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Material safety data sheet

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SECTION 1. Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier:

Commercial name: Nickel sulphate

UN-No.: 3260

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

Identified uses: Production of pure nickel (II) sulphate (VI)

Uses advised against: product cannot be publically available

1.3 Details of the supplier of the material safety data sheet:

KGHM Polska Miedź S.A.

"GŁOGÓW" Copper Smelter

ul. Żukowicka 1, 67-200 Głogów

Person responsible for preparing the MSDS: Agnieszka Piechota, phone no.: (+48 76) 747 7176, e-mail: <u>a.piechota@kghm.pl</u>

1.4 Emergency telephone numbers:

Manufacturer (Poland): (+48 76) 747 65 01 - available 24/7.

Fire Dept. (Poland): 998 – available 24/7.

General Emergency (Poland): 112 – available 24/7.

Marine transport (Foreign countries):

Emergency Telephone Responce Number,

Emergency CONTACT (24-Hour-Number),

GBK/Infotrac ID 105036: (USA domestic): 1 800 535 5053 or international (001) 352 323 3500

SECTION 2. Hazards identification

2.1. Classification of the substance or mixture:

Classification according to the Regulation No. 1272/2008 (CLP):

Carc. 1A; H350 – may cause cancer;

Muta. 2; H341 – suspected of causing genetic defects.

Repr. 1 B; H360D – may damage the unborn child.

STOT RE 1; H372 – causes damage to organs through prolonged or repeated exposure.

Acute Tox. 4; H302 – harmful if swallowed;

Acute Tox. 4; H332 – harmful if inhaled;

Skin Corr. 1; H314 – causes severe skin burns and eye damage;

Resp. Sens. 1; H334 – may cause allergy or asthma symptoms or breathing difficulties if inhaled;

Skin Sens. 1; H317 – may cause an allergic skin reaction;

Met. Corr 1; H290 – may be corrosive to metals;

Aquatic Acute 1; H400 – very toxic to aquatic life;

Aquatic Chronic 1; H410 – very toxic to aquatic life with long lasting effects.





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Classification according to Directive 1999/45/EC:

Carc. cat. 1; R45 – may cause cancer;

Repro. cat. 2; R61 - may cause harm to the unborn child

Xn; R20/22 - harmful by inhalation and if swallowed;

C; R 34 – causes burns;

R42/43 – may cause sensitization by inhalation and skin contact;

T; R48/23 – toxic: danger of serious damage to health by prolonged exposure through inhalation

Muta. cat. 3; R68 – possible risk of irreversible effects;

N; R50/53 – very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

2.2. Label elements:

Restricted to professional users



Signal Word: "DANGER"

Hazard statements (H):

- H350 May cause cancer.
- H341 Suspected of causing genetic defects.
- H360D May damage the unborn child.
- H372 Causes damage to organs through prolonged or repeated exposure.
- H302 Harmful if swallowed.
- H332 Harmful if inhaled.
- H314 Causes severe skin burns and eye damage.
- **H334** May cause allergy or asthma symptoms or breathing difficulties if inhaled.
- **H317** May cause an allergic skin reaction.
- H290 May be corrosive to metals.
- **H410** Very toxic to aquatic life with long lasting effects.

Precautionary Statement (P):

- **P202** Do not handle until all safety precautions have been read and understood.
- P314 Get medical advice/attention if you feel unwell.
- P405 Store locked up.
- **P501** Dispose of contents/container to producer of product.
- **P273** Avoid release to the environment.
- **P406** Store in corrosive resistant/... container with a resistant inner liner.





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2.3 Other hazards:

After heating up to higher temperatures, toxic products of decomposition are released, such as As_2O_3 , SO_2 , SO_3 . At temperature higher than 840°C, nickel (II) oxide is released. The substance reacts with most of metals and releases flammable hydrogen.

Product does not meet classification criteria of PBT and vPvB.

SECTION 3. Composition/information on ingredients

3.1. Substances:

n/a

3.2. Mixtures:

a) according to the Regulation No. 1272/2008 (CLP):

No.	Name of substance	CAS No.	EC No.	Index No.	Content [mass fraction in %]	Symbols	H phrases	REACH registration number
1.	Nickel (II) sulphate (VI) NiSO ₄ x n H20 (n = 1, 3, 4)	7786-81-4	232-104-9	028-009-00-5	88 ≤ c ≤ 96	Carc. 1A Muta. 2 Repr. 1B STOT RE 1 Acute tox. 4 Acute tox. 4 Skin. Irrit. 2 Resp. Sens. 1 Skin. Sens. 1 Aquatic Acute 1 Aquatic Chronic 1	H350i H341 H360D H372 H302 H332 H315 H334 H317 H400 H410	01-2119439361- 44-0003
2.	Sulphuric acid (VI) H ₂ SO ₄ 7664-93-9 231-639-5 016-020-00-8		c ≤ 10	Skin. Corr. 1A	H314	01-2119458838- 20-0041		
3.	Arsenic acid As ₂ O ₃	7778-39-4	231-901-9	033-005-00-1	≤ 0,5	Carc. 1A Acute Tox. 2 Skin. Corr 1B Aquatic Acute 1 Aquatic Chronic1	H350 H300 H314 H400 H410	Impurity included in nickel sulfate registration dossier

b) acc. to Directive 1999/45/EC:

No.	Name of substance	CAS No.	EC No.	Index No.	Content [mass fraction in %]	Symbols	R phrases	REACH registration number
1.	Nickel (II) sulphate (VI) NiSO ₄ x n H ₂ O (n = 1, 3, 4)	7786-81-4	232-104-9	028-009-00-5	88≤c≤ 96	Carc., cat. 1 Repro. cat. 2; Muta. cat.3; T; Xn, Xi; N	49-61- 20/22-38- 42/43- 48/23-68- 50/53	01-2119439361- 44-0003
2.	Sulphuric acid (VI) H ₂ SO ₄	7664-93-9	231-639-5	016-020-00-8	c ≤ 10	С	35	01-2119458838- 20-0041
3.	Arsenic acid As ₂ O ₃	7778-39-4	231-901-9	033-005-00-1	≤ 0,5	Carc. cat.1, T+; C; N	45-28-34- 50/53	Impurity included in nickel sulfate registration dossier







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Full text of H and R phrases not expanded in Section 2 can be found Section 16.

SECTION 4. First Aid measures

4.1 Description of first aid measures:

<u>Respiratory ways</u>: Take the victim out of the place of exposure. Provide calmness in semi-sitting or sitting position. Protect against loss of body heat. **Immediate medical help necessary**.

<u>Contact with eyes</u>: Immediately rinse with a lot of cool, running water, for about 15 minutes, with eyelid open. Avoid intensive water jet because conjunctiva may become mechanically damaged. **Immediate medical help necessary**.

<u>Skin contact</u>: Remove contaminated clothing. Immediately clean contaminated skin with a lot of running water at room temperature. In case of skin changes, seek dermatologist attention.

<u>Alimentary way</u>: Rinse mouth with water. Have the victim drink 2 glasses of water. If the vomiting is self-induced, rinse mouth with water and drink water again. **Immediate medical help necessary**.

<u>General guidelines</u>: Persons endangered to eye intoxication should be instructed about the necessity and method of immediate eye-rinsing.

Note: aqueous solutions have acid reaction, pH of 10% of aqueous solution is about 1. **4.2 Most important symptoms and effects, both acute and delayed:**

Ways of exposure: alimentary way, respiratory ways, skin, eyes.

- respiratory ways: vapour/dust is toxic, pose serious threat to health after long-term exposure, may cause cancer, cause burning of mucosa, dyspnoea, may case sensitization;
- alimentary system: ingestion causes acute pain, nausea, vomiting, diarrhoea, burning of stomach cavity, throat, gullet;
- skin contact: causes burns, ulceration, may cause sensitization;
- > contact with eyes: vapour/dust causes burning of eyelids and eyeballs.

Acute intoxication symptoms:

Product in the form of mist and fumes causes pain, weeping, burns of conjunctiva, cornea, throat pains, cough, shallow breathing, accelerated breathing, breathlessness, glottis spasm, larynx oedema, bronchi spasm, lungs oedema. Death may occur as a result of glottis spasm. Skin contamination causes thermal (exothermic reaction with moist skin) and chemical burning. Eyes contamination causes burning of eyelids, eyeball and permanent damage. When ingested, causes burns of oral cavity, throat, gullet; may lead to perforation of gullet, stomach, bleeding of alimentary tract, shock. Long-term exposure:

Long-term exposure to sulfuric acid may lead to chronic inflammation of conjunctivas, nose bleeding, chronic bronchi inflammation. Repeated exposure of skin may lead to ulceration, changes in nails.

4.3 Indication of any immediate medical attention and special treatment needed:

If the victim is unconscious, make sure that the respiratory tract is not obstructed and place the victim in a recovery position. Provide medical assistance.







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SECTION 5. Firefighting measures

5.1 Extinguishing agents:

<u>Appropriate extinguishing agents</u>: Non-flammable substance. Apply extinguishing agents proper for the surrounding materials: water (if the container is tight) – sprayed jet, carbon dioxide, extinguishing powders, foam extinguishers, sand.

Unsuitable extinguishing agents: Not known.

5.2 Special hazards arising from the substance or mixture:

Substance soluble in water, creating caustic solutions which when in contact with most of metals release extremely flammable hydrogen.

Hazardous decomposition products: at high temperatures, sulphuric acid is distilled off and decomposition takes place releasing toxic sulphur oxides vapours (SO2, SO3), dusts of nickel oxides and arsenic trioxide.

5.3 Advice for fire-fighters:

During fire harmful substances may form. Wear protective, gas-tight clothes and apparatus isolating respiratory ways.

<u>Additional information</u>: Notify those in the surroundings about the fire. Remove all personnel not participating in the breakdown liquidation procedure from the area of hazard. Call fire department or police department. If possible, remove containers from fire hazard area. Do not let the fire water, contaminated with the substance, to penetrate surface or underground water.

SECTION 6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures:

<u>6.1.1 For non-emergency personnel</u>: Do not inhale dusts. Avoid direct contact. In case of choosing evacuation route consider the direction of the dust/fume movement.

<u>6.1.2 For emergency responders:</u> Avoid dust generation, do not inhale dusts. Avoid direct contact. Apply clothing protecting against chemicals as well as eye protection. In case of dust formation, wear dust mask.

Additional information:

Notify those in the surroundings about the emergency. Remove all personnel not participating in the breakdown liquidation procedure from the area of hazard. Call fire department and police if necessary. Protect the spilt substance against rain and wind by covering it with canvas cover.

6.2 Environmental precautions:

Do not let the product penetrate the sewage system, underground and surface water and soil. In case of failure, protect the substance against penetration to the environment. Collect maximum quantity to proper containers in order to utilize it.

6.3 Methods and material for containment and cleaning up:

Liquidate the leak (seal the defective package and put it in the protective package). Collect the spilt









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substance to container (acid-resistant) and dispose of as hazardous waste. Procedure with waste according to section 13.

6.4 Reference to other sections

Personal protection equipment described in section 8.2.2 Disposal considerations in section 13.

SECTION 7. Handling and storage

7.1 Precautions for safe handling:

Avoid generation of vapour/dust within the work stand. When handling the substance, do not drink, eat, smoke; avoid contact with the substance and its solutions. During work, apply eye and skin protection. Work stand should be equipped with eyewash. Work stand should be equipped with means for collecting spilt substance. After work, thoroughly clean hands and face.

7.2 Conditions for safe storage, including any incompatibilities:

Store in properly identified and tight acid resistant containers. Protect the container against damage. Keep the substance in roofed place with impermeable floor; if there is no roof, the substance must be protected against atmospheric precipitation with foil. Properly identify the storage place with access for authorized, trained personnel only.

<u>Ventilation requirements</u>: Premises must be equipped with proper local exhaust ventilation with housing in the area of vapours/dust emission to aerial environment and with general ventilation of the room. In case of insufficient ventilation, wear suitable individual protection of the respiratory system.

<u>Other information</u>: Always keep in original containers. Do not use emptied container for other purposes.

7.3 Specific end use(s):

The uses identified in item 1.2.

SECTION 8. Exposure control/personal protection

8.1 Control parameters:

Values of the highest admissible concentrations that should be controlled (Poland):

No.	Name of substance	CAS No.	NDS [mghn ³]	NDSCh [mg/m ³]
1.	Nickel and its compounds, except nickel tetracarbonyl – calculated to Ni	-	0.25	-
2.	Sulphuric acid (VI)	7664-93-9	1	3
3.	Arsenic and its inorganic compounds calculated to As	-	0.01	-

Values of the highest admissible concentrations that should be controlled (consignee):

No.	Name of substance	CAS No.	TIV-TWA (mg/m ³⁾	TLV-STEL [mg/m ³]
	Soluble nickel compounds, except nickel	-	0.1 (ACGIH-TWA, USA)	-
	tetracarbonyl – calculated to Ni		1 (OSHA PEL, USA)	-
1			0.1 (MEL, Great Britain)	-
1.			0.1 (TWA, Belgium)	-
	Nickel compounds calculated to Ni			
			0.1 (HTP, Finland)	-







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	Soluble nickel salts calculated to Ni			
			0.05 (MAK-Wert, Germany)	-
	Sulphuric acid	7664-93-9	0.2 (ACGIH-TWA, USA)	3 (ACGIH-TWA, USA)
			1 (OSHA-PEL, USA)	-
2.			0.2 (HTP, Finland)	1 (HTP, Finland)
			0.1(MAK-Wert, Germany)	0.1 (MAK-Wert,
				Germany)
	Sulphuric acid (vapours) ⁽¹⁾⁽²⁾		0.05 (European Union)	
	Arconic and its inorganic compounds calculated to As		0.01 (ACGIH-TWA, USA)	-
			0.01 (HTP, Finland)	-
3.	Arsenic and its compounds, except for arsenic hydride calculated to As		0.1 (TWA, Great Britain)	-

⁽¹⁾ When selecting appropriate method of monitoring the exposure, consider potential limitations and disturbances which could be created in the presence of other sulphur compounds.

⁽²⁾ Vapours are defined as trachea fraction.

Legal basis:

Decree of the Minister of Labour and Social Policy of November 29th, 2002 on the highest allowable concentrations and intensities of agents harmful for health in the work environment (Official Journal 02.217.1833 with subsequent amendments); According to Directive of the Commission 91/322/EWG of May 29th, 1991, on establishing indicative limit values by implementing Council Directive 80/1107/EEC on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work. (Official Journal L 177 of 5.7.1991); According to Directive 2000/39/EC - indicative occupational exposure limit values of 8 June 2000 establishing a first list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work. (Official Journal L 142 of 16.6.2000 with subsequent amendments); Directive of the Commission 2009/161/EU of December 17th, 2009, establishing the third list of indicative values of occupational exposure in order to execute the Directive 98/241/EC as well as amending the Commission Directive 2000/39/EC (Official Journal L 338 of 19.12.2009);

The derived no-effect levels (DNELs) for nickel - workers:

- Acute exposure, inhalation, DNEL = 16mg Ni/m³
- Chronic exposure, inhalation, DNEL = 0.05 mg Ni/m³
- Chronic exposure, dermal, DNEL = $0.00044 \text{ mg Ni/cm}^2$

The derived no-effect levels (DNELs) for nickel - the general public:

- Acute exposure, inhalation, DNEL = 9.6 mg Ni/m^3
- Acute exposure, oral, DNEL = 0.012 mg Ni / kg / day
- Chronic exposure, inhalation, DNEL = 0.00002 mg Ni/m³

8.2 Exposure controls:

8.2.1 Appropriate engineering controls:

Information contained in exposure scenarios attached to the Safety Data Sheet.

8.2.2 Personal protection measures same as personal protection equipment:

Eye and face protection:





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Use protective goggles with face protection,

Hands protection:

Use protective gloves,

Skin protection:

Use acid resistant clothing,

Respiratory ways protection:

necessary when vapours/dusts are formed – gas mask (absorber of acidic vapours), dust mask equpped with filter suitable for determined air concentration, if the substance concentration is not known, apply respiratory ways isolation equipment.

Thermal hazards:

Not applicable

Hygiene means:

Immediately change contaminated clothing. Decontaminate clothing in water before reuse. Wash your hands and face after working with the substance. Do not eat and drink during substance handling.

8.2.3 Environmental exposure controls:

Environmental exposure should be controlled in compliance with national environment protection legislation in force.

SECTION 9. Physical and chemical properties

9.1 Information on basic physical and chemical properties:

- Appearance: dark-yellow or yellow-green, fine-crystalline powder;
- Odour: odourless;
- Level of odour perception: n.a.
- pH of saturated solution: about 1;
- Melting/: at temp. 103 °C 110 °C loses crystallization water, anhydrous melt at temp. 280 °C; freezing point not determined
- Initial boiling point and boiling temperature range: n.a.
- Ignition temperature: n.a. inflammable product
- Evaporation rate: n.a.
- Flammability: n.a. inflammable product
- Low/high flammability point or high/low explosion point: n.a.
- Vapour pressure: n.a.
- Vapour density: n.a.
- Relative density: n.a.
- Bulk density: 1,88 g/cm3;
- Solubility in water: at temp. 20 °C about 1,5 g/100 g of water;
- Distribution coefficient: n-octanol/ water: n.a.
- Spontaneous ignition temperature: n.a.



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- Temperature of decomposition: at temp. about 840 °C decomposes with the release of nickel oxides and sulphur oxides; at temp. about 190 °C may sublime As₂SO₃;
- Viscosity: n.a.
- Explosion properties: n.a.
- Oxidizing properties: n.a.

9.2 Other information:

None

SECTION 10. Stability and reactivity

10.1 Reactivity:

When in contact with common metals, hydrogen releases. After heating up, the substance explosively reacts with aluminium and magnesium powder.

10.2 Chemical stability:

The substance is stable under normal conditions.

10.3 Possibility of hazardous reactions:

Not known

10.4 Conditions to avoid:

High temperature, accidental incompatible materials contact.

10.5 Incompatible materials:

Alkali and alkali soil metals – cause heating up, ignition of metal and explosion of released hydrogen. Contact with strong bases causes heating up of the mix and decomposition of NiSO4 to nickel (II) hydroxide.

10.6 Hazardous decomposition products:

In case of heating up to higher temperatures or fire, the following toxic products of decomposition are released: sulphur oxides (SO₂, SO₃), nickel oxides, arsenic oxides.

SECTION 11. Toxicological information

11.1 Information on toxicological effects

a) acute toxicity:

Acute toxicity (oral):

Due to the nickel (II) sulfate (VI) content product meets classification criteria as harmful after swallowing (Acute Tox. 4; H302).

After swallowing causes sharp pain, nausea, vomits, diarrhoea, oral cavity, throat and gullet burns. Acute toxicity (inhalation):

Due to the nickel (II) sulfate (VI) content product meets classification criteria as harmful after inhaling (Acute Tox. 4; H332).

Vapours/dust have toxic action, create serious health risk in long-term exposure, may cause cancer, mucosae burns, dyspnoea, may cause sensitisation.





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Acute toxicity(skin contact):

on the basis of available data the classification criteria are not met.

Toxic and lethal doses and concentartions:

<u>NiSO₄:</u>

LD₅₀ (rat/females, oral): 361,9 mg/kg,

LC50 4h (rat, inhalation): 2,48 mg/l,

LD₅₀ (rat, skin): no data

<u>H₂SO₄:</u>

<u>LD₅₀ (rat, oral): 2140 mg/kg,</u>

LC₅₀ (rat, inhalation): 375 mg/m³,

LC50 4h (mouse, inhalation): 0,85 mg/l,

LC508h (mouse, inhalation): 0,6 mg/l,

LD₅₀ (rat, skin): no data

<u>H₃AsO₄:</u>

LD₅₀ (mouse/females, oral): 160,4 mg/kg,

LD₅₀ (mouse/females, oral): 141,4 mg/kg,

LC₅₀4h (mouse/females, inhalation): 1,153 mg/l,

LC₅₀4h (mouse/females, inhalation): 0,794 mg/l,

LD₅₀ (rabbit/females, skin): 2300 mg/kg

LD₅₀ (rabbit/females, skin): 1750 mg/kg

b) skin corrosion/irritation:

due to pH of the product it is classified as:

Skin Corr.;H314 The substance causes severe skin burns and eye damage.

c) serious eye damage/ eye irritating:

due to pH of the product it is classified as:

Skin Corr.;H314 The substance causes severe skin burns and eye damage.

d) respiratory tract or skin sensitization:

due to NiSO₄ content above concentration limit the product is classified as:

Skin Sens. 1; H317 – may cause an allergic skin reaction.;

Resp. Sens. 1; H334 – may cause allergy or asthma symptoms or breathing difficulties after inhalation. *e) reproductive cells mutagenicity:*

due to NiSO₄ content above concentration limit the product is classified as:

Muta. 2; H341 - suspected of causing genetic defects;

f) carcinogenicity:

due to H_3AsO_4 content above concentration limit the product is classified as:

Carc. 1A; H350 - may cause cancer;

g) harmful for reproduction:



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due to NiSO₄ content above concentration limit the product is classified as:

Repr. 1B; H360D – May damage the unborn child;

h) toxicity to specific organs - single exposure:

on the basis of available data the classification criteria are not met.

i) toxicity to specific organs - repeated exposure:

due to NiSO₄ content above concentration limit the product is classified as:

STOT RE 1; H372 - Causes damage to organs through prolonged or repeated exposure.

