulate Ni.</li> </ol>
3	Operational conditions of use
	<p>Substance used: Nickel Oxide in the form of green powder</p> <p><b>Frequency and duration of use/exposure:</b> 8 hour daily shifts, 5 days per week.</p> <p><b>Other given operational conditions affecting workers exposure:</b></p> <p>The production line is manned by operators who carry out the weighing of raw and intermediate materials, transfer operations e.g. bagging the intermediate product from the mixer and transferring it to the calciner, mixing, cutting chips from the semiconducting ceramic strips, inspecting the mechanised parts of the process (milling, mixing, calcining, sintering and sieving) and assembling the probe (article) form the thermistor and packaging the probe. Maintain clean workplace to prevent accumulation of powders and dusts on surfaces.</p> <p><u>Oral:</u> Good workplace hygiene practice.</p> <p>Transfer operations before and after the calcining step (to contain/bag and move the calcined product through process), weighing out raw and intermediate materials and charging/unloading processing equipment are manual operations and not fully enclosed.</p> <p><u>Inhalation:</u> Enclosure during milling, mixing, calcining, sintering and sieving is not likely to give rise to significant exposures to inhalable NiO.</p> <p>Operations not under complete enclosure e.g. manual NiO-containing powder transfer operations in bags, weighing out NiO raw and intermediate material and cutting chips from the semiconducting are likely to give rise to significant exposures to inhalable and dermal NiO</p> <p><u>Dermal:</u> Automation of processes should be used where possible to eliminate dermal contact</p>
4.	<b>Phase of application</b>
4.1	Risk management measures: Workers
	Industrial
	Human (oral, dermal, inhalative, physical)
	<p><b>Technical measures:</b></p> <p>LEV system with filtration is required for process steps that are not fully enclosed and involve NiO powder or are other vice likely to give rise to Ni containing dust e.g. roll mill and dicing machine.</p> <p><b>Conditions and measures related to personal protection, hygiene and health evaluation</b></p> <p><u>Inhalation:</u> RPE (FFP2) {approved with regard to EN 149} is required for unenclosed processes involving powders e.g. non contained powder transfer processes and weighing out NiO powder raw materials</p> <p><u>Dermal:</u> Gloves suitable for handling powders e.g. Nitrile rubber and other suitable protective clothing are required where direct contact with NiO could occur e.g. non contained powder transfer processes, weighing out NiO powder raw materials and picking/handling chips from the semiconducting ceramic strips.</p>

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4.2	Environment (water, soil, air)					
	ERC 2: Formulation of preparations SPERC for the processing stage of metal compounds					
	Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to sol: <b>Waste water:</b> On-site waste water treatment, Efficiency: 90% <b>Air:</b> Exhaust system, fabric or bag filters					
4.3	Waste					
	Ni-bearing wastes shall be handled as hazardous waste and shall be removed by licensed waste removal company, incinerated or recycled.					
5	<b>Phase of service life</b>					
	End Use - no service life					
6.	<b>Information on estimated exposure and Downstream-user guidance</b>					
6.1	<b>Exposure estimation:</b>					
6.1.1	<b>Human - Industrial worker</b>					
		Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
	<b>Dermal</b>					
	Acute systemic	mg Ni/kg/day		NR		
	Acute local	mg Ni/cm <sup>2</sup> /day		NR		
	Long-term systemic	mg Ni/kg/day		NR	-	
	Long-term local	mg Ni/cm <sup>2</sup> /day	0.024	0.0005	0.02	90th percentile from MEASE modelling (PROC 8b, 14, 22, automated with manual Intervention, partly enclosed, LEV, gloves)
	<b>Inhalation</b>					
	Acute systemic	mg Ni/m <sup>3</sup>	520	0.06	<0.001	Estimated as 3 x the long-term value (highest of 7 measurements). A factor of 3 was considered sufficient as a worst case estimate.
	Acute local	mg Ni/m <sup>3</sup>	3.9	0.06	0.015	Estimated as 3 x the long-term value (highest of 7 measurements). A factor of 3 was considered sufficient as a worst case estimate.
	Long-term systemic	mg Ni/m <sup>3</sup>	0.05 12	0.02	0.4	Highest of 7 measurem. associated with processing steps. Considered likely to represent worst case scenario.
	Long-term local	mg Ni/m <sup>3</sup>	0.05 12	0.02	0.4	Highest of 7 measurem. associated with processing steps. Considered likely to represent worst case scenario.
	NR. Not relevant because of negligible dermal absorption or lack of dermal irritation. <sup>1</sup> When handling powders of particle aerodynamic equivalent diameter (AED) below 10 pm exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m <sup>3</sup> <sup>2</sup> When exposure are solely to metallic and nickel) Oxides (without exposure to any other nickel)					