According to chemical safety assessment carried out for nickel (II) sulfate (VI) the respiratory way exposure causes danger in long-term or repeated exposure and damaged organs are lungs.

j) aspiration hazard:

on the basis of available data the classification criteria are not met.

Toxic action and other harmful actions for human body:

Arsenic and arsenic compounds are toxic for circulatory system, central and peripheral nervous system, liver and kidneys. Nickel causes disorders in the structure of nucleic acid leading to tumours of mouth, throat and lungs as well as nickel egzema.

Additional information:

Information related to possible exposure ways, product properties related symptoms and possible product exposure effects described in section 4.2.

SECTION 12. Ecological information

12.1 Toxicity:

On the basis of Chemical Safety Report for nickel (II) sulfate (VI) the product meets classification criteria as very toxic to aquatic life (Aquatic Acute 1; H400) and very toxic to aquatic life with long lasting effects (Aquatic Chronic 1; H410).

M factor for nickel (II) sulfate (VI) = 1.

Toxic concentration for aqueous animal and plant organisms:

NiSO₄:

LC₅₀/96h fish: Oncorhynchus mykiss: 15,3 mg/l

 $EC_{50}/48h$ crustaceans: *Ceriodaphnia dubia:* >82.1 < 133.1 mg/l (depending on water hardness and alkalinity)

 $EC_{50}/72h$ algae: *Pseudokirchnerella subcapitata*: > 81.5 < 148 µg/l (depending on water hardness and pH)

H₂SO₄:

LC₅₀/96h fish: Lepomis macrochirus: > 16 < 28 mg/l

EC₅₀/48h crustaceans: Daphnia magna: > 100mg/l

EC₅₀/72h algae: *Desmodesmus subspicatus*:

H₃AsO₄:

LC₅₀/96h fish: Cyprinodon variegatus: 28 mg/l





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EC₅₀/48h crustaceans: *Americamysis bahia*: 6,6 mg/l EC₅₀/72h algae: no data <u>Prediceted no effect concentrations (PNECs)</u>: PNEC (surface water) – 3,6 μ g soluble Ni/l PNEC (marine water) – 8,6 μ g soluble Ni/l PNEC (soil) – 29,9 mg Ni/kg dry mass PNEC (STP) – 0,33 mg Ni/l PNEC birds, oral – 5,0 mg/kg mokrej masy PNEC mammals, oral (rat) – 0,73 mg/kg wet mass

12.2 Persistence and degradability:

Product dissolves in contact with surface water. Environmental changes last until ions of Ni⁺² react with ions of S⁻², CO_3^{-2} and precipitation of their sparingly soluble salts.

12.3 Bioaccumulative potential:

Nickel is easily bioaccumulated in phytoplankton and in other water plants. Daily human absorption varies in a range of 0,3-0,5 mg. Alimentary tract absorption in humans is below 10%. Low solubility compounds (metallic nickel dust, nickel sulfate and oxide) accumulate in lungs. Nickel sulfate solution is absorbed at 55-75% from skin in 24 hours. Nickel acquired with food and water is poorly absorbed and quickly excreted from organism. It is accumulated mainly in bones, parenchymal organs, heart and various glands. Nickel from the air is highly accumulated in lungs and transported to other organs.

12.4 Mobility in soil:

Nickel is an element with high mobility in the natural environment, the system soil - plant plays an important role in its circulation in ecosystems. Cultivated plants differ in ability to absorb nickel, although it is usually easily absorbed proportionally to the concentration in the soil until it reaches toxic levels. Nickel as a micronutrient in trace amounts is essential for plants. However, there are large differences in phytoaccumulation and phytotoxicity of nickel, depending on plant species, as well as the form in which nickel is present in the soil. Very important are also properties of soil such as pH, particle size distribution, organic matter content, as well as the interaction between nickel and other trace elements, e.g. cadmium (Cd), copper (Cu), zinc (Zn).

12.5 Results of PBT and vPvB assessment.

Product not classifies as PBT and vPvB.

12.6 Other adverse effects:

Not known.

SECTION 13. Disposal considerations

13.1 Waste treatment methods:

Do not dispose of to sewage system. Do not let the substance to contaminate surface and underground water and soil. Do not dispose of together with municipal waste. Consider the opportunity to reuse. Store the waste on hazardous waste dump yards in tight and durable containers.





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Waste management according to the Directive of the European Parliament and Council 2008/98/EC of November 19th, 2008 on waste (Official Journal EC L 312 of 22.11.2008).

Disposable packages must be handed over to an authorized collector of package waste. Multiple use packages can be still used after previous cleaning.

Waste management according to the Directive of the European Parliament and Council 94/62/EC of December 20th, 1994 on packages and waste packages (Official Journal EC L 365 of 31.12.1994, with subsequent amendments).

SECTION 14. Transport information

14.1 UN number: 3260

14.2 UN proper shipping name:

ADR: CORROSIVE, SOLID, ACIDIC, INORGANIC, OTHERWISE NOT SPECIFIED **RID:** CORROSIVE, ACIDIC, INORGANIC, SOLID, OTHERWISE NOT SPECIFIED

14.3 Transport hazard classes: RID/ADR: 8; IMDG: 8,

14.4 Packing group: RID/ADR: III; IMDG: III,

14.5 Environmental hazards:

Due to toxic effects of the semiproduct on aquatic organisms, means of transport should be labelled with the following mark:



14.6. Special precautions for the user:

Do not damage the containers. In case of unintentional product release, liquidate the leakage (seal, place damaged container in a protective packaging). Collect spilt substance into an acid resistant tank and dispose of as hazardous waste. Personal protection measures as described in section 8.8.2.

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

n/a

Additional information:

Commercial name of material: Nickel sulphate Class/Classification Code: RID/ADR: C2, Limited quantities: RID/ADR 5 kg Packing instructions:

- ADR: P002, IBC08, LP02, R001,
- RID: P002, DPPL08, LP02, R001,
- IMDG: P002, IBC08.

Warning labels: RID/ADR: 8, IMDG: 8





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Hazard identification number: RID/ADR: 80

Special provisions: RID/ADR: 274; IMDG: 223, 274, 944

Other data: special provisions of 5.2.1.8 and 5.4.1.1.18 apply.

SECTION 15. Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:

<u>Nickel (II) sulfate (VI) is not covered</u> by the regulations of the Decree (EC) No. 2037/2000 of the European Parliament and Council of 29th June, 2000 on substances depleting ozone layer (Official Journal L 244 of 29.09.2000, with subsequent amendments) or the Decree (EC) No. 850/2004 of the European Parliament and Council of April 29th, 2004, on permanent organic contamination and changing the Directive 79/117/EWG (Official Journal L 158 of 30.4.2004, with subsequent amendments).

<u>Nickel (II) sulfate (VI) is not subject</u> to regulations of the Decree of the European Parliament and Council (EC) No. 689/2008 of June 17th, 2008 on export and import of hazardous chemicals (Official Journal L 204 of 31.07.2008, with subsequent amendments).

<u>Category</u> of the substance according to Seveso Directive/substances listed in the annex I to the Directive of the Council 96/82/EC of December 9th, 1996, on control of significant breakdowns hazard related to hazardous substances (Official Journal L 192, 08/07/1998, with subsequent amendments): <u>dangerous for the environment</u>.

<u>Nickel compounds are listed</u> in the Annex X to the Decision No. 2455/2001/EC of the European Parliament and Council of November 20th, 2001, establishing the list of priority substances within the scope of water policy, changing the Directive 2000/60/EC (Official Journal L 331, 15/12/2001).

Provisions of law:

The Act of 25 February 2011 on chemical substances and their mixtures (Official Journal 11.63.322); Regulation (EC) No 1907/ 2007 of the European Parliament and Council of December 18th, 2006 on Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH), creating European Chemicals Agency, changing the Directive 1999/45/ EC as well as revoking the Council (EC) decree No 793193/ 93 as well as the Commission Directive (EC) No 1488/94 as well as the Council Directive 76/769/EWG and Council Directive 91/155/EEC, 93/67/EEC, 93/105/EC and 2000121/21/EC (Official Journal EC L 136 of 29.05.2007 with subsequent amendments); Regulation of the European Parliament and Council (EC) No. 1272/2008 dated December 16th, 2008 on classification, marking and packing hazardous substances and mixtures, changing and revoking the Directive 67/548/EWG and 1999/45/EWG as well as changing the Decree (EC) No. 1907/2006 (Official Journal EC L 353 of 31.12.2008 with subsequent amendments); Commission Regulation (EU) No 453/2010 of 20 May 2010 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (OJ L 133, with subsequent amendments); Regulation of the European Parliament and Council Regulation (EC) No 1336/2008 of 16 December 2008 amending Regulation (EC) No 648/2004 in order to adapt it to Regulation (EC) No 1272/2008 on classification, labeling and packaging of substances and mixtures (Official Journal. EU L 354 of 31 December 2008); Decree of the Minister of Labour and Social Policy of November 29th, 2002 on the highest allowable concentrations and intensities of substances harmful for health in the work environment (Official Journal 02.217.1833, with subsequent amendments); Act of August 19th, 2011 on transportation of hazardous goods (Official Journal 1367 2012.01.01); Act of December 14th, 2012, on waste (Official Journal 0.21.2013); Act of June 13th, 2013, on packages and packages waste (Official Journal 0.888.2013); Decree of the Board of Ministers of August 24th, 2004, on the list of works banned for adolescents and conditions of their employing for



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some works. (Official Journal 04.200.2047, with subsequent amendments); Decree of the Board of Ministers of September 10th, 1996 on the list of works banned for women (Official Journal No. 114, item 545, with subsequent amendments).

15.2 Chemical safety assessment:

Chemical safety assessment of nickel (II) sulfate(VI) has been carried out. Chemical safety report is available at KGHM Polska Miedź S.A.

SECTION 16. Other information

Amendments have been made to following sections: 1, 2, 3, 8, 11, 12, 15, 16.

R and H phrases which have not been given in whole in sections 2-15:

R23/25 – Toxic by inhalation and if swallowed.

R35 – Causes severe burns.

R38 – Irritating to skin.

R49 - May cause cancer by inhalation.

H301 – Toxic if swallowed.

H315 – Causes skin irritation.

H318 – Causes serious eye damage.

H331 – Toxic if inhaled.

H350i – May cause cancer by inhalation.

Explanations of abbreviations and acronyms used in the MSDS:

CAS number – means numerical identification assigned to chemical substance by the American organization named Chemical Abstract Service (CAS), enabling substance identification.

Index number – it is an identification code given in part 3 of the annex VI to the Regulation of the European Parliament and Council (EC) No. 1272/2008 dated December 16th, 2008, on classification, marking and packing hazardous substances and mixtures, changing and revoking the Directive 67/548/EEC and 1999/45/EEC as well as changing the Regulation (EC) No 1907/2006.

WE number – the number assigned to chemical substance in EINECS - European Inventory of Existing Chemical Substances, or the number assigned to chemical substance in ELINCS - European List of Notified Chemical Substances or the number in chemical substances inventory included in "No-longer polymers" document.

Registration number – number given by ECHA after substance/semiproduct registration by the manufacturer/importer according to REACH Decree.

UN number – unequivocal marking of hazardous substances and goods assigned by United Nations Central Committee to provide international recognition and use.

Name according to IUPAC – name of a substance given by IUPAC - *International Union of Pure and Applied ChemistryCommittee*

NDS/TLV-TWA – the highest admissible concentration/threshold limit value – weighted average value – concentration of toxic chemical whose action on an employee during 8-hour daily shift and average





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weekly time of work provided in the Labour Code, during the period of his occupational activity should not cause negative changes of his health condition and of health condition of his next generations.

NDSCh/TLV-STEL – the highest admissible short term concentration/short term exposure limit – weighted average of concentration of the specified, toxic chemical compound which should not cause negative changes of an employee health if present in the work environment for not longer than 15 minutes and not more often than twice per shift with occurrences separated by more than 1 hour.

 LD_{50} – dose of toxic substance expressed in milligrams per kilogram of body mass necessary to kill 50% of the examined population within specified time.

 LC_{50} – concentration of a substance in the inhaled air, expressed in milligrams per litre, which causes death of 50% of the examined population after specified period of exposure.

 EC_{50} – substance dose expressed in milligrams per litre causing the given pharmacological effect (e.g. inhibition of growth) at 50% of the examined population within specified time.

Sources of information used during preparation of the MSDS:

- Own results of qualitative and quantitative analyses of nickel (II) sulphate;
- Chemical Safety Report for nickel (II) sulfate(VI); 2010;
- Chemical Safety Report for sulphuric acid; 2010;
- European Chemical Substance Information System (http://ecb.jrc_ec.europa.eu/esis/);
- TOXNET Toxicology Data Network (<u>http://toxnet.nlm.nih.dov/);</u>
- ChemPortal The Global Portal to Information on Chemical Substances (<u>http://webnet3.oecd.org/eChemPortal/Home.aspx);</u>
- "CHEMISTRY structure and reactions". Author: Milton K. Snyder. Wydawnictwa Naukowo-Techniczne, Warszawa, 1975r.
- "Encyclopaedia of technology", vol. Chemistry, rev. N-T. Wyd. WNT, Warszawa, 1965r.
- "Assessment of health risk of Wiślinka inhabitants related to impact of phosphgypsum dump", Marek Biesiada i in., Instytut Medycyny Pracy i Zdrowia Środowiskowego; Sosnowiec, 2006.
- "Nickel content and absorption by plants at various pH of natural soils and contaminated with cadmium or lead", Jolanta Domańska, Ochrona Środowiska i Zasobów Naturalnych nr 40, 2009 r.

<u>Necessary training</u>: Post-related training within the scope of safe use of a substance considering its hazardous properties for humans and the environment.

<u>Information contained in the material safety data sheet</u> is to describe the product within the scope of safety requirements. User is responsible for taking any steps in order to meet the provisions of the national law and to create safe conditions for use of the product. User is held responsible for effects resulting from improper application of this product.

More information can be obtained under the telephone numbers given in section 1.









Table 84. Overview of generic exposure scenarios

	Generic Ex	posure Scenarios	Contributing Exposure Scenarios			Identifie	d use				Applicab	le Use Descr	iptors	ors		
GES#	Sector/life cycle stage	Short Title (environment and health)	Title	Volume (Tonnes)	Manufacture	Formulation	End use	Consumer use	Service life (for articles)	Waste Stage	SU	PC	PROC	AC	ERC or SpERC	
	Nickel sul	phate production			Х											
GES 1		Manufacture of Ni sulp refinery and smelter)	hate (copper	538	Х										ERC 1	
GES 1		Nickel sulphate produc refining	tion from copper		Х						SU 9					
ES 1.1			Reception of spent (Cu-Ni) electrolyte		x								PROC 2			
ES 1.2			Purification		Х								PROC 22			
ES 1.3			Crystallization		Х								PROC 2			
ES 1.4			Packaging		Х								PROC 8b PROC 9			
ES 1.5			Cleaning and maintenance		Х								PROC 0			
GES 2		Solvent extraction of n leachate	ickel sulphate		Х						SU 9				ERC 1	
ES 2.1			Charging		Х								PROC 4			
ES 2.2			Purification		Х								PROC 2			
ES 2.3			Solvent extraction		Х								PROC 2			
ES 2.4			Packaging		Х								PROC 8b PROC 9			
ES 2.5			Cleaning and maintenance		Х								PROC 0			
GES 3		Crystallisation from a p sulphate leachate	ourified nickel		Х						SU 9				ERC 1	
ES 3.1			Charging		Х								PROC 1			
ES 3.2			Crystallisation		Х								PROC 2			

	Generic Ex	posure Sce	narios	Contributing Exposure Scenarios			Identifie	d use				Applicab	le Use Desc	priptors		
GES#	Sector/life cycle stage	Short Title and health)	(environment)	Title	Volume (Tonnes)	Manufacture	Formulation	End use	Consumer use	Service life (for articles)	Waste Stage	SU	PC	PROC	AC	ERC or SpERC
ES 3.3				Drying		Х								PROC 2		
ES 3.4				Packaging		Х								PROC 2		
ES 3.5				Cleaning and maintenance		Х								PROC 0		
	Downstrea	<u>im users of</u>	f Nickel Sulpl	nate												
GES 4		Metal surfa electroplat electroless	ace treatmen ting, nickel e s nickel platii	t: nickel lectroconforming, ng	271		x					SU3 SU15	PC 14 PC 19			ERC 5
ES 4.1				Operations involving dry salts			x							PROC 5 PROC 8a PROC 8b PROC 13 PROC 0		
ES 4.2				Operations with salt solutions			x							PROC 8a PROC 8b PROC 13 PROC 15 PROC 0		
GES 5		Production with nicke	n of batteries I containing a	using electrodes active material	796		X					SU3	PC 19			ERC 5
ES 5.1			Raw materia	handling										PROC 4 PROC 8b		
ES 5.2			Manufacture	of NiSO ₄ solution										PROC 4 PROC 8b		
ES 5.3			Manufacture based} active	of positive {Ni(OH)₂ e mass										PROC 4 PROC 8b PROC 9 PROC 14		

	Generic Ex	eneric Exposure Scenarios Exposure Scenarios					Identifie	ed use				Applicab	le Use Descr	iptors			
GES#	Sector/life cycle stage	ife Short Title (environmen and health)		Title	Volume (Tonnes)	Manufacture	Formulation	End use	Consumer use	Service life (for articles)	Waste Stage	SU	PC	PROC	AC	ERC or SpERC	
														PROC 26			
ES 5.4			Manufacture {Cd(OH)2 dop based} active	of negative bed with Ni(OH)2 mass										PROC 4 PROC 8b PROC 9 PROC 26			
ES 5.5			Manufacture electrodes	of pocket plate										PROC 14 PROC 21			
ES 5.6			Nickel electro {maintenance electroplating manufacture nickel plating	oplating e of NiSO4 g solution & of electrode strip by a steel strip}										PROC 4 PROC 8b PROC 9 PROC 26			
ES 5.7			Cleaning and	I maintenance										PROC 0			
GES 6		Production	n of Ni salts	from Ni Sulphate	1930		x					SU9		PROC 2 PROC 8b PROC 26 PROC 0		ERC 6a	
GES 7		Use of nic manufactu for biogas	kel sulphate iring of micro production	for the onutrient additives	1-10		x					SU 1	PC 12			ERC 2	
ES 7.1			NiSO₄ re	ception										PROC 4 PROC 8b			
ES 7.2			Preparin powder	g the additive										PROC 3			
ES 7.3			Packagii	ng										PROC 9			
ES 7.4			Palletisi	ng										PROC 3			
ES 7.5			Cleaning	and maintenance										PROC 0			

	Generic Ex	posure Scenarios	Contributing Exposure Scenarios			Identifie	d use				Applicab	Applicable Use Descriptors			
GES#	Sector/life cycle stage	Short Title (environme and health)	nt Title	Volume (Tonnes)	Manufacture	Formulation	End use	Consumer use	Service life (for articles)	Waste Stage	SU	PC	PROC	AC	ERC or SpERC
GES 8		Production of nickel- from NiSO₄	containing pigments	136		x					SU 3	PC 19			ERC 2 ERC 5 ERC 6a SPERC: production and formulation stage of metal compounds
ES 8.1		Raw m	aterial handling			X							PROC 8b		•
ES 8.2		Mixing	raw materials			x							PROC 2 PROC 5 PROC 26		
ES 8.3		Drying produc	and calcining t			x							PROC 4 PROC 9 PROC 22		
ES 8.4		Dry mi	lling			Х							PROC 24		
ES 8.5		Wet m drying	lling, washing and			Х							PROC 22 PROC 24		
ES 8.6		Blendi	ng and packaging			X							PROC 9		
ES 8.7		Cleani	ng and maintenance			Х							PROC 0		

9.2 Generic exposure scenarios for nickel sulphate production

9.2.1 INTRODUCTION TO NICKEL SULPHATE PRODUCTION

Nickel sulphate is produced as a by-product of production of copper and other metals and via the refining of nickel matte and nickel intermediates produced during the recyling of a variety of secondary materials (*e.g.* spent nickel catalysts, nickel/cobalt residues, copper-nickel alloys and drosses). These production processes are described in three GES in this section; nickel sulphate production from copper refining, solvent extraction of nickel sulphate leachate and crystallisation from purified nickel sulphate leachate.

Estimated and measured environmental (*i.e.*, in freshwater, marine aquatic, air and terrestrial compartments) and occupational (*i.e.*, process-specific occupational hygiene data from personal/static monitoring) exposure data for nickel suphate production, are detailed in <u>Appendix D3</u> (section 1; environment), <u>Appendix D4</u> (human health), and <u>Appendix D5</u> (MvE) and provide full details on the exposure and risk characterisation data used in the GES. Detailed information on the environmental tiered approach for site-specific exposure assessment and risk characterization is found in <u>Appendix D1</u>. Detailed information on local exposure calculation factors and regional ambient backgrounds can be found in <u>Appendix D2</u>.

As discussed in section 9.1, since it was not possible to attribute emissions to any specific process/activity, the environmental exposure assessment was conducted for nickel sulphate production sites as a whole. Conversely, the occupational exposure assessment was broken down by process/activity. Therefore, three GES are successively presented in the following sections, for the different nickel sulphate production processes, each one includes process-specific human exposure information and a common production sector environmental assessment element. In addition, secondary poisoning, WWTP, STP and MvE assessments are presented in separate sections for the entire nickel sulphate production sector.

9.2.2 GES 1: NICKEL SULPHATE PRODUCTION FROM COPPER REFINING

1. Title GES 1 Nickel sulphate production from cop	Title ES 1 Nickel sulphate production from copper refining									
Life cycle	Manufacture of Ni sulphate									
Free short title	Nickel sulphate production from copper refining									
Systematic title based on use descriptor	SU: SU9 - Manufacture of fine chemicals PC: Not relevant ERC: ERC1 – Manufacture of substances PROC: PROC 2 - Use in closed, continuous process with occasional controlled exposure (e.g. sampling) PROC 22 - Potentially closed processing operations with minerals/metals at elevated temperature PROC 8b - Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9 - Transfer of substance or preparation into small containers (dedicated filling line, in-cluding weighing) PROC 0 - Cleaning and maintenance									
Processes, tasks, activities covered (environment)	Manufacture of Ni sulphate in refineries									
Processes, tasks, activities covered (workers)	Electrolytic refining of spent (Cu-Ni) electrolyte from copper anode production and recrystallisation of NiSO ₄ 6H ₂ O or NiSO ₄ 2H ₂ O from this nickel sulphate NiSO ₄ solution Contributing exposure scenario ES 1.1: PROC 2: Reception of spent (Cu-Ni) electrolyte obtained from electrolysis (of Ni-containing Cu anode to give Cu cathode) from the copper refinery Contributing exposure scenario ES 1.2: PROC 22: Purification by de-copperisation of spent electrolyte to give a NiSO ₄ solution									

	Contributing exposure scenario ES 1.3:						
	PROC 2: Concentration of the NiSO ₄ solution by volume reduction and						
	precipitation/crystallisation of NiSO46H2O or NiSO42H2O from the NiSO4						
	solution						
	Contributing exposure scenario ES 1.4:						
	PROC 8b, PROC 9: Packaging of moist NiSO ₄ 6H ₂ O or NiSO ₄ 2H ₂ O crystals						
	Contributing exposure scenario ES 1.5:						
	PROC 0: Cleaning and Maintenance reported as examples of regular and						
	service maintenance						
2. Operational conditions and risk manager	nent measures						
2.1 Control of environmental exposure							
Environmental related free short title	Manufacture of Ni sulphate (copper refinery and smelter)						
Systematic title based on use descriptor (environment)	ERC1 – Manufacture of substances						
Processes, tasks, activities covered	Manufacture of Ni sulphate in refineries						
(environment)							
Environmental Assessment Method	Measured local and regional concentrations are used for calculation of PEC						
Product characteristics							
Solids, low grade dust							
Average particle size (as diameter) range from	approx. 0.05 to 0.2 mm						
Amounts used							
Maximum daily use at a site	1.5 tonnes/day (50 th % emission days, 25 th % tonnage)						
Maximum annual use at a site	538 tonnes (25 th %, 2007)						
Frequency and duration of use							
Pattern of release to the environment	350 days per year per site (50th%)						
Environment factors not influenced by risk	management						
Receiving surface water flow rate	18000 m ³ /d						
Dilution capacity, freshwater	10 (default) m³/d						
Dilution capacity, marine	100 (default) m³/d						
Other given operational conditions affecting	g environmental exposure						
None							
Technical conditions and measures at proc	ess level (source) to prevent release						
None							
Technical onsite conditions and measures	to reduce or limit discharges, air emissions and releases to soil						
Waste water:	*						
On-site waste water treatment plant (chemical	precipitation)						
Efficiency: ->99% removal							
Release factor after on-site treatment: To fresh	water and marine water: 5.90 g/T (10 th %)						
Air:							
Treatment of air emission (filters, wet or dry sc	rubber).						
Efficiency: ->99% removal							
Release factor after on-site treatment: 72.5 g/T	(max)						
Organizational measures to prevent/limit re	lease from site						
None							
Conditions and measures related to munici	pal 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 externa	al treatment of waste for disposal						
Ni bearing waste shall be recovered or recycle	d if possible. Ni bearing waste shall be considered hazardous if the Ni content						
is above the generic cutoffs (for mixtures) as si	tated in regulation (EC) No. 1272/2008. Ni bearing waste mixtures may be						
assessed as substances according to regulation	on (EC) No. 1272/2008 criteria. Disposal of Ni bearing waste shall comply with						
local, state or national waste legislation and re-	mains the responsibility of the waste treatment operator.						
Conditions and measures related to externa	al recovery of waste						
Not applicable							
2.2 Control of workers exposure for contrib	uting exposure scenario 1.1						
eception of spent (Cu-Ni) electrolyte obtained from electrolysis (of Ni-containing Cu anode to give Cu cathode) from the							

copper refinery									
Workers related free short title	Manufacture o	f Ni sulphate							
	Nickel sulphate	e production from copper refining							
	PRUC 2 Recention of s	pent (Cu Ni) electrolyte obtained from electrolysis (of Ni							
Processes, tasks, activities covered	containing Cu	anode to give Cu cathode) from the copper refinery							
Assessment Method	Estimation usir	ng a Tier 1 model.							
Product characteristic									
Solids, low grade dust									
Average particle size (as diameter) range from	approx. 0.05 to	0.2 mm							
Concentration of nickel in solid is 22-32 % dep	ending on hydra	ate and moisture levels.							
Amounts used	Amounts used								
Not relevant									
Frequency and duration of use/exposure									
All production workers generally work 8 hour sl	hifts.								
The actual pattern of exposure is determined b	y the amount o	f manual and driving work, use of control rooms and level of							
automation, mechanisation and provision of co	ntainment by pl	ant applicable to activities. Duration of exposure ranges from							
0.5h/8h to 7h/8h.									
Human factors not influenced by risk management									
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~ 10 m²/d							
Area of skin contact with the substance under	conditions of								
		480 cm ²							
Body weight		70 kg							
Douy weight // V Ky Other given operational conditions affecting workers exposure									
The Cu-Ni spent electrolyte is pumped in pipes	The Cu-Ni spent electrolyte is numbed in pipes from the conner refinery into the purification plant								
Technical conditions and measures at proc	ess level (sou	rce) to prevent release							
The transfer of the spent electrolyte solution shall be totally enclosed with no emission to the workplace									
Technical conditions and measures to control dispersion from source towards the worker									
None	•								
Organisational measures to prevent /limit re	eleases, dispe	rsion and exposure							
None	-	·							
Conditions and measures related to person	al protection,	hygiene and health evaluation							
Dermal: Use of properly designed gloves is rec	luired for opera	tions where direct contact is possible							
Inhalation: Use of RPE (APF 40) is required for	r operations wh	ere exposure to Ni dust or powder is possible.							
2.3 Control of workers exposure for contrib	uting exposure	e scenario 1.2							
Purification by de-copperisation of spent electro	olyte to give a N	ViSO4 solution							
Workers related free short title	Manufacture o	f Ni sulphate							
	Nickel sulphate	e production from copper refining							
Use descriptor covered	PROC 22	de comparisation of countral started to the size of NICO coulding							
Processes, tasks, activities covered	Purification by	de-coppensation of spent electrolyte to give a NISO4 solution							
Assessment Method	Esumation of e	exposure based on measured data and by use of a filer i							
Product characteristic	model.								
Solids, low grade dust									
Average particle size (as diameter) range from	approx. 0.05 to	0.2 mm							
Concentration of nickel in solid is 22-32 % dep	ending on hydra	ate and moisture levels.							
Amounts used									
Not relevant									
Frequency and duration of use/exposure									
All production workers generally work 8 hour sl	hifts.								
The actual pattern of exposure is determined b	y the amount o	f manual and driving work, use of control rooms and level of							
automation, mechanisation and provision of co	ntainment by pl	ant applicable to activities. Duration of exposure ranges from							
U.5n/8h to /h/8h.									
Human factors not influenced by rick mana	aamant								
Poppiration volume under conditions of use	gement	Not relevant							
espiration volume under conditions of use Not relevant									

Room size and ventilation rate		Not relevant			
Area of skin contact with the substance under use	conditions of	1980 cm ²			
Body weight		Not relevant			
Other given operational conditions affecting	g workers expo	osure			
The copper impurity is removed from this election	rolyte by evapor	ration/crystallisation (Cu as copper sulphate, CuSO ₄) and			
electrowinning by cascade electrolysis (of Cu a	is cathode) to g	ive a NiSO ₄ solution.			
Technical conditions and measures at proc	ess level (sour	ce) to prevent release			
The evaporation of the spent electrolyte solution	in and precipital	tion of CuSO ₄ shall be fully enclosed.			
Electrowinning is usually carried out in open ca	rol dispersion	from source towards the worker			
Organisational measures to prevent /limit re	leases disner	sion and exposure			
None					
Conditions and measures related to person	al protection.	nygiene and health evaluation			
PPE is required for all production processes af	ter reception of	spent electrolyte and for maintenance, cleaning, and non-			
routine production (clearing up spills and clearing process is controlled by full or half- face respira Protection factor, APF = 40 for particulate given Acid resistant gloves are required to control ski	ng obstructions ator e.g. 3M 680 n by full face ma in exposure to li	inside pant) activities. Inhalation exposure to mists from this 10, Protection factor, APF = 20 (based on use of P3), ask EN136 with EN 143 filter. quid splashes which may occur during both de-copperisation			
24 Control of workers exposure for contrib	uting exposure	a scenario 1 3			
Concentration of the NiSO ₄ solution by volume the NiSO ₄ solution	reduction and p	precipitation/crystallisation of NiSO46H2O or NiSO42H2O from			
Workers related free short title	Manufacture of Nickel sulphate	Ni sulphate			
Use descriptor covered	PROC 2				
Processes, tasks, activities covered	Concentration of the NiSO ₄ solution by volume reduction and precipitation/crystallization multi-hydrated (NiSO ₄ 6H ₂ O or NiSO ₄ 2H ₂ O) NiSO ₄ from the NiSO ₄ solution				
Assessment Method	Estimation of e	xposure based on measured data			
Product characteristic					
Solids, low grade dust					
Average particle size (as diameter) range from	approx. 0.05 to	0.2 mm			
Concentration of nickel in solid is 22-32 % depe	ending on hydra	ate and moisture levels.			
Amounts used					
Not relevant					
All production workers generally work 8 hour of	aiffa				
The actual pattern of exposure is determined b	withe amount of	f manual and driving work, use of control rooms and level of			
automation mechanisation and provision of co	ntainment by pl	ant applicable to activities. Duration of exposure ranges from			
0.5h/8h to 7h/8h.					
Human factors not influenced by risk managed	gement				
Respiration volume under conditions of use		Not relevant			
Room size and ventilation rate		Not relevant			
Area of skin contact with the substance under use	conditions of	Not relevant			
Body weight		Not relevant			
Other given operational conditions affecting	g workers expo	osure			
The NiSO4 solution is heated (submerged arc burners) and concentrated by evaporation under reduced pressure. The NiSO46H ₂ O or NiSO42H ₂ O, is crystallised out of solution in a crystallising unit {surface (coat and coil) cooled crystallisers} and separated from the solution by centrifugation or filtration (belt filter). Washed NiSO46H ₂ O, recovered on the belt filter, is redissolved to produce a commercial NiSO4 solution. The solid product(s) NiSO46H ₂ O or NiSO42H ₂ O is (are) moist after recovery. The waste solution and washings, containing sulfuric acid, is directed to a storage container from which it is neutralised and disposed. Technical conditions and measures at process level (source) to prevent release					
The concentrated solution shall be piped from the evaporator into an enclosed crystallising unit. The steam and sulfuric acid mist from the enclosed evaporator shall be extracted and the airflow cleaned by demisters and condensers. The moist					

NiSO₄6H₂O or NiSO₄2H₂O solid shall be recovered from solution using either i) a partially enclosed belt filter, with extraction fitted close to the openings at both ends of the belt filter casing, or ii) a centrifuge which is closed by design.

Technical conditions and measures to control dispersion from source towards the worker

LEV shall be installed on the belt filters. Fixed capturing hoods located in close proximity of and directed at the source of emission for belt filters and packaging units are required. The design shall enable that the work is performed in the capture zone of the ventilation system and the capture zone shall be indicated at the workplace.

Organisational measures to prevent /limit releases, dispersion and exposure

None

Conditions and measures related to personal protection, hygiene and health evaluation

PPE is required for all production processes after reception of spent electrolyte and for maintenance, cleaning, and nonroutine production (clearing up spills and clearing obstructions inside pant) activities.

There is little particulate emission from the moist product. Inhalation exposure to mists generated during separation and skin exposure to liquid splashes, mists or the NiSO₄6H₂O or NiSO₄2H₂O solid during operating the centrifuge and routing the sulfuric acid solution to a treatment plant are controlled by RPE and acid proof gloves respectively.

Full or half- face respirator e.g. 3M 6800, Protection factor = 20 (based on use of P3), Protection factor = 40 for particulate given by full face mask EN136 with EN 143 filter should be available for instances of unforeseen release of mists from evaporators.

Acid proof gloves are required to control skin exposure to any liquid splashes and during cleaning of spills. These activities shall be automated and closed.

2.5 Control of workers exposure for contributing exposure scenario 1.4

Packaging of moist NiSO46H2O or NiSO42H2O crystals

Workers related free short title	Manufacture of Ni sulphate Nickel sulphate production from copper refining
Use descriptor covered	PROC 8b, PROC 9
Processes, tasks, activities covered	Packaging of moist NiSO ₄ 6H ₂ O or NiSO ₄ 2H ₂ O crystals
Assessment Method	Estimation of exposure based on measured data
Product characteristic	

Solids, low grade dust

Average particle size (as diameter) range from approx. 0.05 to 0.2 mm

Concentration of nickel in solid is 22-32 % depending on hydrate and moisture levels.

Amounts used

Not relevant

Frequency and duration of use/exposure

All production workers generally work 8 hour shifts.

The actual pattern of exposure is determined by the amount of manual and driving work, use of control rooms and level of automation, mechanisation and provision of containment by plant applicable to activities. Duration of exposure ranges from 0.5h/8h to 7h/8h.

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	Not relevant				
use	Not relevant				
Body weight	Not relevant				
Other given operational conditions affecting workers exposure					
The hydrated nickel sulphate is weighed and packed into bulk containers (1000 kg) or other forms of packaging. Bagging is					
usually carried out by a worker using a manually operated bagging unit and then warehoused.					

Technical conditions and measures at process level (source) to prevent release

Enclosement is required for screw conveyors that transfer the moist NiSO₄6H₂O or NiSO₄2H₂O to the packaging units where it is bagged into bulk containers (big bags).

Technical conditions and measures to control dispersion from source towards the worker

LEV shall be installed on bagging units in the packaging area at the end of the production process. Fixed capturing hoods located in close proximity of and directed at the source of emission for belt filters and packaging units are required. The design shall enable that the work is performed in the capture zone of the ventilation system and the capture zone shall be indicated at the workplace.

Organisational measures to prevent /limit releases, dispersion and exposure

None

Conditions and measures related to personal protection, hygiene and health evaluation

PPE is required for all production processes after reception of spent electrolyte and for maintenance, cleaning, and non-

routine productio respirator e.g. 3l mask EN136 wit NiSO42H ₂ O.	on (clearing u M 6800, Prot h EN 143 filt	up spills and ection factor er are requir	clearin = 20 (ed to c	ig obstr based control a	ructior on us any de	ns i e o erm	inside pant) of P3), Prote nal and inha	activ ction latior	ities. facto r exp	Acid pr or = 40 f osure to	oof gloves and full or half- face or particulate given by full face o particulate NiSO46H2O or
2.5 Control of v	vorkers exp	osure for co	ntribu	ting ex	xposi	ire	scenario 1	.5			
Cleaning and Ma	aintenance re	eported as e	xample	es of re	gular	and	d service m	ainter	nance	Э	
Workers related	d free short	title		Manufa Nickel s	acture sulpha	of ate	Ni sulphate production	from	copp	er refini	ng
Use descriptor	covered		PROC 0							5	
			(Cleanin	nd and	M	laintenance	repol	rted a	as exam	ples of regular and service
Processes, tasi	ks, activities	scovered	maintenance								
Assessment Method Estimation of exposure based on measured data											
Product charac	teristic										
Solids, low grade	e dust		f		0.05	4	0.0				
Average particle	size (as dial	meter) range	trom a	approx.	. 0.05	10	U.2 mm	ا معربا			
Concentration of	r nickei in soi	10 IS ZZ-3Z 7	₀ aepe	naing c	on nyo	Iat	te and mois	ture	eveis		
Amounts used											
Not relevant											
Frequency and	duration of	use/exposi	ire		10						
Routine inspecti	ons of evapo	prators are m	ade ev	/ery 4-1	12 we	eks	S.				
Major maintenar	nce works ar	e performed	every	4-5 yea	ars.						
Human factors	not influence	ced by risk r	nanag	ement							
Respiration volu	me under co	nditions of u	se				Not relevan	t			
Room size and v	entilation ra	te					Not relevan	t			
Area of skin cor	ntact with the	substance u	under o	conditio	ons of		Not relevant				
use						_					
Body weight				<u> </u>		I	Not relevan	t			
Other given op	erational co	nditions aff	ecting	worke	ers ex	po	sure				
The inspection in evaporator lining	ncludes: clea g and repairir	ining of the ii ng any leaks	nstallat in this	tion (by system	≀ flush า.	ing	y with hot wa	ater),	chec	king bu	rners and the integrity of the
Technical cond	litions and r	neasures at	proce	ss leve	el (so	urc	ce) to preve	ent re	leas	е	
None											
Technical conditions and measures to control dispersion from source towards the worker											
None											
Organisational measures to prevent /limit releases, dispersion and exposure											
None											
Conditions and measures related to personal protection, hygiene and health evaluation											
During cleaning	and mainten	ance derma	expos	sure sha	all be	cor	ntrolled by w	vearir	ng ac	id proot	f gloves and inhalation exposure
to mists and par	ticulates sha	Il be controlle	ed by u	use of f	ull or	hal	f- face resp	irator	e.q.	3M 680	0, Protection factor = 20 (based
on use of P3), P	rotection fac	tor = 40 for p	articul	ate give	en by	full	l face mask	EN13	36 wi	th EN 1	43 filter.
3. Exposure an	d risk estim	ation		Ŭ	,						
Environment											
ERC 1											
Manufacture of	f Ni sulphate	(copper refi	nery ar	nd sme	lter)			[Matha	de fan aslaudetien ef
compartment	Unit	PNEC	PEC	Regional	Cloc	al	PEC	RC	R	ivietno <u>env</u> iro	nmental concentration
Freshwater	µg/L	3.6	2.9		0.32)	3.22	0.91	1	Measu	ured values, Tier 3-RWC
Marine	µg/L	8.6	0.3		0.03	}	0.33	0.04	1		
Terrestrial	mg/kg	29.9	16.2		0.10)	16.3	0.55	5		
STP	mg Ni/kg	0.33	-				-	-		Waste an ST	water is not connected to P
					1		I				
Workers											
FS 1.1											
PROC 2: Reception of spent (Cu-Ni) electrolyte obtained from electrolysis (of Ni-containing Cu anode to give Cu											
cathode) from the copper refinery											
		Unit		DNEI	L	E	xposure	1	RC	R	Methods for calculation of
		1							1		onposuro