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	compounds) and the mean particle size of the aerosol is greater than 10 pm AED (s 10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M3 could be reasonably assumed to be safe							
<b>6.1.2</b>	<b>Environment</b>							
	ERC 2: Formulation of preparations, SPERC – processing stage of metal compounds Production of ceramics (ceramics for solid Oxide fuel cells; ceramics for thermistor products)							
	Compartment	Unit	PNEC	PEC <sub>Regional</sub>	C <sub>local</sub>	PEC	RCR	Methods for calculation of environmental concentrations and PNEC
	Freshwater	µg Ni/L	3.55	2.9	0.36	3..26	0.84	Measured values, Tier 3-RWC
	Marine	µg Ni / L	8.6	0.3	0.36	0.66	0.08	Measured values, Tier 3-RWC
	Terrestrial, Direct discharge	mg/kg	29.9	16.2	9.7E-05	16.2	0.54	Measured values, Tier 3-RWC
<b>7</b>	<b>Downstream-user guidance</b> Guidance to DU to evaluate whether he works inside the boundaries set by the ES The immediate DU (the "customer") next to the registrant (as other DUs as well) has to perform the following actions: <ul style="list-style-type: none"> <li>to check whether the ES fits his own uses, and the uses of his customers as taking place within the boundaries of the ES supplied to him in order</li> <li>to <i>identify</i> and <i>apply</i> the relevant measures to his own processes</li> <li>to <i>include</i> the ES and other information in the eMSDS received from the registrant into his own safety data sheet (if he places the substance or preparation on the market), and to <i>identify</i> and <i>recommend</i> appropriate RMMs to his customers.</li> <li>or to carry out an own chemicals safety assessment if the above proves not be the case.</li> </ul>							
	<b>Recommendations for evaluation whether he works inside the boundaries set by the ES</b>  <b>Workers:</b> Scaling considering duration and frequency of use Collect process monitoring data. Use aerosol particle size Information, when available, to confirm the appropriate use of an inhalable DNEL (e.g., <10% of Nickel mass in respirable fraction). Chemical speciation data showing that only Ni metal and/or Ni Oxides are present in the workplace air can be used to indicate RCR <1 at inhalable exposure levels between 0.05 and 0.2 mg Ni/m <sup>3</sup> . <b>Environment:</b> Scaling tool: Metals EUSES IT tool (free download: <a href="http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool">http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool</a> ) Scaling of the release to air and water environment includes: Refining of the release factor to air and waste water and/or and the efficiency of the air filter and wastewater treatment facility. Scaling of the PNEC for aquatic environment by using a tiered approach for correction for bioavailability and background concentration (C <sub>local</sub> approach). Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C <sub>local</sub> approach).							