Dermal					
Acute systemic	mgNi/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term	mg Ni/kg/day	-	NR		
systemic					
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.11	Exposure modeled using MEASE, a Tier 1 model for PROC2. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through non-direct handling. Use of properly designed gloves is assumed
Inhalation					
Acute systemic	ma Ni/m ³	16	0.039	0.002	3 x long-term exposure
Acute local	mg Ni/m ³	0.7	0.039	0.056	estimate
Long-term systemic and local	mg Ni/m ³	0.05	0.013	0.26	Exposure modeled using MEASE, a Tier 1 model for PROC2. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through non-direct handling of a closed system without breaches. The use of RPE of APF 40 is also assumed.
FS 1 2					
PROC 22: Purification by de	e-copperisation of	spent electro	olvte to give a NiSC)₄ solution	
	Unit	DNEL	Exposure	RCR	Methods for calculation of
			concentration		exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm ² /day	-	NR		
Long-term	mg ini/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.11	Exposure modeled using MEASE, a Tier 1 model for PROC 22. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through non-direct handling of non-dispersive use process. Use of gloves is also assumed.
Inhalation					
Acute systemic	mg Ni/m ³	16	0.018	0.001	3 x long-term exposure
Acute local	mg Ni/m ³	0.7	0.018	0.03	estimate for 'evaporator

					and filter' operator
Long-term systemic and local	mg Ni/m³	0.05	0.006	0.12	Highest of two personal, inhalable exposure measurements for 'evaporator and filter' operator
PROC 2: Concentration of t NiSO42H2O from the NiSO4	he NiSO4 solution solution	by volume r	eduction and precip	oitation/crysta	Illisation of NiSO46H2O or
	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/cm²/day	0.00044	Not reported	<1	Qualitative assessment ¹
Inhalation				1	
Acute systemic	mg Ni/m ³	16	0.018	0.001	3 x long-term exposure
Acute local	mg Ni/m ³	0.7	0.018	0.03	estimate for 'evaporator and filter' operator
Long-term systemic and local	mg Ni/m ³	0.05	0.006	0.12	Single personal, inhalable exposure measurement for 'evaporator and filter' operator
¹ Dermal exposure likely to	be sufficiently cont	trolled by pre	evention of acid bur	'ns	
ES 1.4					
PROC 8b, PROC 9: Packa	ging of moist NISO	46H2O cryst	als	DOD	
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term svstemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.00067	1.5 excl. PPE <1 with gloves	75 th percentile (full body exposure) based on packaging data from an analogous operation (packaging of NiSO ₄ 6H ₂ O). Qualitative assessment ¹
Inhalation					
Acute systemic	mg Ni/m ³	16	0.03	0.002	3 x long-term respirable exposure value for filling and loading to containers.
			0.06	0.004	Inhalable value estimated
Acute local	mg Ni/m ³	0.7	0.03	0.043	as twice the respirable exposure level
			0.06	0.086	
Long-term systemic and local	mg Ni/m³	0.05	0.01	0.20	Personal, respirable measurement taken during filling and loading to containers.
			0.02	0.4	Inhalable value estimated as twice the respirable exposure level

¹ Dermal exposure likely to	¹ Dermal exposure likely to be sufficiently controlled by prevention of acid burns				
ES 1.5	•				
PROC 0: Cleaning and Mai	ntenance reported	as example	s of regular and ser	vice maintena	nce
	Unit	DNEL	Exposure	RCR	Methods for calculation of
			concentration		exposure
Dermal	N1/1 / 1				
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term	mg Ni/kg/day	-	NR		
systemic					
Long-term local	mg Ni/cm²/day	0.00044	0.00067	1.5 excl. PPE <1 with gloves	75 th percentile (full body exposure) based on packaging data from an analogous operation (packaging of NiSO ₄ 6H ₂ O). Qualitative assessment ¹
1.1.1.2					
Innalation	NI / 2	40	0.04	0.045	
Acute systemic	mg Ni/m ³	16	0.24	0.015	3 x long-term inhalable
Acute local	mg Ni/m ³	0.7	0.24	0.343	exposure value (estimated as twice the respirable exposure level)
Long-term systemic and local	mg Ni/m ³	0.05	0.08	1.6 excl. RPE By use of RPE (APF 20): 0.08	Inhalable value estimated as twice the respirable exposure level (personal, respirable value was the maximum result of 4 measurement ranges for evaporators and crystalliser service)

NR: Not Relevant

¹ Dermal exposure likely to be sufficiently controlled by prevention of acid burns

4. Guidance to evaluate whether a site 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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendices C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.2.3 GES 2: NICKEL SULPHATE PRODUCTION: SOLVENT EXTRACTION OF NICKEL SULPHATE LEACHATE

1. Title GES 2 Solvent extraction of nickel subhete	lasshata				
l ife cycle	Manufacture of Ni sulphate				
	Solvent extraction of nickel sulphate leachate				
Free short title	Nickel sulphate production from other leaching processes				
	SU: SU9 - Manufacture of fine chemicals PC: Not relevant ERC: ERC1 – Manufacture of substances PROC: PROC4 – Use in batch and other process (synthesis) where opportunity for exposure arises PROC2 – Use in closed, continuous process with				
Systematic title based on use descriptor	occasional controlled exposure (e.g. sampling) PROC8b - Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC9 - Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC0 – Cleaning and maintenance				
Processes, tasks, activities covered (environment)	Manufacture of Ni sulphate in refineries				
Processes, tasks, activities covered (workers)	Purification (of an impure nickel sulphate, NiSO ₄ , solution) by precipitation and solvent extraction and recrystallisation (of nickel sulphate hexahydrate, NiSO ₄ .6H ₂ O) from this nickel sulphate NiSO ₄ solution Contributing exposure scenario ES 2.1: PROC 4: Impure NiSO ₄ and nickel carbonate, NiCO ₃ , are charged into a reactor and dissolved in sulfuric acid together with the solution of crude NiSO ₄ .6H ₂ O to give an impure NiSO ₄ solution Contributing exposure scenario ES 2.2: PROC 2: Purification of the impure NiSO ₄ solution by precipitation and separation of iron, Fe, and copper, Cu from solution Contributing exposure scenario ES 2.3: PROC 2: Removal of cobalt, Co, by solvent extraction of the purified NiSO ₄ solution and recrystallisation (from the raffinate), separation and drying of NiSO ₄ .6H ₂ O Contributing exposure scenario ES 2.4: PROC 8b, PROC 9: Packaging of NiSO ₄ 6H ₂ O into bags Contributing exposure scenario ES 2.5:				
2. Operational conditions and risk manager	nent measures				
2.1 Control of environmental exposure	Manufacture of Ni sulphate (conner refinery and smalter)				
Systematic title based on use descriptor (environment)	ERC1 – Manufacture of substances				
Processes, tasks, activities covered (environment)	Manufacture of Ni sulphate in refineries				
Environmental Assessment Method	Measured local and regional concentrations are used for calculation of PEC				
Product characteristics					
Solid, low grade dust Powder					
Amounts used					
Maximum daily use at a site	1.5 tonnes/day (50 th % emission days, 25 th % tonnage)				
Maximum annual use at a site	538 tonnes (25 th %, 2007)				
Frequency and duration of use					
Pattern of release to the environment	350 days per year per site (50th %)				

Environment factors not influenced by risk	management				
Receiving surface water flow rate	18000 m ³ /d				
Dilution canacity freshwater	10 (default) m ³	(d			
Dilution capacity marine 100 (default) m3/d					
Other given operational conditions affecting	n environment:				
None	genvironmenta				
Technical conditions and measures at proc	ass laval (sour	ce) to prevent release			
None	ess level (soul	ce) to prevent release			
Technical onsite conditions and measures t	o reduce or lin	nit discharges, air emissions and releases to soil			
Waste water:		int discharges, an emissions and releases to som			
On-site water water treatment plant (chemical	precipitation)				
Efficiency: ->90% removal	precipitation				
Release factor after on-site treatment: To fresh	water and mari	ne water: 5 90 g/T (10th %)			
Air					
Treatment of air emission (filters, wet or dry sci	rubber).				
Efficiency: ->99% removal					
Release factor after on-site treatment: 72.5 g/T	(max)				
Organizational measures to prevent/limit re	lease from site				
None					
Conditions and measures related to munici	pal sewage tre	atment 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					
Ni bearing waste shall be recovered or recycled	d if possible. Ni	bearing waste shall be considered hazardous if the Ni content			
is above the generic cutoffs (for mixtures) as st	ated in regulation	on (EC) No. 1272/2008. Ni bearing waste mixtures may be			
assessed as substances according to regulatio	n (EC) No. 127	2/2008 criteria. Disposal of Ni bearing waste shall comply with			
local, state or national waste legislation and ren	mains the respo	nsibility of the waste treatment operator.			
Conditions and measures related to externa	al recovery of v	vaste			
Not applicable					
2.2 Control of workers exposure for contrib	uting exposure	e scenario 2.1			
Impure NiSO ₄ and nickel carbonate, NiCO ₃ , ar	e charged into	a reactor and dissolved in sulfuric acid together with the			
solution of crude NiSO4.6H2O to give an impure	e NiSO ₄ solution	1			
Workers related free short title	Manufacture of Ni sulphate				
	Solvent extraction of nickel sulphate leachate				
Use descriptor covered	PROC 4 – Use in batch and other process (synthesis) where opportunity for				
•	exposure arise	<u>S</u>			
Presses tooks activities asympthetic		and nickel carbonate, NICO ₃ , are charged into a reactor and			
Processes, tasks, activities covered	dissolved in su				
Assessment Method	Give an impule	timation of exposure using a Tier 1 model			
Assessment method	Estimation of e	xposure using a rier r model.			
Product characteristic					
Solid, low grade dust. INI concentration > 25 %					
Allouins used					
Nut recovering					
Frequency and utilation of use/exposure All production workers generally work 8 hour shifts					
All production workers generally work o nour shifts.					
automation and mechanisation applicable to activities. Duration of exposure ranges from 0.5h/8h to 7h/8h.					
Human factors not influenced by risk management					
Respiration volume under conditions of use I induction $1000000000000000000000000000000000000$					
Room size and ventilation rate					
Area of skin contact with the substance under conditions of					
use		480 cm ²			
Body weight		70 ka			

Other given operational conditions affecting	g workers expo	osure			
The reactor is charged by enclosed tipping of c and crude NiSO ₄ solution into the reactor.	crude NiSO4 and	I NiCO ₃ from bulk containers bags and piping of sulfuric acid			
Technical conditions and measures at proc	ess level (soui	rce) to prevent release			
The reactor shall be closed during the leaching	of the NiSO4 a	nd NiCO3 into the H2SO4 solution.			
Technical conditions and measures to cont	rol dispersion	from source towards the worker			
LEV is required to control inhalation exposure	to particulate ge	enerated during loading reactor.			
Organisational measures to prevent /limit re	eleases, disper	rsion and exposure			
None					
Conditions and measures related to person	al protection,	hygiene and health evaluation			
Air-assisted filtering visor with P3 filter element	t (Willson Turbo	visor) Protection = 20 (based on use of powered respirator			
meeting EN12492 requirement or equivalent su	uitable P3 level	protection) and rigger gloves are required for all activities.			
RPE is required to control inhalation exposure	to particulate ge	enerated during loading reactor.			
Gloves are also required to control against any	skin contact w	th the raw materials.			
2.3 Control of workers exposure for contrib	uting exposure	e scenario 2.2			
Purification of the impure NISO4 solution by pre	ecipitation and s	Separation of Iron, Fe, and copper, Cu from solution			
Workers related free short title	Manufacture of	r Ni suipnate			
	Solvent extract	ion of nickel sulphate leachate			
Use descriptor covered		ampling)			
	Exposure (e.g.	sampling)			
Processes, tasks, activities covered	iron, Fe, and c	opper, Cu from solution			
Assessment Method	Estimation of e	exposure using a Tier 1 model.			
Product characteristic					
Aqueous Solution. Concentration of Ni > 25%.					
Amounts used					
Not relevant					
Frequency and duration of use/exposure					
All production workers generally work 8 hour sl	hifts.				
I he actual pattern of exposure is determined b automation and mechanisation applicable to ac	oy the amount o ctivities. Duratio	f manual and driving work, use of control rooms and level of n of exposure ranges from 0.5h/8h to 7h/8h.			
Human factors not influenced by risk mana	gement				
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m ³ /d			
Room size and ventilation rate		Not relevant			
Area of skin contact with the substance under	conditions of	480 cm ²			
use					
Body weight 70 kg					
Other given operational conditions affecting	g workers expo	Disure			
Cu and Fe are precipitated chemically or by ev	aporation/crysta	allisation in a closed reactor and separated from the solution			
by a covered beit filter/open filter press. These	e solids are sen				
Presidiate conditions and measures at proc	ion are lorgely	logod operations			
Precipitation and initiation of Cu and Fe impunt	rel dienergien	from acurac towards the worker			
I EV is required to control inhalation exposure t	to particulate or	noni source towards the worker			
Organisational measures to prevent /limit re	LEV is required to control innalation exposure to particulate generated during filter press operation.				
None					
Conditions and measures related to personal protection, hygiene and health evaluation					
Air-assisted filtering visor with P3 filter element (Willson Turbovisor) Protection = 20 (based on use of powered respirator					
meeting EN12492 requirement or equivalent suitable P3 level protection) and ridger gloves are required for all activities					
Masks are required to control inhalation exposure during certain tasks					
Gloves are also required to control against any dermal exposure to Cu and Fe solids being stored in preparation for being					
sent to landfill.					
2.4 Control of workers exposure for contributing exposure scenario 2.3					
Removal of cobalt, Co, by solvent extraction of separation and drying of NiSO4 6HaO	the purified Nis	SO4 solution and recrystallisation (from the raffinate),			
	Manufacture o	f Ni sulphate			
Workers related free short title	Solvent extract	tion of nickel sulphate leachate			
		· · · · · · · · · · · · · · · · · · ·			

Use descriptor covered	PROC2 – Use in closed, continuous process with occasional controlled					
	Removal of cobalt. Co, by solvent extraction of the purified NiCO, colution					
Processes, tasks, activities covered	and recrystallisation (from the raffinate), separation and drying of NiSO4.6H ₂ O					
Assessment Method	Estimation of e	xposure using a Tier 1 model.				
Product characteristic		· •				
Solid, low grade dust, and solution						
Amounts used						
Not relevant						
Frequency and duration of upployneouro						
Frequency and duration of use/exposure	L:0.					
All production workers generally work 8 nour s	niπs.					
automation and mechanisation applicable to a	ctivities. Duration	n of exposure ranges from 0.5h/8h to 7h/8h.				
Human factors not influenced by risk mana	gement					
Respiration volume under conditions of use	•	Light to medium level work is routinely undertaken ~10 m ³ /d				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance under	conditions of					
use		480 cm ²				
Body weight		70 kg				
Other given operational conditions affecting	g workers expo	sure				
The filtrate, containing NiSO4, is pumped to the	e enclosed solve	ent extraction unit where it is purified to give NiSO4 in the				
raffinate. The NiSO46H2O is crystallised from t	he raffinate in th	e crystalliser and then these crystals are transferred to the				
drier in enclosed conveyors.						
Technical conditions and measures at proc	ess level (sour	ce) to prevent release				
None	•					
Technical conditions and measures to cont	rol dispersion	from source towards the worker				
Solvent extraction, crystallising and drying sha	all be enclosed a	and fitted with LEV to control inhalation exposure to mists.				
LEV is required to control inhalation exposure	to particulate ge	nerated during drying and to vapours during volume reduction				
and (unspecified) masks are required for certa	in (unspecified)	tasks				
Organisational measures to prevent /limit re	eleases, disper	sion and exposure				
None						
Conditions and measures related to person	al protection.	voiene and health evaluation				
Air-assisted filtering visor with P3 filter element	t (Willson Turbo	visor) Protection = 20 (based on use of powered respirator				
meeting EN12492 requirement or equivalent s	uitable P3 level	protection) and rigger gloves are required for all activities				
RPF is required to control inhalation exposure	in certain (unide	entified) tasks				
Gloves are required to control dermal exposure	9 9					
2.5 Control of workers exposure for contrib	uting exposure	e scenario 2 4				
Packaging of NiSO46H2O into bags	aning expectate					
	Manufacture of	Ni sulnhate				
Workers related free short title	Solvent extract	ion of nickel sulphate leachate				
	PROC8b - Tran	aster of substance or preparation (charging/discharging)				
	from/to vessels	large containers at dedicated facilities				
Use descriptor covered	PROC9 - Trans	ster of substance or preparation into small containers				
	(dedicated fillin	a line including weighing)				
Processes tasks activities covered	Packaging of NiSO.6H ₂ O into bags					
Assessment Method	Estimation of e	xposure based on measured data				
Product characteristic						
Solid Jow grade dust	Product characteristic					
Solid, low grade dust Powder						
Amounts used						
Not relevant						
Frequency and duration of use/exposure						
All production workers generally work 8 hours	hifts.					
The actual pattern of exposure is determined by the amount of manual and driving work, use of control rooms and level of automation and mechanisation applicable to activities. Duration of exposure ranges from 0.5h/8h to 7h/8h.						

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	Net relevant			
use		Not relevant			
Body weight		Not relevant			
Other given operational conditions affecting	g workers expo	osure			
The crystals are transferred from the drier in ar	n enclosed conv	eyor to the packaging station where they are packed in 25 kg			
bags on an automated bagging line and into big	g bags (1000 kg) on an enclosed manually operated bagging unit. Filling big			
bags (1000 kg) is manually operated but large	y enclosed (sec	curing the spout of the empty big bag over the fill point,			
initiating/terminating the automatic filling of the	bag, removing	the spout of the big bag from the filling nozzle and manually			
closing the full bag). The powder is allowed to	settle in the big	bags before removing them from the filling nozzle. Big bags			
are then driven to the warehouse.					
Technical conditions and measures at proc	ess level (sour	ce) to prevent release			
None					
Technical conditions and measures to cont	rol dispersion	from source towards the worker			
The filling nozzles shall be fitted with LEV.	•				
Organisational measures to prevent /limit re	eleases, disper	sion and exposure			
None	· · ·	•			
Conditions and measures related to person	al protection.	hygiene and health evaluation			
Air-assisted filtering visor with P3 filter element	(Willson Turbo	visor) Protection = 20 (based on use of powered respirator			
meeting EN12492 requirement or equivalent su	uitable P3 level	protection) and rigger gloves are required for all activities.			
2.5 Control of workers exposure for contrib	uting exposure	e scenario 2.5			
Cleaning and Maintenance reported as example	es				
	Manufacture of	f Ni sulphate			
Workers related free short title	Solvent extract	ion of nickel sulphate leachate			
Use descriptor covered	PROC 0 – Clea	aning and maintenance			
Processes tasks activities covered	Cleaning and M	Anintenance reported as examples			
Assessment Method	Estimation of e	vnosure based on aTier 1 model			
Product characteristic					
Solid low grade dust					
Powder					
Amounts used					
Not relevant					
Frequency and duration of use/exposure					
Not given					
Human factors not influenced by risk mana	noment				
Perpiration volume under conditions of use	gement	Light to modium lovel work is routinely undertaken $\sim 10 \text{ m}^{3/d}$			
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~ 10 mº/u			
Area of akin contract with the substance under	conditions of	Not relevant			
		960 cm ²			
use Rody woight		70 kg			
Other given exerctional conditions effective					
Other given operational conditions affecting	j workers expo	ond electrics of electronic equipment by dry (very units) and			
Cleaning of premises typically includes wet cle	eaning of floors	and cleaning of plant and equipment by dry (vacuuming) and			
wet (power wasning) methods. Maintenance in	cludes opening	or pipes and reactors and can occasionally include opening of			
equipment in order to inspect for blockages, leaks and damage and carry out repairs.					
ecnnical conditions and measures at process level (source) to prevent release					
I ecnnical conditions and measures to control dispersion from source towards the worker					
LEV is required to control innalation exposure to tumes, particulate and liquid aerosols generated					
Organisational measures to prevent /limit releases, dispersion and exposure					
None					
Conditions and measures related to personal protection, hygiene and health evaluation					
Air-assisted filtering visor with P3 filter element (Willson Turbovisor) Protection = 20 (based on use of powered respirator					
meeting EN12492 requirement or equivalent su	litable P3 level	protection) and rigger gloves are required for all activities.			
(Unspecified) masks are required for certain (u	nspecified) task	(S.			
Gioves are required to control dermal exposure	e to particulate a	and liquid splasnes to the skin.			
3. Exposure and risk estimation	3. Exposure and risk estimation				

ERC 1											
Manufacture o	f Ni sulphate	(copp	er refir	nery and sme	lter)	1			Mathadaf	or coloulation of	
compartment	Unit	PN	EC	PEC _{Regional}	Clocal		С	RCR	Methods for calculation of environmental concentration		
Freshwater	µg/L	3.6		2.9	0.32	.32 3.22		.91	Measured values, Tier 3-RWC		
Marine	µg/L	8.6		0.3	0.03	0.33	0	.04			
Terrestrial	errestrial mg/kg 29.			16.2	0.10	16.3	0	.55			
STP mg Ni/kg 0.3		0.33		-	-	-	-		Waste water is not connected to an STP		
Vorkers ES 2.1 PROC 4: Impu with the solution Dermal Acut Acut Long Long	re NiSO4 and on of crude N <u>e systemic</u> <u>e local</u> g-term syster g-term local	d nicke liSO4.6	el carb H ₂ O to Unit mg N mg N mg N	oonate, NiCO: o give an imp ii/kg/day ii/cm²/day ii/cm²/day	a, are cha ure NiSC DNEL - - 0.0004	arged ir D4 solut CC N N N 4 0.	nto a re ion xposure oncentr R R R 00005	actor a e ation	nd dissolved RCR 0.113	A in sulfuric acid togethe Methods for calculation of exposure Exposure modeled using MEASE, a Tier model for PROC 4. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through nor direct handling of non dispersive use process. Use of glove	
Inhalation					4.6						
Acute systemic			mg Ni/m ³		16	0.	0.099		0.006	3 x long-term	
Acut Long and local	<u>e local</u> j-term syster	nic	<u>mg N</u> mg N	li/m ³	0.7	0.	099		0.14 0.66	exposure estimate Exposure modeled using MEASE, a Tier model for PROC 4. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through nor direct handling of nor dispersive use process. Use RPE (APF = 40) and LEV are assumed.	

	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of					
Dermal					exposure					
Acute systemic	ma Ni/ka/day	-	NR							
Acute local	mg Ni/cm²/day	-	NR							
Long-term systemic	mg Ni/kg/day	-	NR							
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.11	Exposure modeled using MEASE, a Tier 1 model for PROC 2. It is assumed that Ni is handled as a solution with Ni concentration more than 25%. Only incidental exposure is assumed through non- direct handling of non- dispersive use process. Use of gloves is also assumed.					
Inholation										
	ma Ni/m ³	16	0.003	< 0.01	3 x long term					
	mg Ni/m²	0.7	0.003	< 0.01	oxposure estimate					
	mg Ni/m²	0.7	0.003	0.01	Exposure estimate					
and local					using MEASE, a Tier 1 model for PROC 2. It is assumed that Ni is handled as a solution with Ni concentration more than 25%.Only incidental exposure is assumed through non- direct handling of non- dispersive use process. Use RPE (APF = 20) and LEV are assumed.					
ES 2.3 PROC 2: Removal of cobalt, Co, by solvent extraction of the purified NiSO ₄ solution and recrystallisation (from the raffinate), separation and drying of NiSO _{4.6H2} O										
	Unit	DNEL	Exposure concentration	KUK	calculation of exposure					
Dermal										
Acute systemic	mg Ni/kg/day	-	NR							
Acute local	mg Ni/cm²/day	-	NR							
Long-term systemic	mg Ni/kg/day	-	NR							
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.11	Exposure modeled using MEASE, a Tier 1 model for PROC 2. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through non-					
					direct handling of non- dispersive use process. Use of gloves is also assumed.					
--	----------------------------	---------------	---------------	---	---					
Inhalation										
	ma Ni/m ³	16	0.018	< 0.01	3 x long_term					
	mg Ni/m ³	0.7	0.010	< 0.01	exposure estimate					
Acute local	mg Ni/m°	0.7	0.010	0.025	exposure estimate					
		0.05	0.000	0.025	Functional and a local					
and local	mg Ni/m ³	0.05	0.006	0.12	Exposure modeled using MEASE, a Tier 1 model for PROC 2. It is assumed that Ni solids have medium dustiness and have concentration more than 25%. Only incidental exposure is assumed through non- direct handling of non- dispersive use process. Use of RPE (APF = 20) and LEV are assumed.					
ES 2.4 PROC 8b. PROC 9: Packaging of	of NiSO₄6H₂O into b	ads								
	Unit		Exposure	RCR	Methods for					
		DITLE	concentration	Non	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/cm²/day	0.00044	0.00067	1.5 excl. PPE <1 with gloves	75 th percentile (full body exposure) based on packaging data from an analogous operation (packaging of NiSO₄6H₂O). Qualitative assessment ¹					
Inhalation										
Acute systemic	ma Ni/m ³	16	0.03	<0.01	3 x long-term					
Acute local	mg Ni/m ³	0.7	0.03	0.04	interpolated 75 th percentile value					
					aggregated over all activities					
Long-term systemic and local	mg Ni/m ³	0.05	0.01	0.2	75 th percentile value of personal exposure measurements (n=12) aggregated over all activities					
¹ Dermal exposure likely to be su	ifficiently controlled	by use of rig	ger gloves							
ES 2.5 PROC 0: Cleaning and Maintena	ance reported as exa	amples								
	Unit	DNEL	Exposure	RCR	Methods for					
			concentration		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/cm²/day	0.00044	0.00003	0.068	Calculated using MEASE, a tier 1 model for PROC 10 for a solid of medium dustiness with non dispersive use and non-direct handling for less than 240 minutes. Use of properly designed gloves and only incidental exposure is assumed.
Inhalation					
Acute systemic	mg Ni/m ³	16	0.099	0.006	3 x long-term
Acute local	mg Ni/m ³	0.7	0.099	0.14	exposure estimate
Long-term systemic and local	mg Ni/m³	0.05	0.033	0.66	Calculated using MEASE, a tier 1 model for PROC 10 for a solid of medium dustiness with non dispersive use and non-direct handling for less than 240 minutes. Use of LEV and RPE (APF=20) is assumed.

NR: Not Relevant

Acute local inhalation

Based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher

4. Guidance to evaluate whether a site 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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.2.4 GES 3: CRYSTALLISATION (OF NICKEL SULPHATE HEXAHYDRATE, NiSO4.6H2O) FROM A PURIFIED NICKEL SULPHATE NiSO4 LEACHATE

1. Title	
GES 3 Crystallisation from a purified nickel	sulphate leachate
Life cycle	Manufacture of Ni sulphate
Free short title	Crystallisation from a purified nickel sulphate leachate
	Nickel sulphate production from nickel matte
	SU: SU9 - Manufacture of fine chemicals
	FC. Not relevant EPC: EPC1 Manufacture of substances
	PROC: PROC1 – Manufacture of substances
Systematic title based on use descriptor	
	PROC2 – Use in closed continuous process with
	occasional controlled exposure (e.g. sampling)
	PROC0 – Cleaning and maintenance
Processes, tasks, activities covered	Manufactura of Ni aulabata in refinariaa
(environment)	
	Crystallisation (of nickel sulphate hexahydrate, NiSO4.6H ₂ O) from a purified
	nickel sulphate NISO4 leachate
	Contributing exposure scenario ES 3.1:
	Contributing exposure scenario ES 3.2:
	PROC 2: Crystallisation and separation of NiSO $_4$ 6H $_2$ O from this NiSO $_4$
Processes, tasks, activities covered	solution
(workers)	Contributing exposure scenario ES 3.3:
	PROC 2: Drying of NiSO4.6H2O
	Contributing exposure scenario ES 3.4:
	PROC 2: Packaging of NiSO ₄ 6H ₂ O
	Contributing exposure scenario ES 3.5:
	PROC 0: Cleaning and Maintenance
2. Operational conditions and risk manager	nent measures
2.1 Control of environmental exposure	Manufacture of Ni culmbete (componenting and consister)
Environmental related free short title	Manufacture of Ni sulphate (copper refinery and smelter)
Systematic title based on use descriptor	ERC1 – Manufacture of substances
Processes tasks activities covered	
(environment)	Manufacture of Ni sulphate in refineries
Environmental Assessment Method	Measured local and regional concentrations are used for calculation of PEC
Product characteristics	· · · · · · · · · · · · · · · · · · ·
Solid, low grade dust	
50% of powder has diameter ~1 mm	
Amounts used	
Maximum daily use at a site	1.5 tonnes/day (50 th % emission days, 25 th % tonnage)
Maximum annual use at a site	538 tonnes (25 th %, 2007)
Frequency and duration of use	
Pattern of release to the environment	350 days per year per site (50 ^m %)
Environment factors not influenced by risk	management
Receiving surface water flow rate	18000 m ³ /d
Dilution capacity, freshwater	10 (detault) m ³ /d
Dilution capacity, marine	100 (default) m ³ /d
Uther given operational conditions affecting	g environmental exposure
Lechnical conditions and measures at proc	ess level (source) to prevent release
none	

Technical onsite conditions and measures	to reduce or lin	nit discharges, air emissions and releases to soil			
Waste water:					
On-site waste water treatment plant (chemical	precipitation)				
Efficiency: ->99% removal					
Release factor after on-site treatment: To fresh	water and mari	ne water: 5.90 g/T (10th %)			
Air:					
Treatment of air emission (filters, wet or dry sc	rubber).				
Efficiency: ->99% removal					
Release factor after on-site treatment: 72.5 g/T	(max)				
Organizational measures to prevent/limit re	lease from site				
None					
Conditions and measures related to munici	pal sewage tre	atment 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 externa	l treatment of	waste for disposal			
Ni bearing waste shall be recovered or recycler	d if possible. Ni	bearing waste shall be considered bazardous if the Ni content			
in above the generic suteffs (for mixtures) as of	u il possible. Ni	an (EC) No. 1272/2009. Ni haaring wasta mixturaa may ba			
is above the generic cutons (for mixtures) as si		2/2009 aritaria. Dianagal of Ni bearing waste filixiules fildy be			
assessed as substances according to regulate	(EC) NO. 127	2/2006 chiena. Disposal of Ni bearing waste shall comply with			
local, state or national waste legislation and rel	mains the respo	onsibility of the waste treatment operator.			
Conditions and measures related to externa	al recovery of v	vaste			
Not applicable	-				
2.2 Control of workers exposure for contrib	uting exposure	e scenario 3.1			
A purified NiSO ₄ leachate solution is obtained r	eady for proce	ssing			
Workers related free short title	Manufacture of Ni sulphate				
Use descriptor covered	PROC 1 – Use	in closed process (synthesis), no likelihood of exposure			
Processes, tasks, activities covered	A purified NiS0	D_4 leachate solution is obtained ready for processing			
Assessment Method Estimation of exposure using a Tier 1 model					
Product characteristic					
Solid, low grade dust					
Amounts used					
Not relevant					
Frequency and duration of use/expessive					
All production workers gonorally work 8 hour of	aifte				
The actual pattern of exposure is determined b automation and mechanisation applicable to ac	y the amount o ctivities. Duratio	f manual and driving work, use of control rooms and level of n of exposure ranges from 0.5h/8h to 7h/8h.			
Human factors not influenced by risk mana-	nement				
Pespiration volume under conditions of use	gement	I just to medium level work is routinely undertaken $\sim 10 \text{ m}^3/d$			
Poom size and ventilation rate		Not relevant			
Area of align contract with the substance under	aanditiana of				
use	conditions of	240 cm ²			
Body weight		70 kg			
Other given operational conditions affecting	g workers exp	osure			
All activities are largely run from control room v	vhen operators	are not required to directly observe or intervene in the			
process.					
The reactor is charged by piping purified NiSO	solution into th	ne reactor.			
Technical conditions and measures at process level (source) to prevent release					
None given	,	, ,			
Technical conditions and measures to cont	rol dispersion	from source towards the worker			
None diven					
Organisational measures to prevent /limit re	leases disne	rsion and exposure			
Training to reinforce good practice and hygian	issues and ev	nosure and hiological monitoring of operators is regularly			
performed.					
Conditions and measures related to person	al protection,	hygiene and health evaluation			
Air-assisted filtering visor with P3 filter element	(Willson Turbo	visor) Protection = 20 (based on use of powered respirator			

meeting EN12492 requirement or equivalent su	uitable P3 level	protection) and rigger gloves are required for all activities.
Gloves are required to control dermal exposure	e when charging	
Crystallisation and separation of NiSO, 6H ₂ O fr		solution
	Manufacture o	f Ni sulnhata
Workers related free short title	Crystallisation	from a nurified nickel sulphate leachate
	PROC2 – Use	in closed, continuous process with occasional controlled
Use descriptor covered	exposure (e.g.	sampling)
Processes, tasks, activities covered	Crystallisation	and separation of NiSO ₄ .6H ₂ O from this NiSO ₄ solution
Assessment Method	Estimation of e	exposure using a Tier 1 model
Product characteristic		
Solid, low grade dust		
50% of powder has diameter ~1 mm		
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
All production workers generally work 8 hour sh	nifts.	
The actual pattern of exposure is determined b	y the amount o	f manual and driving work, use of control rooms and level of
automation and mechanisation applicable to ac	tivities. Duratio	n of exposure ranges from 0.5h/8h to 7h/8h.
Human factors not influenced by risk managed	gement	
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m ³ /d
Room size and ventilation rate		Not relevant
Area of skin contact with the substance under	conditions of	480 cm ²
use		
Body weight		70 kg
Other given operational conditions affecting	g workers exp	osure
All activities are largely run from control room v	vhen operators	are not required to directly observe or intervene in the
process.		
The NiSO ₄ solution is evaporated under reduce	ed pressure, the	hydrated nickel sulphate, NiSO ₄ 6H ₂ O, crystallises out of the
concentrated solution in the crystalliser and is s	separated from	the solution by centrifugation. This activity is automated and
enclosed.		
Technical conditions and measures at proc	ess level (soul	ce) to prevent release
Leaching, evaporation/crystallisation/centrifuga	ition shall be er	iciosed with high level of containment. Evaporation shall be
carried out under negative pressure.		from a current towards the worker
Technical conditions and measures to control	rol dispersion	from source towards the worker
LEV Ishall be used to extract the gases and va	pours generate	a during heating and evaporating the solution.
Training to reinforce good practice and hygions	icauca and or	sion and exposure
norformed		posure and biological monitoring of operators is regularly
penoinieu.	al protection	hygione and health evaluation
Air assisted filtering visor with D3 filter element	Willson Turbo	visor) Protection = 20 (based on use of nowered respirator
meeting EN12/02 requirement or equivalent s	itable P3 level	protection) and rigger gloves are required for all activities
2.4 Control of workers exposure for contribution	uting exposure	e scenario 3 3
Drying of NiSO $_4$ 6H $_2$ O	uting exposure	
	Manufacture o	f Ni sulphate
Workers related free short title	Crystallisation	from a nurified nickel sulnhate leachate
	PROC2 - Use	in closed, continuous process with occasional controlled
Use descriptor covered	exposure (e a	sampling)
Processes, tasks, activities covered	Drving of NiSC	6H2O
Assessment Method	Estimation of e	exposure using a Tier 1 model
Product characteristic		
Solid low grade dust		
50% of powder has diameter ~1 mm		
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
All production workers generally work 8 hour sh	nifts.	
	-	

The actual pattern of exposure is determined by the amount of manual and driving work, use of control rooms and level of automation and mechanisation applicable to activities. Duration of exposure ranges from 0.5h/8h to 7h/8h. Human factors not influenced by risk management Respiration volume under conditions of use Light to medium level work is routinely undertaken ~10 m³/d Room size and ventilation rate Not relevant Area of skin contact with the substance under conditions of 480 cm² use Body weight 70 kg Other given operational conditions affecting workers exposure All activities are largely run from control room when operators are not required to directly observe or intervene in the process. The crystals are dried using a vacuum belt filter and transferred in an enclosed conveyor to intermediate storage silos. Technical conditions and measures at process level (source) to prevent release Filtering of leachate is carried out using open filter presses. Technical conditions and measures to control dispersion from source towards the worker LEV is required to control inhalation exposure to particulates during release from the filter and packaging. LEV is also used to extract the gases and vapours generated during drying of the NiSO46H2O Organisational measures to prevent /limit releases, dispersion and exposure Training to reinforce good practice and hygiene issues and exposure and biological monitoring of operators is regularly performed. Conditions and measures related to personal protection, hygiene and health evaluation Air-assisted filtering visor with P3 filter element (Willson Turbovisor) Protection = 20 (based on use of powered respirator meeting EN12492 requirement or equivalent suitable P3 level protection) and rigger gloves are required for all activities. 2.5 Control of workers exposure for contributing exposure scenario 3.4 Packaging of NiSO₄6H₂O Manufacture of Ni sulphate Workers related free short title Crystallisation from a purified nickel sulphate leachate PROC2 – Use in closed, continuous process with occasional controlled Use descriptor covered exposure (e.g. sampling) Processes, tasks, activities covered Packaging of NiSO₄6H₂O Assessment Method Estimation of exposure based on measured data Product characteristic Solid, low grade dust 50% of powder has diameter ~1 mm Amounts used Not relevant Frequency and duration of use/exposure All production workers generally work 8 hour shifts. The actual pattern of exposure is determined by the amount of manual and driving work, use of control rooms and level of automation and mechanisation applicable to activities. Duration of exposure ranges from 0.5h/8h to 7h/8h. 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 Not relevant use Body weight Not relevant Other given operational conditions affecting workers exposure All activities are largely run from control room when operators are not required to directly observe or intervene in the process. There is automated packaging of NiSO4.6H2O crystals small jet bags (25 kg) and stacking the full jet bags onto and shrink wrapping filled pallets. Filling big bags (1000 kg) is manually operated but largely enclosed (securing the spout of the empty big bag over the fill point, initiating/terminating the automatic filling of the bag, removing the spout of the big bag from the filling nozzle and manually closing the full bag). The powder is allowed to settle in the big bags before removing them form the filling nozzle which are fitted with LEV. Pallets and big bags are then driven to the warehouse. Technical conditions and measures at process level (source) to prevent release Packaging and transfer systems shall be enclosed and the level of containment high. Technical conditions and measures to control dispersion from source towards the worker