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**GES 7 Production of nickel-containing pigments**

	<b>Exposure scenario identification</b>	
<b>1</b>	<b>Short title of the exposure scenario</b>	
	GES 7: Production of nickel-containing pigments	
<b>2</b>	<b>Processes and activities covered by the exposure scenario</b>	
	<p><b>Workers</b>            PROC 8b: Raw materials handling            Contributing exposure scenario ES 7.1            PROC 2, PROC 26: Mixing raw materials - NiO in a powder mixture            Contributing exposure scenario ES 7.2            PROC 22: Drying and Calcining product - Drying and calcining of wet product mix or calcining of dry product mix            Contributing exposure scenario ES 7.3            PROC 24: Dry milling            Contributing exposure scenario ES 7.4            PROC 24: Wet milling, Washing and Drying - calcined NiO products containing salts are ground wet, washed to eliminate excess of soluble salts and dried            Contributing exposure scenario ES 7.5            PROC 9: Blending and packaging: The calcined powder product is blended with additives and packed (bags or big bags)            Contributing exposure scenario ES 7.6            PROC 0: Cleaning and maintenance: Cleaning and maintenance operations are regularly performed on-site. This involves Cleaning and maintenance of equipment and installations used for handling of raw materials and final product            Contributing exposure scenario ES 7.7</p> <p><b>Environment:</b>            Production of inorganic pigments:            Dosing and mixing; Drying (if wet mixing); Calcination (charge)-, Calcination (discharge); Milling (dry or wet); Washing (optional); Drying (if washed);            Mixing and/or packaging; Laboratory; Cleaning and maintenance</p>	
<b>3</b>	<b>Operational conditions of use</b>	
	<p><b>Frequency and duration of use/exposure:</b> 8 hour daily shifts, 5 days per week.            Oral: Good workplace hygiene practice.</p> <p><b>Other given operational conditions affecting workers exposure:</b>            ES 7.1 NiO is supplied as finely divided powder            Manual Opening of NiO bags and manual tipping or automatic discharge of NiO powders and other ingredients, including water, into the reactor            ES 7.2 NiO in a powder mixture            Dry or wet (stirring suspensions) mixing together of all raw materials in a closed reactor            ES 7.3 Wet or dry NiO-containing suspension            Continuous and automated drying and calcining operation can be performed in tunnel ovens or rotary kilns. During operation of the 'discontinuous' drying and calcining processes, the mixture of raw materials is (manually or automatically) loaded into crucibles and conveyed through the oven on wagons. Then the calcined product is unloaded (manually or automatically) from the crucible and transferred to milling.            ES 7.4 Solid Ni-containing calcined product            The dry calcined product is milled in an enclosed ball mill and conveyed to packaging.            ES 7.5 Solid Ni-containing calcined product            The dry calcined product is milled wet then washed and dried (atomisers, jet drier)            ES 7.6 Ni-containing powder pigment            ES 7.7 Variable includes powders and more coarse residues</p>	
<b>4.</b>	<b>Phase of application</b>	
	Risk management measures: Workers	Industrial
	Human (oral, dermal, inhalative, physical)	
	<p>ES 7.1  <b>Technical measures:</b>            LEV is required for processes that are not fully enclosed and are likely to give rise to NiO dust, such as opening of bags, charging of reactors or preparing suspensions of solid NiO.            Inhalation: The manual opening of bags and tipping of the NiO powder from the bags into the reactor is likely to give rise to significant exposures to inhalable NiO. The automated closed</p>	

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conveying of NiO feedstock significant exposures to inhalable NiO.

Dermal: The manual opening of bags and tipping significant dermal exposures to NiO dust.

Personal protection:

Inhalation: RPE (FFP1) (approved with regard to EN149) is minimum required for handling final product.

Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are optional.

ES 7.2

Technical measures:

LEV is required for processes that are not automated or enclosed and are likely to give rise to NiO dust, such as open conveying of dry product mix.

Inhalation: The automated closed conveying of product mix from the wet process is unlikely to give rise to significant exposures to inhalable NiO. Automated open conveying of product mix from the dry process may give rise to significant exposures to inhalable NiO.

Dermal: Containment of the processes should be used where possible to eliminate dermal contact

Personal protection:

Inhalation: RPE (FFP1, 2 or 3) {approved with regard to EN 149} is required at process steps that are not fully enclosed and are likely to give rise to Ni dust or fumes.

Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are required

ES 7.3

Technical measures:

LEV is required for processes not fully enclosed and likely to give rise to NiO dust, such as calcining the product in crucibles in a tunnel oven

Inhalation: The calcining of product mix where ovens are not fully enclosed and where there are manual interventions is likely to give rise to significant exposures to inhalable NiO. Automated open conveying of product from the calciner may give to significant exposures to inhalable NiO

Dermal: Automation and containment of the processes should be used where possible to eliminate dermal contact

Personal protection:

Inhalation: RPE (FFP1) {approved with regard to EN 1491 at process steps that are not fully enclosed and are likely to give rise to Ni containing dust, e.g. handling of the final product. When handling powders of particle diameter below 10 pm, RPE (FFP2) {approved with regard to EN 1491 is required.

Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are required.

ES 7.4

Technical measures:

LEV is required for processes not fully enclosed and that are likely to give rise to NiO containing dust

Inhalation: Not fully enclosed powder transfer operations are likely to give rise to significant exposures to inhalable Ni

Dermal: Automation of processes should be used where possible eliminate dermal contact.

Personal protection:

Inhalation: RPE (FFP1) {approved with regard to EN 1491 at process steps that are not fully enclosed and are likely to give rise to Ni containing dust, e.g. handling of the final product. When handling powders of particle diameter below 10 pm, RPE (FFP2) (approved with regard to EN 149) is required.

Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are optional

ES 7.5

Technical measures:

LEV is required for processes not fully enclosed and likely to give rise to NiO-containing dust

Inhalation: Not fully enclosed operations for powder drying and transfer are likely to give rise to significant exposures to. inhalable Ni

Dermal: Automation of processes should be used where possible to eliminate dermal contact

Personal protection:

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<p>Inhalation: RPE (FFP1,) (approved with regard to EN149) is minimum required for handling final product.                  Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are optional.</p> <p>ES 7.6  <u>Technical measures:</u>                  LEV is required for processes not fully enclosed and that are likely to give rise to NiO-containing dust                  Inhalation: Automated drum and big bag filling with some manual interventions (such as loading of empty /unloading of full drums, closing of lids and manually adding or removing pellets to achieve the correct mass) during the filling of drums with NiO powder) are likely to give rise to significant exposures to NiO powder and dust  <u>Dermal:</u> Automation of processes should be used where possible to eliminate dermal contact.                  Personal protection:  <u>Inhalation:</u> RPE (FFP1,) {approved with regard to EN 149} is minimum required for handling final product. When handling powders of particle diameter below 10 pm, RPE (FFP2) {approved with regard to EN 149} is required.  <u>Dermal:</u> Suitable gloves (PVC or equivalent), goggles and special safety clothing are required.</p> <p>ES 7.7  <u>Technical measures:</u>                  Local and general exhaust ventilation  <u>Personal protection:</u>                  Inhalation: RPE (FFP1, APF 20) is required.                  Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are required.</p>						
<p>Environment (water, soil, air)</p> <p>ERC2: Formulation of preparations                  SPERC data for metals and metal compounds for the production and formulation stage of metal compounds such as pigments.</p> <p><b>Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil</b></p> <p>ES 1 Discharge to STP: Off-site wastewater treatment plant, municipal STP                  Release factor is based on SPERC data for metals and metal compounds for the production and formulation stage of metal compounds such as pigments (90th % release factor for wastewater 0.02%). Release factor: 200 g/T                  ES 2 Direct discharge: On-site wastewater treatment by chemical precipitation and Filtration.                  Efficiency: 90%                  Release factor after on-site treatment: 51.5 g/T                  Air:                  ES 1 and ES 2:                  Treatment of air emissions by fabric or bag Filters.                  Release factor to air after on-site treatment: 40 g/T (max)</p>						
<b>Waste</b>						
<p>Ni-bearing wastes shall be handled as hazardous waste and shall be removed by licensed waste removal company, incinerated or recycled.</p>						
<b>5</b>	<b>Phase of service life</b>					
	End Use - no service life					
<b>6</b>	<b>Information on estimated exposure and Downstream-user guidance</b>					
<b>6.1</b>	<b>Exposure estimation:</b>					
<b>6.1.1</b>	<b>Human - Industrial worker</b>					
	<b>ES 7.1/2 PROC 8b, PROC, 2, PROC 26: Raw Materials Handling and Mixing</b>					
		Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
	Dermal					