LEV shall be ins factor = 0.1). Fix	talled on bag ed capturing	gging lines ar I hoods shall	nd units in the be located in	e packag i close p	ing area a roximity of	t the end o and directe	f the production process (Reduction ed at the source of emission for belt
filters and packa	ging units. T	he design sh	all enable that	at the wo	ork is perfo	rmed in the	e capture zone of the ventilation system
LEV is required	to control inf	alation expo	sure to partic	ce. ulates d	uring relea	se from the	e filter and packaging.
Organisational	measures t	o prevent /li	mit releases	, disper	sion and e	exposure	
Training to reinfo performed.	orce good pr	actice and hy	giene issues	and exp	oosure and	l biological	monitoring of operators is regularly
Conditions and	measures	related to pe	ersonal prote	ection, h	ygiene ar	nd health e	valuation
Air-assisted filter	ring visor wit	h P3 filter ele	ement (Willso	n Turbo	visor) Prote	ection = 20	(based on use of powered respirator
meeting EN1249	92 requireme	ent or equival	ent suitable F	P3 level	protection)	and rigger	gloves are required for all activities.
2.5 Control of w	vorkers exp	osure for co	ntributing e	xposure	scenario	3.5	
Cleaning and Ma	aintenance		I				
Workers related	d free short	title	Manufa Crystal	acture of lisation f	Ni sulphat	e fied nickel	sulphate leachate
Use descriptor	covered		PROC	0 – Clea	ning and r	naintenanc	e
Processes, tasl	ks, activities	s covered	Cleanir	ng and M	laintenanc	е	
Assessment Me	ethod		Estima	tion of e	xposure us	sing a Tier	1 model
Product charac	teristic						
Solid, low grade	dust						
50% of powder h	nas diameter	·~1 mm					
Amounts used							
Not relevant		. ,					
Frequency and	duration of	use/exposu	re				
Duration of task	maximum 4	hours					
Human factors	not influence	ced by risk n	nanagement		1 :		lossed is not in the second set along 10 as 2/d
Respiration volu	me under co		se		Light to m	edium ieve	I work is routinely undertaken ~10 m³/d
Room size and V	entilation ra		undor conditio	no of	Not releva	nt	
Area of skin cor use	itact with the	e substance u	inder conditio	ons of	960 cm ²		
Body weight					70 ka		
Other given op	erational co	nditions affe	ecting worke	ers expo	sure		
Unspecified instr	ructions for c	leaning, mai	ntenance and	d emerae	ency proce	dures are f	ollowed
Technical cond	litions and r	neasures at	process lev	el (sour	ce) to prev	vent releas	Se
None given					_/		
Technical cond	litions and r	neasures to	control disp	persion	from sour	ce towards	s the worker
None given							
Organisational	measures t	o prevent /li	mit releases	, disper	sion and e	exposure	
Training to reinfo performed.	orce good pr	actice and hy	giene issues	and exp	osure and	l biological	monitoring of operators is regularly
Conditions and	measures	related to pe	ersonal prote	ection, h	nygiene ar	nd health e	valuation
Air-assisted filter meeting EN1249	ring visor wit 2 requireme	h P3 filter ele ent or equival	ement (Willso ent suitable F	n Turbov P3 level	visor) Prote protection)	ection = 20 and rigger	(based on use of powered respirator gloves are required for all activities.
by RPF and glov	es when un	dertaking ma	intenance an	id cleani	na work		
3 Exposure and	d risk estim	ation			ng work.		
Environment							
ERC 1							
Manufacture of	f Ni sulphate	(copper refir	nery and sme	lter)			
compartment	Unit	PNEC	PEC _{Regional}	Clocal	PEC	RCR	Methods for calculation of environmental concentration
Freshwater	µg/L	3.6	2.9	0.32	3.22	0.91	Measured values, Tier 3-RWC
Marine	µg/L	8.6	0.3	0.03	0.33	0.04	1
Terrestrial	mg/kg	29.9	16.2	0.10	16.3	0.55]
STP	mg Ni/kg	0.33	-	-	-	-	Waste water is not connected to an STP
Workers							

FS 3 1					
PROC 1: A purified NiSO4 lea	chate solution is ob	tained ready	/ for processing		
	Unit	DNEL	Exposure	RCR	Methods for calculation
Dermal	+		concentration		
Acute systemic	ma Ni/ka/day	-	NR		
Acute local	mg Ni/cm²/dav	-	NR		
Long-term	mg Ni/kg/dav	-	NR		
systemic					
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.114	Exposure estimated using MEASE for PROC 1 (> 25% concentration, non-direct handling, non- dispersive use, intermittent exposure for more than 4 hours, and use of gloves)
Inhalation					
Acute systemic	mg Ni/m ³	16	0.003	< 0.001	3 x long-term exposure
Acute local	mg Ni/m ³	0.7	0.003	0.004	estimate
Long-term systemic and local	mg Ni/m ³	0.05	0.001	0.002	Exposure estimated using MEASE for PROC 1 (medium dustiness solid, > 25% concentration, non-direct handling, non-dispersive use, intermittent exposure for more than 4 hours, and use of RPE (APF=20))
ES 3.2 PROC 2: Crystallisation and s	eparation of NiSO4	.6H ₂ O from t DNEL	his NiSO4 solution Exposure	RCR	Methods for calculation
Dermel			concentration		ot exposure
	ma Ni/ka/day				
Acute Systemic	mg Ni/kg/uay	-	NR		
Long-term	mg Ni/kg/dav	-	NR		
systemic	<u> </u>				
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.113	Exposure estimated using MEASE for PROC 2 (> 25% concentration, non-direct handling, non- dispersive use, intermittent exposure for more than 4 hours, and use of gloves)
Inhalation	1				
Acute systemic	mg Ni/m ³	16	0.018	0.001	3 x long-term inhalable
Acute local	mg Ni/m ³	0.7	0.018	0.026	exposure estimate
Long-term systemic and local	mg Ni/m ³	0.05	0.006	0.12	Long-term exposure estimate based on a single measurement taken during 'operating evaporator and filter'during an analogous

					activity (NiSO _{4.6H2} O recovery (from solution) operation for NiSO _{4.6H2} O produced from a purified spent electrolyte)
ES 3.3					
PROC 2: Drying of NiSO4.6H ₂ ()		-		Matheda far calculation
	Unit	DNEL	concentration	RUR	of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term	mg Ni/kg/day	-	NR		
systemic					
Long-term local	mg Ni/cm²/day	0.00044	0.00005	0.113	Exposure estimated using MEASE for PROC 2 (> 25% concentration, non- direct handling, non- dispersive use, intermittent exposure for more than 4 hours, and use of gloves)
Inholation					
	ma Ni/m3	16	0.22	0.00	2 y long torm ovnoguro
Acute systemic	mg Ni/m³	10	0.33	0.02	s x long-term exposure
Long-term systemic and local	mg Ni/m ³	0.05	0.11	2.2 (excluding RPE) By use of RPE (APF 20): 0.11	Exposure estimated using MEASE for PROC 2 (medium dustiness solid, > 25% concentration, non- direct handling, non- dispersive use, intermittent exposure for more than 4 hours
ES 3.4					
PROC 2:Packaging of NiSO46	H2O		F		Mathada fan ei billing
	Unit	DNEL		KUK	vietnous for calculation
Dermal					
Δcuto evetomic	ma Ni/ka/day	 	NR		
Acute local	ma Ni/cm ² /day		NR		
	mg Ni/kg/day		NR		
systemic	ing Mi/kg/uay	-			
Long-term local	mg Ni/cm²/day	0.00044	0.00067	1.5 excl. PPE ¹ <1 with gloves	75 th percentile of personal measurements (n=8; full body) taken during packaging of NiSO ₄ and nickel hydroxycarbonate. It was assumed that all exposure consisted of NiSO ₄ Qualitative assessment ²

Inhalation					
Acute systemic	ma Ni/m ³	16	0.069	0.004	3 x long-term 75 th
	mg Ni/m ³	0.7	0.069	0.004	percentile personal
Acute local	ing N/III	0.7	0.003	0.030	exposure estimate for
					exposure estimate for
	an a Ni/ma3	0.05	0.000	0.46	
Long-term systemic	mg Ni/m°	0.05	0.023	0.40	75 th percentile of
and local					personal, innalable
					measurements (n=7) for
					packaging. Packaging
					value includes NiSO ₄
					and nickel
					hydroxycarbonate, as the
					packaging was carried
					out in same area and the
					operators rotate between
					both
¹ Estimated exposure exceed	the DNEL (dermal)	, suitable glo	oves and clothing sl	hould be wo	rn to minimize skin contact
with Ni species and the assoc	iated risk of sensitiz	zation.	Ū		
² Dermal exposure likely to be	sufficiently control	ed by use of	f rigger gloves		
ES 3.5					
PROC 0: Cleaning and Mainte	enance				
	Unit	DNEL	Exposure	RCR	Methods for calculation
			concentration		of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term	mg Ni/kg/day	-	NR		
systemic					
Long-term local	mg Ni/cm ² /day	0.00044	0.00003	0.68	Exposure estimated
Ũ	U				using MEASE for
					PROC 10 (> 25%
					concentration, non-
					direct handling non-
					dispersive use
					intermittent exposure
					for the maximum of A
					bours and use doves)
					nours, and use gloves)
Inhalation					
Acute systemic	ma Ni/m ³	16	0.045	0.003	3 X long-term exposure
Acute local	mg Ni/m ³	0.7	0.045	0.000	estimate
	mg Ni/m ³	0.05	0.015	0.004	Exposure estimated
systemic	ing in/iii	0.00	0.010	0.0	using MEASE for
	ma Ni/m ³	0.05	0.015	0.3	PROC 10 (low
Long-termilocal	ing in/in-	0.05	0.015	0.5	dustiness solid $> 25\%$
					accontration non
					direct handling see
					direct nanoling, non-
					uispersive use,
					intermittent exposure
					for the maximum of 4
					hours, and use RPE
					(APF = 20))
NR: Not Relevant					
Acute local innalation		alable for the	and last all the second second	1. h ()	
based on respirable size aero	sois. Equivalent inf	ialable fracti	on levels expected	to be at leas	si o-iola nigher

4. Guidance to evaluate whether a site 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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.2.4.1 Summary of the secondary poisoning exposure and risk characterisation assessment for nickel sulphate production

The methodology applied to assess secondary poisoning for nickel sulphate production is extracted from the European Union Risk Assessment for Nickel (2008/2009). A detailed report on the methodology used to derive the $PNEC_{oral}$ and bioaccumulation factors (BAF) are provided in <u>Appendix D3</u>.

(·)					
				PEC/PNEC	PEC/PNEC
F um auma	DEC weter	DEC weter	PEC _{oral} mollusk	Aquatic bird	Aquatic mammal
Expsure			(mg/kg wet	(Oystercatcher)	(European Otter)
Scenario	(mg/L)	(mg/L)	mollusk)	PNEC=12.3 mg/kg;	PNEC=2.3 mg/kg;
				RAF=1	RAF=0.025
1	0.0032	0.0029	0.83	0.07	0.01
2	0.0032	0.0029	0.82	0.07	0.01

Table 85. Freshwater aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (European Otter)

Table 86. Marine aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (Harbor seal). Two scenarios are assumed: C. edule present and C. edule absent.

PEC _{local} water	PEC _{regional} water (mg/L)	PEC _{oral} mollusk (mg/kg wet mollusk)		PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1		PEC/PNEC Aquatic mammal (Harbor seal) PNEC=4.6 mg/kg; RAF=0.025	
(mg/L)		C. edule present BAF=1631	C.edule absent BAF= 270	C.edule present BAF=1631	C.edule absent BAF=270	C.edule present BAF=1631	C.edule absent BAF=270
		L/Kg	L/Kg	L/Kg	L/Kg	L/Kg	L/Kg
0.00033	0.0003	0.51	0.085	0.04	0.01	0.003	0.0005

Table 87.	Terrestrial food chain: concentration,	PECoral and risk	characterisation fo	r worm-eating b	oirds and
mammals	6				

PEC in soil compartment (mg/kg)	Regional soil background concentration (mg/kg)	PEC _{oral} local Tissue + gut 100% worms (mg/kg ww)	PEC _{oral} local Tissue + gut 30% worms 70% isopods (mg/kg ww)	PEC/PNEC Birds (starling) PNEC=8.5 mg/kg RAF=1	PEC/PNEC Mammals (shrew) 100% worms PNEC=0.12 mg/kg RAF=0.036	PEC/PNEC Mammals (shrew) 30% worms 70% isopods PNEC=0.12 mg/kg RAF=0.025
16.30	16.20	2.40	0.98	0.28	0.72	0.21

9.2.4.2 Porewater concentrations in the soil compartment for nickel sulphate production

The derived $PEC_{porewater}$ for the generic scenario is 0.025 mg Ni/L. More details for the calculation of the $PEC_{porewater}$ are provided in <u>Appendix D3</u>.

Table 00	Due di sta di Eu				:	
Table oo.	Predicted EX	posure conc	entrations	PEC)	IN I	porewater

0.025	PEC _{local porewater} (mg/L)
0.025	0.025

9.2.4.3 Atmospheric compartment for nickel sulphate production

An overview of the local air concentrations and PEC in the air compartment are provided in the assessment for Man via the Environment below or <u>Appendix D5</u>.

9.2.4.4 Exposure concentrations in on site waste water treatment plants (WWTP) for nickel sulphate production

The calculated Nickel concentrations in the effluent of the on-site WWTP are used further in the risk characterisation (see <u>Appendix D3</u>). For the freshwater compartment, the calculated effluent concentration for the on-site WWTP is 0.005 mg/L.

Table 03. Oblicentiations in on-site waste water reatment plant						
Information type	Calculated effluent concentration in on-site WWTP (mg/L)					
Selected for GES Freshwater	0.005					
Selected for GES Marine	0.005					

Table 89. Concentrations in on-site waste water treatment plant

9.2.4.5 Man via Environment exposure and risk characterisation assessments for production of Nickel Sulphate

For each sector, an overview of the range of operational conditions (OC) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared to 11.5 ng Ni/m³ or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m³. An assessment of predicted level of compliance for this sector based on site-specific measured or predicted exposures is provided in Section 5 of <u>Appendix D5</u>.

	tonnage (T Ni/year)	daily emissions to air (kg Ni/d)	release factor to air (g Ni/T)	Emission days to air per site (d/y)	C _{local} , air* (ng Ni/m³)	PEC air\$ (ng Ni/m³)
min	257	0.01	7	200	1	10
max	1840	0.21	72	365	8	16
median	914	0.14	68	350	2	11

Table 90. Sector overview

*: based on different air models (EUSES, GPM, IFDM)

 $: based on C_{\mbox{\tiny local}} \ predicted + regional background$

9.3 Generic exposure scenarios for downstream users of nickel sulphate

9.3.1 INTRODUCTION

This section describes the potential exposure to nickel sulphate from the environmental and occupational standpoints for the downstream uses made known to the Nickel Consortia before the 1st of November 2009. Additional uses made known after this REACH legal deadline will be added when registration dossier updates occur; as of January 2011, no new uses were identified to the Nickel Consortia. The exposure assessment and risk characterisation covered by the current DUs GES are likely to be refined over time due to the iterative process of the exposure scenarios communication in the supply chain.

The actual identified downstream uses of nickel sulphate cover the following sectors:

- Metal surface treatment nickel electroplating, nickel electroforming and electroless nickel plating
- Production of batteries using positive nickel electrodes);
- Production of nickel salts from nickel sulphate
- Use of nickel sulphate in the manufacturing of micronutrient additives for biogas production
- Use of nickel sulphate in pigment ptoduction

Estimated and measured environmental (*i.e.*, in freshwater, marine aquatic, air and terrestrial compartments) and occupational (*i.e.*, process-specific occupational hygiene data from personal/static monitoring) exposure data for nickel sulphate production, are detailed in <u>Appendix D3</u> (section 1- environment), <u>Appendix D5</u> (MvE) and <u>Appendix D4</u> (section 1-human health) and provide full details on the exposure and risk characterisation data used in the GES. Detailed information on the environmental tiered approach for site-specific exposure assessment and risk characterization is found in <u>Appendix D1</u>. Detailed information on local exposure calculation factors and regional ambient backgrounds can be found in <u>Appendix D2</u>.

As discussed in section 9.1, since it was not possible to attribute emissions to any specific process/activity, the environmental exposure assessment was conducted for nickel sulphate production sites as a whole. Conversely, for many of the GES the occupational exposure assessment was broken down by process/activity.

Secondary poisoning, WWTP, and the MvE assessments are presented in separate sections for each of the use sector.

9.3.2 GES 4: METAL SURFACE TREATMENT

1. Title							
GES 4 Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating							
Life cycle	End use – DU of Ni sulphate						
Free short title	Metal surface treatment – nickel electroplating, nickel electroforming and						
	electroless nickel plating						
Systematic title based on use descriptor	SU: SU 3 Industrial use						

	SU 15 Manufacture of fabricated metal products				
	PC: PC 19 Intermediate use				
	PC 14 Metal Surface Treatment Products				
	ERC: ERC5: Industrial use resulting in inclusion into or onto a matrix				
	PROC PROC 5: Mixing or blending in batch processes for formulation of				
	prenarations and articles (multistage and/or significant contact)				
	$PPOC_{8a}$: Transfer of substance or proparation (charging/discharging)				
	FROC 6a. Transier of substance of preparation (charging/discharging)				
	from/to vessels/large containers at non-dedicated facilities				
	PROC 8b: Transfer of substance or preparation (charging/discharging)				
	from/to vessels/large containers at dedicated facilities				
	PROC 13: Treatment of articles by dipping and pouring				
	PROC 15: Use as laboratory reagent				
	PROC 0: Cleaning and maintenance				
	Nickel electroplating without topcoat				
	Nickel electroplating with chromium topcoat				
Processes tasks activities covered	Nickel electroplating with other topcoats such as gold, silve, brass or organic				
(any incompant)	compounds				
(environment)	Nickel composite electroplating such as nickel plus silicon carbide				
	Nickel electroforming				
	Electroless nickel plating				
	Contributing exposure scenario FS 4 1				
Processes tasks activities covered	Operations involving dry salts				
(workers)	Contributing exposure scenario ES 4.2:				
(workers)	Contributing exposure scenario ES 4.2.				
2. Operational conditions and risk manager	nent measures				
2.1 Control of environmental exposure					
Environmental related free short title	Metal surface treatment – Nickel electroplating, nickel electroforming and electroless nickel plating				
Systematic title based on use descriptor (environment)	ERC5: Industrial use resulting in inclusion into or onto a matrix				
	Nickel electroplating without topcoat				
	Nickel electroplating with chromium topcoat				
	Nickel electroplating with other topcoats such as gold silver brass or organic				
Processes, tasks, activities covered	compounds				
(environment)	Nickel composite electronlating such as nickel plus silicon carbide				
	Nickel electroforming				
	Flootroloss nickol plating				
	Electioness mickel plating				
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used				
	tor calculation of PEC				
Product characteristics					
Ni sulphate: Dry powder of approximately 100	%or solution of 25-50%				
Amounts used					
	ES 1: 0.05 tonnes/day (median 50th % emission days, 50th % tonnage)				
Maximum daily use at a site	ES 2: 1.23 tonnes/day (median 50 th % emission days, 75 th % tonnage)				
	ES 3: 0.02 tonnes/day (median 50 th % emission days, 25 th % tonnage)				
	ES 1: 11 tonnes (median 50th %, 2007); Discharge to STP				
Maximum annual use at a site	ES 2: 271 tonnes (75th %, 2007); Discharge to STP				
	ES 3: 3.9 tonnes (25th %, 2007); Direct discharge				
Frequency and duration of use					
Pattern of release to the environment	220 days per vear per site (median 50 th %)				
Environment factors not influenced by rick	management				
Environment ractors not innuenced by fisk	ES 1 disobargo to STD: 1 8vE/ m3/d				
Dessiving surface water flow ant	ES I discharge to STP. 1.0XE4 III/d				
Receiving surface water flow rate	ES 2 discharge to STP: 2.0XE0 m²/d				
	ES 3 direct discharge: 1.6xE2 m³/d				
	ES 1: 10 (50 ^m %)				
Dilution capacity, freshwater	ES 2: 1000 (max)				
	ES 3: 10 (50 th %)				
Dilution canacity marine	100 (default)				