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	Acute systemic	mg Ni/kg/day		NR		
	Acute local	mg Ni/cm <sup>2</sup> /day		NR		
	Long-term systemic	mg Ni/kg/day		NR	-	
	Long-term local	mg Ni/cm <sup>2</sup> /day	0.024	0.0005	0.02	90th percentile from MEASE modelling (PROC8a, 8b, partly enclosed, gloves)
Inhalation						
	Acute systemic	mg Ni/m <sup>3</sup>	520	0.06	4.001	3 x long term exposure measurement for charging the calciner
	Acute local	mg Ni/m <sup>3</sup>	<sup>3,9</sup>	0.06	0.02	3 x long term exposure measurement for charging the calciner
	Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.02	0.4	Based on 8 personal exposure measurements for charging the calciner
	Long-term local	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.02	0.4	
NR. Not relevant because of negligible dermal absorption or lack of dermal irritation. <sup>1</sup> When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m <sup>3</sup> <sup>2</sup> When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤ 10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/m <sup>3</sup> could be reasonably assumed to be safe (see Appendix C3).						
<b>ES 7.3 PROC 22: Drying and calcining product</b>						
		Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal						
	Acute systemic	mg Ni/kg/day		NR		
	Acute local	mg Ni/cm <sup>2</sup> /day		NR		
	Long-term systemic	mg Ni/kg/day		NR	-	
	Long-term local	mg Ni/cm <sup>2</sup> /day	0.024	0.005	0,21	90th percentile from MEASE modelling (PROC22, automated with manual Intervention, partly enclosed, gloves)
Inhalation						
	Acute systemic	mg Ni/m <sup>3</sup>	520	0.06	4.001	3 x long term exposure measurement for charging the calciner
	Acute local	mg Ni/m <sup>3</sup>	<sup>3,9</sup>	0.06	0.02	3 x long term exposure measurement for charging the calciner
	Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.02	0.4	Based on 8 personal exposure measurements for charging the calciner
	Long-term local	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.02	0.4	
<sup>1</sup> When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/M <sup>3</sup> . In this case the RCR is 2. Use of RPE (APF=20) reduces the risk RCR = 0.1. <sup>2</sup> When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤ 10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M <sup>3</sup> could be reasonably assumed to be safe (see Appendix C3).						
<b>ES 7.4 PROC24: Dry Milling</b>						
		Unit	DNEL NiO	Exposure concentration	RCR	Methods for calculation of exposure
Dermal						
	Acute systemic	mg Ni/kg/day		NR		
	Acute local	mg Ni/cm <sup>2</sup> /day		NR		
	Long-term systemic	mg Ni/kg/day	-	NR		

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Long-term local	mg Ni/cm <sup>2</sup> /day	0.024	0.005	0.2	90th percentile from MEASE modelling (PROC24, automated enclosed)
Inhalation					
Acute systemic	mg Ni/m <sup>3</sup>	520	0.12	<0.001	Estimated as 3 x long term value A factor of 3 was considered sufficient to account the limited dataset
Acute local	mg Ni/m <sup>3</sup>	3.9	0.12	0.03	Estimated as 3 x long term value A factor of 3 was considered sufficient to account the limited dataset
Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.04	0.8	Based on a single personal exposure measurements reported for milling
Long-term local	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.04	0.8	

<sup>1</sup>When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m<sup>3</sup>. In this case the RCR is 4. Use of RPE (APF=20) reduces the risk RCR = 0.2

<sup>2</sup>When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M<sup>3</sup> could be reasonably assumed to be safe.