Other given operational conditions affecting	g environmental exposure
None	
Technical conditions and measures at proc	ess level (source) to prevent release
None	
Technical onsite conditions and measures	to reduce or limit discharges, air emissions and releases to soil
Waste water:	
On-site wastewater treatment in a physico-che	mical treatment plant by chemical precipitation, sedimentation, filtration or a
combination.	
Efficiency: 95 - >99%	
Off-site waste water treatment plant, communit	y sewer system
Efficiency 40%	
ES 1 freshwater Discharge to STP and Marine	. 131 g/1 (median)
ES2 freshwater Discharge to STP: 827 g/T (75	%) ====================================
ES 3 Direct discharge to freshwater: 63 g/1 (25	^{wi} %)
Air:	
Treatment of stack air emission by wet scrubbe	
Efficiency 99%	
Release factor after on-site treatment: 80 g/T (max)
Organizational measures to prevent/limit re	lease from site
None	
Conditions and measures related to munici	pal sewage treatment plant
Municipal Sewage Treatment Plant (STP)	Yes
Discharge rate of the Municipal STP	2000 m³/d (default)
Incineration of the sludge of the Municipal	No. oludro is applied to agricultural soil
STP	no – sludge is applied to agricultural soli
Conditions and measures related to externa	al treatment of waste for disposal
Ni bearing waste shall be recovered or recycle	d if possible. Ni bearing waste shall be considered hazardous if the Ni content
is above the generic cutoffs (for mixtures) as si	tated in regulation (EC) No. 1272/2008. Ni bearing waste mixtures may be
assessed as substances according to regulation	on (EC) No. 1272/2008 criteria. Disposal of Ni bearing waste shall comply with
local, state or national waste legislation and re-	mains the responsibility of the waste treatment operator.
Conditions and measures related to externa	al recovery of waste
Not applicable	
2.2 Control of workers exposure for contrib	uting exposure scenario ES 4.1
Operations involving dry salts	
Workers related free short title	Metal surface treatment – nickel electroplating, nickel electroforming and
	electroless nickel plating
	PROC 5: Mixing or blending in batch processes for formulation of
	preparations and articles (multistage and/or significant contact)
	PROC 8a: Transfer of substance or preparation (charging/discharging)
Use descriptor covered	from/to vessels/large containers at non-dedicated facilities
	PROC 8b: Transfer of substance or preparation (charging/discharging
	from/to vessels/large containers at dedicated facilities
	PROC 13: Treatment of articles by dipping and pouring
	PROC 0: Cleaning and maintenance
	Raw material handling
Processes, tasks, activities covered	Preparation of Ni sulphate solution
	Cleaning and maintenance
Assessment Method	Estimation of exposure based on measured data and a Tier 1 model
Product characteristic	
Ni sulphate: Dry powder of approximately 100	% or solution of 25-50%
Amounts used	
Not relevant	
Frequency and duration of use/exposure	
Addition of NI suppate to tank ranging from on	ce per snift to once every 2 or 3 weeks
Human factors not influenced by risk mana	gement
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	Not relevant			
use Body weight	Not relevant				
Other given operational conditions affecting	workers exp				
Ni sulphate is supplied and handled in dry form	Ambient temp	erature and humidity should apply. Maintain clean workplace			
to prevent accumulation of powders and dusts	on surfaces I le	erature and numberly should apply. Maintain clean workplace			
material or accumulations of dust within the wo	rk aroa				
Oral: Good workplace bygiene practice					
Technical conditions and measures at proce	ass laval (sour	rce) to prevent release			
Automation and enclosure of processes where	nossihle				
Technical conditions and measures to contr	rol dispersion	from source towards the worker			
I EV is required for operations involving handling	na nowder in on	en workspace such as rinning and tinning sacks, weighing			
mixing adding powders to solution		en workspace sach as hpping and tipping sacks, weighing,			
Organisational measures to prevent /limit re	leases disner	sion and exposure			
None					
Conditions and measures related to person	al protection	avgiene and health evaluation			
Inhalation: Use of RPF (EP3: APF = 20) is requ	ired for cleanin	a and maintenance operations involving dusts and powders			
Dermal: Gloves and other suitable protective cl	othing are regu	ired to minimise dermal contact with powder			
2.3 Control of workers exposure for contribution	uting exposure	a scenario FS 4 2			
Operations with salt solutions	uting exposure	5 SCCHUID ED 4.2			
operations with salt solutions	Motal surface t	reatment – nickel electronlating, nickel electroforming and			
Workers related free short title	electroless nick	cel plating			
	PROC 8a: Tran	nsfer of substance or preparation (charging/discharging)			
	from/to vessels	/large containers at non-dedicated facilities			
	PROC 8b. Trai	nsfer of substance or preparation (charging/discharing from/to			
Use descriptor covered	vessels/large c	ontainers at dedicated facilities			
	PROC 13: Treatment of articles by dinning and nouring				
	PROC 15: Use	15: Use as laboratory reagent			
	PROC 0: Clear	ning and maintenance			
	Addition Ni suli	phate to tank			
	Dipping of item	s to be coated			
	Removal of coa	ated items			
Processes, tasks, activities covered	Rinsing of coat	ed items			
	Removal of spe	ent solution/rinse water from tank			
	Wastewater ha	nandling – rinse water			
	Cleaning and n	naintenance			
Assessment Method	Estimation of e	xposure based on measured data			
Product characteristic					
Ni sulphate: Solution of 25-50%					
Amounts used					
Not relevant					
Frequency and duration of use/exposure					
8 hour shifts					
Human factors not influenced by risk manage	gement				
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	Not relevant			
use					
Body weight		Not relevant			
Other given operational conditions affecting workers exposure					
Ni sulphate is added to the plating bath in solution. Plating process involves immersion of piece into plating tank followed by					
immersion of piece into rinse tanks. Temperature of plating baths is typically 25-75°C.					
Plating bath is agitated by bubbling air through the electrolyte solution to ensure even availability of Ni salt to piece being					
plated.					
Maintain a clean workplace.					
Oral: Good workplace hygiene practice					
Lechnical conditions and measures at proc	ess level (sour	ce) to prevent release			
Automation and enclosure of processes should	be used where	possible			

Plating is either manual, semi-automated or automated:

Manual plating - parts are placed on racks or hangers and manually transferred from tank to tank

Semi-automated plating - parts are manually loaded on to jigs that are moved between the baths using an overhead hoist Automated plating – as semi-automated process except jigs moved electronically

If no LEV, automation and enclosure of the following processes: Addition of solutions to plating tanks, dipping and removal of pieces to be plated (plating and rinsing tanks) are required (fluids may directly pumped in and out of tanks, dipping process may be entirely automated and enclosed)

Tank should be covered if not enclosed (e.g. by use of floating cover). Storage vessels used for electroplating solutions should be capped.

Technical conditions and measures to control dispersion from source towards the worker

LEV is required for operations where mists may be created including addition of solutions to plating tanks, dipping and removal of pieces to be plated (plating and rinsing tanks)

Organisational measures to prevent /limit releases, dispersion and exposure

None

Conditions and measures related to personal protection, hygiene and health evaluation

Inhalation: Use of RPE is required for cleaning and maintenance operations.

Dermal: Gloves and other suitable protective clothing are required to minimise dermal contact with solution (acid resistant) 3. Exposure and risk estimation

Environment

ERC 5:

Metal surface treatment – nickel electroplating, nickel electroforming and electroless nickel plating

			,				
Compartment	Unit	PNEC	PECRegional	Clocal	PEC	RCR	Methods for calculation of
							environmental concentrations
Freshwater	µg Ni/L	3.55	2.9	0.14	3.04	0.86	Measured values, Tier 3-RWC
ES 1							
Freshwater	µg Ni/L	3.55	2.9	0.22	3.12	0.88	
ES 2							
Freshwater	µg Ni/L	3.55	2.9	0.44	3.34	0.94	
ES 3							
Marine	µg Ni/L	8.6	0.3	6.43	6.73	0.78	
Terrestrial	mg Ni/kg	29.9	16.2	9.56	25.76	0.86	
ES 2 - sludge							
application							
Terrestrial	mg Ni/kg	29.9	16.2	0.01	16.21	0.54	
ES 2 – no							
sludge							
application							
STP ES 1	mg Ni/kg	0.33	-	-	0.01	0.04	
STP ES 2	mg Ni/kg	0.33	-	-	0.306	0.926	

Workers ES 4.1

PROC 5, 8a, 8b, 13, 0: Operations involving dry salts

	0,				
	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/cm²/day	0.00044	0.00003	0.068	Exposure estimated using MEASE for PROC 8a (> 25% concentration, non- direct handling, intermittent exposure for 60-240 minutes, and

					use of gloves)
					V /
Inhalation					
Acute systemic	mg Ni/m ³	16	0.5	0.031	Estimated 75 th
Acute local	mg Ni/m ³	0.7	0.5	0.714	percentile short term
				excl.	exposure for handling of
				RPE	dry NiSO4 powder with
				_	LEV in place
				By use	
				(P3, ADE 20):	
				AFF 20). 0.00	
Long-term systemic	ma Ni/m ³	0.05	0.033	0.09	Exposure estimated
and local	ing N/m	0.00	0.000	0.00	using MEASE for PROC
					8a (>25% concentration.
					solid, medium
					dustiness, Use of LEV,
					RPE (APE 20))
ES 4.2					
PROC 8a, 8b, 13, 15, PROC 0: O	perations with salt	solutions	· -		
	Unit	DNEL	Exposure	RCR	Methods for calculation
Descal			concentration		of exposure
Dermai	ma Nilka/day				
Acute systemic	mg Ni/kg/day	-			
	mg Ni/kg/day	-			
	mg Ni/rg/day	-	7x10-5	0.16	Estimated 75th
Long-term local	ing Ni/citi /day	0.00044	1710	0.10	percentile exposure to
					soluble nickel
					associated with
					electroplating based on
					the EU RAR (2008-
					2009). Assumes
					suitable protective
					clothing employed
Inholation					
	ma Ni/m3	16	0.06	0.004	2 x the estimated 75th
Acute systemic	mg Ni/m ³	10	0.06	0.004	5 X the estimated 75"
Acute local	ing M/m	0.7	0.00	0.000	airborne soluble Ni
Long-term systemic	ma Ni/m ³	0.05	0.02	04	Estimated 75th
and local	ing tuin	0.00	0.02	0.1	percentile exposure to
					airborne soluble Ni
					assuming manual
					plating process with
					effective LEV in place
NR: Not Relevant					
Acute local inhalation	Fault rate at the bart	hin fac - 4 -			2 fold high or
based on respirable size aerosols	. ⊏quivalent innala	DIE TRACTION	ievels expected t	u de at least	s-iola nigher

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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.3.2.1 Summary of secondary poisoning exposure and risk characterisation assessments for metal surface treatment

The methodology applied to assess secondary poisoning is extracted from the European Union Risk Assessment for Nickel (2008/2009). A detailed report on the methodology used to derive the PNEC_{oral} and bioaccumulation factors (BAF) are provided in <u>Appendix D3</u>.

Selected exposure scenario (ES)	PEC _{local} water (mg/L)	PEC _{regional} water (mg/L)	PEC _{oral} mollusk (mg/kg wet mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1	PEC/PNEC Aquatic mammal (European Otter) PNEC=2.3 mg/kg; RAF=0.025
ES 1: df=10	0.0030	0.0029	0.79	0.07	0.01
ES 2: df=100	0.0030	0.0029	0.80	0.07	0.01
ES 3: df=1000	0.0032	0.0029	0.82	0.07	0.01

Table 91. Freshwater aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (European Otter)

Table 92. Marine aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (Harbor seal). Two scenarios are assumed: C. edule present and C. edule absent.

PEC _{local} water	PEC _{regional} water (mg/L)	PEC _{oral} (mg/kg we	mollusk et mollusk)	PEC/ Aquat (Oyster PNEC=12 RA	PNEC ic bird catcher) 2.3 mg/kg; F=1	PEC/PNEC Aquatic mammal (Harbor seal) PNEC=4.6 mg/kg; RAF=0.025	
(mg/L)		<i>C. edule</i> present BAF=1631 L/kg	<i>C.edule</i> absent BAF= 270 L/kg	<i>C.edule</i> present BAF=1631 L/kg	<i>C.edule</i> absent BAF=270 L/kg	<i>C.edule</i> present BAF=1631 L/kg	<i>C.edule</i> absent BAF=270 L/kg
0.0042	0.0003	3.65	0.60	0.3	0.05	0.02	0.007

Selected exposure scenarios	PEC in soil compartment (mg/kg)	PEColoca Regional soil Tissue background gut concentration 100% (mg/kg) worm (mg/k		PEC _{oral} local Tissue + gut 30% worms 70% isopods (mg/kg ww)	PEC/PNEC Birds (starling) PNEC=8.5 mg/kg RAF=1	PEC/PNEC Mammals (shrew) 100% worms PNEC=0.12 mg/kg RAF=0.036	PEC/PNEC Mammals (shrew) 30% worms 70% isopods PNEC=0.12 mg/kg RAF=0.025
ES 1: sludge application	25.76	16.20	3.11	1.27	0.37	0.93	0.26
ES 2: no sludge application	16.2	16.2	2.4	0.98	0.28	0.72	0.20

Table 93. Terrestrial food chain: concentration, PECoral and risk characterisation for worm-eating birds and mammals

9.3.2.2 Summary of porewater concentrations in the soil compartment for metal surface treatment

The derived $PEC_{porewater}$ for the generic scenario is 0.03 mg Ni/L. More details for the calculation of the $PEC_{porewater}$ are provided in <u>Appendix D3</u>.

Table 94. Predicted Exposure Concentrations (PEC) in porewater

PEC _{local porewater} (mg/L)
0.04

9.3.2.3 Summary of atmospheric compartment for metal surface treatment

An overview of the local air concentrations and PEC in the air compartment are provided in the assessment for Man via the Environment below or <u>Appendix D5</u>.

9.3.2.4 Summary of exposure concentrations in on site waste water treatment plants (WWTP) for metal surface treatment

Table 95 reports the calculated Ni concentrations in the effluent of the on-site WWTP (see Appendix D3

Selected exposure scenarios	Calculated effluent concentration in on-site WWTP (mg/L)
ES 1: freshwater STP-df - 10	0.04
ES 2: freshwater STP-df - 100	5.66
ES 3: freshwater STP-df - 1000	0.01
ES marine	0.90

Table 95. Concentrations in on-site waste water treatment plant

9.3.2.5 Summary of Man via Environment exposure and risk characterisation assessments for metal surface treatment

For each sector, an overview of the range of operational conditions (OCs) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared

to 11.5 ng Ni/m³ or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m³. An assessment of predicted level of compliance for this sector based on site-specific measured or predicted exposures is provided in Section 5 of <u>Appendix D5</u>.

Table 96. Sector overview

	tonnage (T Ni/year)	daily emissions to air (kg Ni/d)	release factor to air (g Ni/T)	Emission days to air per site (d/y)	C _{local} , air* (ng Ni/m³)	PEC air ^{\$} (ng Ni/m³)
min	4	<0.01	15	220	<1	9
max	1500	0.24	4000	336	43	52
median	14	0.08	2032	235	12	12

*: based on EUSES air model

S: based on C_{local} predicted + regional background depending on available information. For two companies calculations were based on a SPERC with a release factor of 4000 g/T.

9.3.3 GES 5: PRODUCTION OF BATTERIES

1. Title					
GES 5 Production of batteries using electrodes	s with nickel containing active materials				
	Intermediate use – DU of NISO4				
Free short title	Production of batteries				
Systematic title based on use descriptor	 SU: SU 3 Industrial use PC: PC 19 – intermediate use ERC: ERC5 Industrial use resulting in inclusion into or onto a matrix PROC: PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 14: Production of preparations or articles by tabletting, compression, extrusion, pelletisation PROC 26: Handling of inorganic substances at ambient temperature PROC 0 : Cleaning and maintenance 				
Processes, tasks, activities covered (environment)	Production of batteries using electrodes with nickel containing active materials				
Processes, tasks, activities covered (workers)	CES 5.1: PROC 4 & 8b: Raw materials handling CES 5.2: PROC 4 & 8b: Manufacture of NiSO ₄ solution CES 5.3: PROC 4, 8b, 9, 14 & 26: Manufacture of positive {Ni(OH) ₂ based} active mass CES 5.4: PROC 4, 8b, 9 & 26: Manufacture of negative {(Cd(OH) ₂ doped with Ni(OH) ₂ based activie mass} CES 5.5: PROC 14 & PROC 21: Manufacture of pocket plate electrodes CES 5.6: PROC 4, 8b, & 26: Nickel electroplating {maintenance of NiSO ₄ electroplating solution & manufacture of electrode strip by nickel plating a steel strip} CES 5.7: PROC 0: Cleaning and maintenance *CES: Contributing Exposure Scenario				
2. Operational conditions and risk management measures					
2.1 Control of environmental exposure					
Environmental related free short title	Production of batteries using positive nickel electrodes				
Systematic title based on use descriptor (environment)	ERC5: Industrial use resulting in inclusion into or onto a matrix				

Processes, tasks, activities covered (environment)	Production of batteries using electrodes with nickel containing active materials				
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used				
Product characteristics					
NiSO ₄ solution and NiSO ₄ 6H ₂ O powder					
Amounts used					
Maximum daily use at a site	2.9 tonnes/day (median 50th % emission days, max tonnage)				
Maximum annual use at a site	796 tonnes (max. 2007)				
Frequency and duration of use					
Pattern of release to the environment	276 days per year (median 50 th %)				
Environment factors not influenced by risk	management				
Receiving surface water flow rate	2xE6 m ³ /d				
Dilution capacity, freshwater	1000 (max)				
Dilution capacity, marine	100 (default)				
Other given operational conditions affecting	g environmental exposure				
None					
Technical conditions and measures at proc	ess level (source) to prevent release				
None					
Technical onsite conditions and measures	to reduce or limit discharges, air emissions and releases to soil				
Waste water:					
On-site waste water treatment in a physico-che	emical treatment plant by chemical precipitation or one of the following				
measures: Sedimentation, Filtration, Electrolys	is, Reverse osmosis, or ion exchange.				
Release factor after on-site treatment: To fresh	water and marine water: 42.7 g/1				
Air					
Treatment in exhaust system (fabric or bag filte	ars electrostatic precipitation ceramic filters wet dry or semi-dry scrubbers)				
Efficiency 99% removal					
Release factor after on-site treatment: 25.4 g/T					
Organizational measures to prevent/limit re	lease from site				
None					
Conditions and measures related to munici	pal sewage treatment plant				
Municipal Sewage Treatment Plant (STP)	No				
Discharge rate of the Municipal STP	Not relevant				
Incineration of the sludge of the Municipal STP	Not relevant				
Conditions and measures related to externa	al treatment of waste for disposal				
Ni bearing waste shall be recovered or recycle	d if possible. Ni bearing waste shall be considered hazardous if the Ni content				
is above the generic cutoffs (for mixtures) as s	tated in regulation (EC) No. 1272/2008. Ni bearing waste mixtures may be				
assessed as substances according to regulation	on (EC) No. 1272/2008 criteria. Disposal of Ni bearing waste shall comply with				
local, state or national waste legislation and re	mains the responsibility of the waste treatment operator.				
Conditions and measures related to externa	al recovery of waste				
Not applicable					
2.2 Control of workers exposure for contributing exposure scenario ES 5.1					
Raw material handling					
Workers related free short title	Production of batteries				
	PROC 4: Use in batch and other process (synthesis) where opportunity for				
Use descriptor covered	PROC 9b; Transfer of substance or propagation (sharsing/dispharsing)				
	from/to vessels/large containers at dedicated facilities				
	Inhanging NiSO(6H ₂ O) involves receiving opening and emptying of bass of				
Processes, tasks, activities covered	NISO46H2O				
	Estimation of inhalation exposure based on measured data				
Assessment Method	Estimation of dermal exposure based on Tier 1 model.				
Product characteristic					
Nickel sulphate powder, NiSO ₄ 6H ₂ O					
Nickel sulphate powder, NiSO ₄ 6H ₂ O Amounts used					
Nickel sulphate powder, NiSO ₄ 6H ₂ O Amounts used Not relevant					