**ES 7.5 PROC24: Wet milling, washing 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 <sup>2</sup> /day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm <sup>2</sup> /day	0.024	0.00005	0.002	90th percentile from MEASE modelling (PROC24, automated enclosed)
Inhalation					
Acute systemic	mg Ni/m <sup>3</sup>	520	0.012	<0.001	Estimated as 3 x long term value A factor of 3 was considered sufficient to account the limited dataset
Acute local	mg Ni/m <sup>3</sup>	3.9	0.012	0.003	Estimated as 3 x long term value A factor of 3 was considered sufficient to account the limited dataset
Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>	0.004	0.08	Based on a single personal exposure measurements reported for milling

<sup>1</sup>When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m<sup>3</sup>. In this case the RCR is 3. Use of RPE (APF=20) reduces the risk RCR = 0.15

<sup>2</sup>When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M<sup>3</sup> could be reasonably assumed to be safe.

**ES 7.6 PROC 9: Mixing and/or packaging**

	Unit	DNEL NiO	Exposure	RCR	Methods for calculation of
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				concentration		exposure
Dermal						
Acute systemic	mg Ni/kg/day	-		NR		
Acute local	mg Ni/cm <sup>2</sup> /day	-		NR		
Long-term systemic	mg Ni/kg/day	-		NR		
Long-term local	mg Ni/CM <sup>2</sup> /day	0.024		0.011	0.46	Read across from dermal exposure to insoluble Ni for packing Ni Metal Powder
Inhalation						
Acute systemic	mg Ni/m <sup>3</sup>	520		0.3	<0.001	10 x long term exposure measurement based on handling powders during packaging. A factor of 10 was considered sufficient to account for the limited dataset.
Acute local	mg Ni/m <sup>3</sup>	3.9		0.3	0.08	10 x long term exposure measurement based on handling powders during packaging. A factor of 10 was considered sufficient to account for the limited dataset.
Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>		0.03	0.6	Based on a single personal exposure measurement for mixing and/or packaging
Long-term systemic	mg Ni/m <sup>3</sup>	0.05 <sup>1,2</sup>		0.03	0.6	

<sup>1</sup>When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m<sup>3</sup>. In this case the RCR is 3. Use of RPE (APF=20) reduces the risk RCR = 0.15

<sup>2</sup>When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤ 10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M<sup>3</sup> could be reasonably assumed to be safe.

**ES 7.7 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/cm <sup>2</sup> /day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/CM <sup>2</sup> /day	0.024	0.00003	<0.001	90th percentile from MEASE modelling (PROC10, no direct handling, non dispersive techniques, no more than 4 hours, gloves)
Inhalation					
Acute systemic	mg Ni/m <sup>3</sup>	520	1.0 26	0.002	3 x modelled exposure value
Acute local	mg Ni/m <sup>3</sup>	3.9	1.0 26	0.26	3 x modelled exposure value
Long-term	mg Ni/m <sup>3</sup>	0.051,2	0.3	6.84 excl.	90th percentile from MEASE

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	systemic			42	RPE	modelling
	Long-term local	mg Ni/m <sup>3</sup>	0.051,2	0.3 42	By use of RPE (P3, APF 20): 0.34  6.84 excl. RPE  By use of RPE (P3, APF 20):	90th percentile from MEASE modelling

<sup>1</sup>When handling powders of particle aerodynamic equivalent diameter (AED) below 10 µm, exposures (8h TWA) to these powders should be kept under 0.01 mg Ni/m<sup>3</sup>. In this case the RCR is 3. Use of RPE (APF=20) reduces the risk RCR = 0.15

<sup>2</sup>When exposure are solely to metallic and nickel oxides (without exposure to any other nickel compounds) and the mean particle size of the aerosol is greater than 10 µm AED (≤ 10% of aerosol mass in respirable fraction), inhalable exposure levels up to 0.2 mg Ni/M<sup>3</sup> could be reasonably assumed to be safe.

**6.1.2 Environment**

ERC2, SPERC: Production and formulation of metal compounds Production of nickel-containing inorganic pigments from NiO

Compartment	Unit	PNEC	PEC Regional	C local	PEC	RCR	Methods for calculation of environmental concentrations and PNEC
Freshwater ES1 Discharge to STP	µg Ni/L	3.55	2.9	0.17	3.07	0.86	Measured values, Tier 3-RWC
Freshwater ES2 Direct discharge	µg Ni/L	3.55	2.9	0.08	2.98	0.84	Measured values, Tier 3-RWC
Marine ES1 and ES2	mg/kg	8.6	0.3	0.82	1.12	0.13	Measured values, Tier 3-RWC
Terrestrial ES1 Discharge to STP		29.9	16.2	0.73	16.93	0.57	Measured values, Tier 3-RWC
Terrestrial ES2 Direct discharge		29.9	16.2	0.002	16.2	0.54	Measured values, Tier 3-RWC

**7 Downstream-user guidance**

Guidance to DU to evaluate whether he works inside the boundaries set by the ES  
The immediate DU (the “customer”) next to the registrant (as other DUs as well) has to perform the following actions:

- to check whether the ES fits his own uses, and the uses of his customers as taking place within the boundaries of the ES supplied to him in order
- to *identify* and *apply* the relevant measures to his own processes
- to *include* the ES and other information in the eSDS received from the registrant into his own safety data sheet (if he places the substance or preparation on the market), and to *identify* and *recommend* appropriate RMMS to his customers.
- or to carry out an own chemicals safety assessment if the above proves not be the case.

**Recommendations for evaluation whether he works inside the boundaries set by the ES**

**Workers**

Scaling considering duration and frequency of use.

Collect process monitoring data. Use aerosol particle size Information, when available, to confirm the appropriate use of an inhalable DNEL (e.g. ≤10% of Nickel mass in respirable fraction). Chemical speciation data showing that only Ni metal and/or Ni oxides are present in the workplace air can be used to indicate RCR <1 at inhalable exposure levels Between 0.05 and 0.2 mg Ni/m<sup>3</sup>.

**Environment**

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

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## Annex II Abbreviations used

ARCHE	Assessing risks of Chemical
CAS	Chemical abstract service
C <sub>local</sub>	locale Concentration
CLP	Classification, labelling & packaging
CSA	Chemical Safety Assessment
CSR	Chemical Safety Report
DNEL	derived no effect level
EC <sub>10</sub>	Effect concentration 10% (Konzentration, bei der bei 10% der Test-Population nachteilige Wirkungen auftreten)
EINECS	European Inventory of Existing Commercial Chemical Substances
EN	Euro-Norm
ERC	Environmental release Class
ES	Exposure Scenario
F0	Parental generation
F1	First generation
GES	Generic Exposure Scenario (Standardexpositionsszenarium)
IARC	International Agency on Research on Cancer
IC <sub>50</sub>	50% Inhibition Concentration
IUCLID	International Uniform Chemical Information Database
L(E)C <sub>50</sub>	Concentration causing 50% lethality(L) or adverse effects (E)
LD <sub>50</sub>	Dose causing 50% lethality
LOAEC	Lowest observed adverse effect concentration
LOAEL	Lowest observed adverse effect level
MEASE	Estimation and assessment of substance exposure to metals
NAEC	No adverse effect concentration
NAEL	No adverse effect level
NOEC	No observed effect concentration
NOAEC	No observed adverse effect concentration
NOAEL	No observed adverse effect level
NOEL	No observed effect level
PC	Chemical product category
PBT	Persistent, bioaccumulative and toxic
PEC	Predicted environmental concentration
PNEC	Predicted no effect concentration
PROC	Process Category
RCR	Risk characterisation ratio
RMM	Risk management measure
RPE	Respiratory protective equipment
RWC	reasonable worst case
SPERC	Sector specific environmental release class
STOT	Specific target organ toxicity
STP	Sewage treatment plant
SU	Sector of Use
TWA	time weighted average