Frequency and duration of use/expos	sure					
Unbagging 20 kg of NiSO46H2O takes b	between 10 and 20 minutes once	e per month.				
Human factors not influenced by risk	c management					
Respiration volume under conditions of	use	Not relevant				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance	e under conditions of use	480 cm ²				
Body weight		Not relevant				
Other given operational conditions a	ffecting workers exposure					
NiSO ₄ 6H ₂ O is delivered in bags which a	are (manually) hooked onto a co	nveyer system which transports it to the ventilated				
'slicing post' where the bag is opened n	nanually and the contents poure	d into a vessel or holding container.				
Apply ambient temperature and humidit	ty.					
Maintenance of clean workplace to prev	vent accumulation of powders a	nd dusts on surfaces.				
Handling procedures should be designed	ed to eliminate requirement for d	lermal contact.				
Oral: Good workplace hygiene practice						
Technical conditions and measures	at process level (source) to pr	event release				
Inhalation: Automation with some manu	al intervention (lifting and secur	ing bags of NiSO ₄ 6H ₂ O) but not complete enclosure				
of transfer operations are likely to give i	rise to significant exposures to ir	nhalable NiSO46H2O				
Dermal: Automation of processes shoul	d be used where possible to elin	ninate dermal contact.				
Technical conditions and measures	to control dispersion from sou	urce towards the worker				
LEV is required for processes that are r	not fully enclosed or processes I	kely to give rise to NiSO46H2O dust				
Organisational measures to prevent	/limit releases, dispersion and	l exposure				
None						
Conditions and measures related to	personal protection, hygiene	and health evaluation				
Inhalation: Use of RPE is required when	re exposure to NiSO ₄ 6H ₂ O aero	sol and dust is possible, required for example where				
process steps are not fully enclosed.						
Dermal: Gloves suitable for handling po	owders and other suitable protect	tive clothing are required where direct contact with				
NiSO ₄ 6H ₂ O could occur						
2.3 Control of workers exposure for o	contributing exposure scenar	io ES 5.2				
Manufacture of the NISO4 solution						
Workers related free short title	Production of batteries					
	PROC 4: Use in batch and othe	er process (synthesis) where opportunity for exposure				
Use descriptor covered						
·	PROC 80: Transfer of substand	e or preparation (cnarging/discnarging) from/to				
	vessels/large containers at ded	ICATED TACILITIES				
Processes, tasks, activities covered	Filtering and pumping the solution b	y dissolving nickel briquettes in sulphunc acid and				
	Estimation of inholation evenes					
Assessment Method	Estimation of innalation exposu	henned on Tier 1 medel				
Product characteristic	Estimation of dermal exposure					
NiSO, solution						
Amounts used						
Not relevant						
Frequency and duration of use/experience	SURO					
Prequency and duration of use/expos	sure					
o nour sint Uluman factore not influenced by rick management						
Reastration volume under conditions of		Net relevant				
Respiration volume under conditions of	use	Not relevant				
Room size and ventilation rate	under conditions of use					
Area of skin contact with the substance under conditions of use 480 cm ²						
Douy weight [Not relevant]						
Other given operational conditions affecting workers exposure						
Information of clean workplace to prevent accumulation of powders and dusts on surfaces.						
nanuning procedures should be designed to enminate requirement for dermal contact.						
Ural: Good workplace hygiene practice						
Internition: Complete anglesure of mixin	at process lever (source) to pr	event release				
inhalation. Complete enclosure of MIXIN	iy and transfer operations are u	nikely to give rise to significant exposures to				
Dermal: Automation of processos should	d ha usad where possible to ali	minate dermal contact				
Technical conditions and massures	to control disporsion from co-	innate definial contact.				
LEV is required for processes that are	to control dispersion from sol	ince towards the worker				
LEV is required for processes that are not fully enclosed or processes likely to give rise to NISO4 mists						

Organisational measures to prevent /limit	releases, dispersion and	exposure			
None	and wate stice busiess	and bealth avaluation			
Conditions and measures related to perso	onal protection, nyglene a	and nealth evaluation			
Innalation: Use of RPE is required where exp	posure to NISO4 aerosol an	a mist is possible.			
2.4 Control of workers exposure for control	ibuting experies contact wi				
2.4 Control of workers exposure for control	ive mass	0 ES 5.3			
Manufacture of positive {Ni(OH)2 based} act	Dreduction of bottorion				
workers related nee short the	PROC 4: Lies in betch and	other process (ounthesis) where experturity for			
	ovnosuro prisos	other process (synthesis) where opportunity for			
	PROC 8h. Transfer of sub	stance or preparation (charging/discharging) from/to			
vessels/large containers at dedicated facilities					
Use descriptor covered	PROC 9. Transfer of subst	ance or preparation into small containers (dedicated			
	filling line including weight	na)			
	PROC 14 [·] Production of pr	reparations or articles by tabletting, compression			
	extrusion, pelletisation				
	PROC 26: Handling of inor	ganic substances at ambient temperature			
	NiSO ₄ solution is mixed with	th caustic soda or sodium carbonate in order to			
Processes, tasks, activities covered	precipitate Ni(OH) ₂ which is	s mixed with other ingredients to make a positive			
, ,	active mass material for use in electrode production.				
Assessment Mathad	Estimation of inhalation ex	posure based on measured data.			
Assessment Method	Estimation of dermal expos	sure based on Tier 1 model.			
Product characteristic					
NiSO ₄ solution {and Ni(OH) ₂ }					
Amounts used					
Not relevant					
Frequency and duration of use/exposure					
8 hour shifts					
Human factors not influenced by risk mar	nagement				
Respiration volume under conditions of use	-	Not relevant			
Room size and ventilation rate		Not relevant			
Area of skin contact with the substance und	er conditions of use	480 cm ²			
Body weight		Not relevant			
Other given operational conditions affect	ing workers exposure				
A dry powder mass which is fed/pressed into	tablet/briquettes and may	be sealed inside strips to form into pocket plates is			
largely Ni(OH)2 but may contain some residu	ial NiSO4.				
Maintenance of clean workplace to prevent a	accumulation of powders ar	nd dusts on surfaces.			
Handling procedures should be designed to	eliminate requirement for d	ermal contact.			
Oral: Good workplace hygiene practice					
Technical conditions and measures at pro	ocess level (source) to pr	event release			
Inhalation: Partly enclosed operations are lik	ely to give rise to significan	t exposures to inhalable Ni(OH) ₂ or likely to generate			
Ni-containing mists or dust. However, the like	elihood of these aerosols c	ontaining and giving rise to significant NISO4			
exposure is low.					
Reduced pressure in the production systems	s can be used to reduce exp	posure.			
Dermai: Automation of processes should be used where possible to eliminate dermal contact.					
recrinical conditions and measures to control dispersion from source towards the worker					
Creaniantianal managuran to provent limit relaces a dispersion and expressure.					
Organisational measures to prevent /ilmit releases, dispersion and exposure					
Segregation of workers in a control room from where they run the operation on the factory floor.					
Inhalation: Lise of PDE is required where or	and protection, hygiene a	d mist is possible			
Initial on. Use of RPE is required where exposure to NISU4 acrosol and mist is possible.					
2.5 Control of workers exposure for contributing exposure scenario ES.5.4					
Manufacture of negative (Cd(OH)2 doned wi	th Ni(OH)2 based) active m				
Workers related free short title	Production of hatteria	s			
	PROC 4. Lies in hatel	and other process (synthesis) where opportunity for			
	exposure arises	and early proceed (syntholis) where opportunity for			
Use descriptor covered	PROC 8b: Transfer of	substance or preparation (charging/discharging)			
from/to vessels/large containers at dedicated facilities					

	PROC 9: Transfer of substance or preparation into small containers					
	(dedicated filling line, includin	g weighing)				
	PROC 26: Handling of inorga	nic substances at ambient temperature				
Processes, tasks, activities covered	NiSO ₄ solution is mixed with (CdO and the mixture treated to give a				
	Estimation of inholation even	for use in electrode production.				
Assessment Method	Estimation of dermal exposur	e based on Tier 1 model.				
Workers related free short title						
Product characteristic						
NiSO ₄ solution						
Amounts used						
Not relevant						
Frequency and duration of use/exposure						
8 hour shifts						
Human factors not influenced by risk manage	ement					
Respiration volume under conditions of use		Not relevant				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance under c	onditions of use	480 cm ²				
Body weight		Not relevant				
Other given operational conditions affecting	workers exposure					
A Cd(OH) ₂ based negative active mass may cor	tain traces of unreacted NiSO4	which is used to make the Ni(OH) ₂				
component of the negative active mass.						
Maintenance of clean workplace to prevent accu	imulation of powders and dusts	on surfaces.				
Handling procedures should be designed to elim	inate requirement for dermal c	ontact.				
Oral: Good workplace hygiene practice						
Technical conditions and measures at proce	ss level (source) to prevent re	elease				
Inhalation: Partly enclosed operations are likely	to give rise to some exposures	to inhalable Ni(OH) ₂ or likely to generate Ni-				
containing mists or dusts arising from unreacted	NiSO4. However, the likelihood	of these aerosols containing and giving rise				
to significant NISO4 exposure is low.						
Reduced pressure in the production systems cal	n be used to reduce exposure.	armal contest				
Dermal: Automation of processes should be use	d where possible to eliminate d	ermai contact.				
Lechnical conditions and measures to control	of dispersion from source tov	and processes				
LEV is required for processes that are not fully e						
Organisational measures to prevent /infinit rei	bare they run the operation on	ure the factory floor				
Conditions and measures related to persona	I protection, bygione and bea	Ith evaluation				
Inhalation: Use of RPF is required where expose	re to NiSO4 aerosol and mist is	nossible				
Dermal: Waterproof acid resistant doves are rec	uired where contact with NiSO	solution occurs				
2.6 Control of workers exposure for contribu	ting exposure scenario ES 5	5				
Manufacture of electrodes as nocket plate elect	rodes					
Workers related free short title	Production from Ni(OH) ₂ of batte	ries using nickel electrodes				
F	PROC 14 [·] Production of prepar	ations or articles by tabletting compression				
	extrusion, pelletisation					
Use descriptor covered	PROC 21: Low energy manipula	tion of substances bound in materials and/or				
a	rticles					
Processes, tasks, activities covered F	Preparing 'electrode' strips and	ablets				
Assessment Method	lot Relevant (Ni sulphate not pi	esent)				
Product characteristic		· · · · · · · · · · · · · · · · · · ·				
Ni as Ni(OH) ₂ electrodes						
Amounts used						
Not relevant						
Frequency and duration of use/exposure						
8 hour shifts						
Human factors not influenced by risk manage	ement					
Respiration volume under conditions of use Not relevant						
Room size and ventilation rate	Not rele	evant				
Area of skin contact with the substance under c	onditions of use Not rele	evant				
Body weight	Not rele	Not relevant				
Other given operational conditions affecting workers exposure						

Maintenance of a clean workplace is used to prevent accumulation of powders and dusts on surfaces. Oral: Good workplace hygiene practice Technical conditions and measures at process level (source) to prevent release Inhalation: Partly enclosed operations are likely to give rise to significant exposures to inhalable Ni(OH)2 or likely to generate Ni-containing mists or dust. Reduced pressure in or enclosure of the production systems can be used to reduce exposure. Dermal: Automation of processes should be used where possible to eliminate dermal contact. Technical conditions and measures to control dispersion from source towards the worker LEV is required for processes that are not fully enclosed or operated under reduced pressure. Organisational measures to prevent /limit releases, dispersion and exposure Segregation of workers in a control room from where they can run the operation on the factory floor. Conditions and measures related to personal protection, hygiene and health evaluation Inhalation: RPE (FFP3) {approved with regard to EN 149} is required for not fully enclosed processes. Dermal: Gloves suitable for handling powders and other suitable protective clothing are required where direct contact with Ni(OH)₂ could occur. 2.5 Control of workers exposure for contributing exposure scenario ES 5.6 Nickel electroplating {maintenance of NiSO4 electroplating solution & manufacture of electrode strip by nickel plating a steel strip} Production of batteries Workers related free short title PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8b: Transfer of substance or preparation (charging/discharging) Use descriptor covered from/to vessels/large containers at dedicated facilities PROC 26: Handling of inorganic substances at ambient temperature Nickel electroplating of strips and of other 'jigged' items using a NiSO4 rich Processes, tasks, activities covered solution Estimation of inhalation exposure based on measured data. Assessment Method Estimation of dermal exposure based on Tier 1 model. Product characteristic NiSO₄ solution and NiSO₄6H₂O powder (and Ni plated strips) Amounts used Not relevant Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk management Respiration volume under conditions of use Not relevant Room size and ventilation rate Not relevant Area of skin contact with the substance under conditions 480 cm² of use Body weight Not relevant Other given operational conditions affecting workers exposure Maintenance of clean workplace to prevent accumulation of powders and dusts on surfaces. Handling procedures should be designed to eliminate requirement for dermal contact. Oral: Good workplace hygiene practice Technical conditions and measures at process level (source) to prevent release Inhalation: Automation and enclosure of strip plating with some manual intervention (topping up NiSO4 solution with NiSO4 6H₂O and jigging work pieces for bath electroplating) are likely to give rise to some exposures to inhalable NiSO₄ mist and NiSO₄ 6H₂O dust Dermal: Automation of processes should be used where possible to eliminate dermal contact. Technical conditions and measures to control dispersion from source towards the worker LEV is required for processes that are not fully enclosed or processes likely to give rise to NiSO4 mists or dusts Organisational measures to prevent /limit releases, dispersion and exposure None Conditions and measures related to personal protection, hygiene and health evaluation Inhalation: Use of RPE and/ or face visor is required where exposure to NiSO4 aerosol, mist and splashes is possible. Dermal: Waterproof acid resistant gloves are required where contact with NiSO4 solution occurs. Other given operational conditions affecting workers exposure Maintenance of clean workplace to prevent accumulation of powders and dusts on surfaces. Handling procedures should be designed to eliminate requirement for dermal contact.

Oral: Good workplace hygiene practice										
Technical condi	tions and n	neasures at	process	s leve	el (sou	irce) to	o prevent	release		
Inhalation: Autor	nation and er	nclosure of s	strip plati	ng ar	e unlik	ely to g	give rise to	o exposur	es to	inhalable NiSO4 mist and NiSO4
6H ₂ O dust excep	t where mar	ual interven	tion is re	quire	d for s	ome el	ements of	f the task	e.g.	topping up NiSO ₄ solution with
NiSO ₄ 6H ₂ O and	jigging work	pieces for b	ath elect	ropla	ting.					
Dermal: Automat	ion of proces	sses should	be used	wher	e pos	sible to	eliminate	dermal co	ontac	ot.
2.6 Control of w	orkers expo	osure for co	ntributi	ng ex	cposu	re scer	nario ES (5.7		
PROC 0 : Cleani	ng and main	tenance								
Workers related	free short	title	Pro	oduct	tion of	batterie	es			
Use descriptor of	covered		PR	0C (): clea	ning ar	nd mainter	nance		
Processes, task	s, activities	covered	Cle	eanin	g and	mainte	nance of	plant and	pren	nises
	<u>,</u>		Es	timat	ion of	inhalati	on exposi	ure based	on i	neasured data.
Assessment Me	thod		Es	timat	ion of	dermal	exposure	based or	n Tie	r 1 model.
Product charact	eristic						•			
NiSO ₄ solution ar	nd NiSO₄6H	>O dust								
Amounts used										
Not relevant										
Frequency and	duration of	uselexnosu	ire							
4 hour duration w	vithin an 8 hr	our shifts								
Human factors	num an one	od by rick n	nanador	nont						
Pesniration volum	no under co	nditions of us	nanayer	nem			Not role	ant		
Respiration volui	ontilation rat		50				Not rolo	vant		
Area of akin oon	toot with the	eubetenee i	ndor oor	aditio	no of i	100		vanit		
Area or skin con	lact with the	Substance u		Iuliu		156	900 CIII2	(ant		
Body weight		aditions off					NOL TEIE	Vant		
Other given ope	rational col	naitions atte	ecting w	orke	rs exp	osure				
Maintenance of c	lean workpla	ace to preve	nt accum	nulatio	on of p	powders	s and dus	ts on surfa	aces	
Handling procedu	ires should l	be designed	to elimin	nate r	equire	ment fo	or dermal	contact.		
Oral: Good workp	blace hygien	e practice			.,					
Technical condi	tions and n	neasures at	process	sleve	el (sou	irce) to	prevent	release		
General ventilation	on provision	to the premi	ses							-
Technical condi	tions and m	neasures to	control	disp	ersior	n from	source to	wards th	e wo	orker
None										
Organisational I	neasures to	o prevent /li	mit relea	ases,	dispe	ersion	and expo	sure		
None										
Conditions and	measures r	elated to pe	ersonal p	orote	ction,	hygiei	ne and he	ealth eval	uati	on
Inhalation: Use o	f RPE is req	uired becaus	se expos	ure to	o NiSC	D4 aero	sol and m	ist is likely	/.	
Dermal: Waterpro	oof acid resis	stant gloves	are requ	ired v	where	contac	t with NiS	O ₄ solutio	n oc	curs.
3. Exposure and	l risk estima	ation								
Environment										
ERC 5										
Production of ba	atteries usin	g positive nic	ckel elec	trode	S					
Compartment	Unit	PNEC	PECRed	jional	Clocal		PEC	RCR	Me	thods for calculation of
'									en	vironmental concentrations
Freshwater	ua Ni/L	3.55	2.9		0.17		3.07	0.86	Me	asured values. Tier 3-RWC
Marine	ua Ni/L	8.6	0.3		1.67		1.97	0.23		····, ····,
Terrestrial	ma Ni/ka	29.9	16.2		0.01		16.3	0.54		
STP	ma Ni/ka	0.33	-		-		-	-	Wa	aste water is not connected to
011	ing Ming	0.00					_		an	STP
									un	011
Workors										
Workers										
	Dow motorio	la handling								
PRUC 4 & 00. I	kaw matena	is nanoling		0						
		Unit		DN	EL	Expo	sure	RCR		Methods for calculation of
						conce	entration			exposure
Dermal										
Acute	systemic	mg Ni/kg	g/day	-		NR				
Acute local mg Ni/cm²/da		m²/day	yNF		NR					

Long-term	mg Ni/kg/day	-	NR					
systemic								
Long-term local	mg Ni/cm²/day	0.00044	0.000003	7x10 ⁻³	90th percentile from MEASE modelling (PROC8b, exposure duration <15 mins, LEV, gloves)			
Inhalation								
Acute systemic	mg Ni/m ³	16	0.082	5.13x 10 ⁻³	The higher of 2 static			
Acute local	mg Ni/m³	0.7	0.082	0.12	exposure values for the unbagging of NiSO ₄ 6H ₂ O. LEV is assumed to be in place			
Long-term	mg Ni/m ³	0.05	Not	Not	This operation is not of long			
systemic and local			applicable	applicable	term duration			
ES 5.2 PROC 4 & 8b: Manufacture of the NiSO4 solution								
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure			
Dermal								
Acute systemic	ma Ni/ka/dav	-	NR					
Acute local	mg Ni/cm²/day	-	NR					
Long-term	mg Ni/kg/day	-	NR					
systemic								
Long-term local	mg Ni/cm²/day	0.00044	0.00003	0.07	90th percentile from MEASE modeling (PROC 4, enclosed, LEV, gloves)			

					enclosed, LEV, gloves)
Inhalation					
Acute systemic	mg Ni/m ³	16	0.066	4.13x10 ⁻³	3 x the long term inhalation
Acute local	mg Ni/m ³	0.7	0.066	0.0943	exposure.
Long-term	mg Ni/m ³	0.05	0.022	0.44	The highest of 3 personal
systemic and local					inhalable nickel exposure
					measurements

ES 5.3

PROC 4, 8b, 9, 14 & 26: Manufacture of positive {Ni(OH)₂ based} active mass

	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	mg Ni/kg/day	-	NR		
systemic					
Long-term local	mg Ni/cm²/day	0.00044	0.00001	0.023	90 th percentile from MEASE modeling (PROC 4, enclosed, segregated workers, gloves)
Inholotion					
Innaiation					
Acute systemic	mg Ni/m ³	16	0.468	0.03	Estimated as 3x the
Acute local	mg Ni/m ³	0.7	0.468	0.67	estimated 75 th percentile long term exposure concentration reported as

				'paste mixing'
mg Ni/m ³	0.05	0.156	3.12 excl RPE ¹ By use of RPE (P3, APF 20): 0.156	The 75 th percentile value for long term exposure measurements reported as 'paste mixing'
acture of negative (고((이머))2 석이	ned with Ni(OH)	based) activ	0 mass
Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
ma Niller/day				
mg Ni/kg/day mg Ni/cm²/day	-	NR		
mg Ni/kg/day	-	NR		
mg Ni/cm²/day	0.00044	0.00001	0.023	90 th percentile from MEASE modeling (PROC 4, enclosed, segregated workers, gloves)
mg Ni/m ³ mg Ni/m ³	16 0.7	0.006	3.75x10-4 8.6x10 ⁻³	Exposure to NiSO4 is not relevant for this activity. Ni is only in the form of Ni Dihydroxide.
mg Ni/m ³	0.05	0.002	0.04	The higher of 2 personal 'inhalable nickel' exposure measurements
e of pocket plate ele	ectrodes			
Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
mg Ni/kg/day	-	NR		
mg Ni/cm²/day mg Ni/kg/day	-	NR		
mg Ni/cm²/day	0.00044	Not Applicable		Exposure to NiSO ₄ is not relevant for this process/activity. Ni is only in the form of Ni dibydrovide
mg Ni/m ³	16	Not Applicable		Exposure to NiSO ₄ is not relevant for this
mg Ni/m ³	16 0.7	Not Applicable Not Applicable		Exposure to NiSO ₄ is not relevant for this process/activity. Ni is only in the form of Ni dihydroxide
	mg Ni/m ³ mg Ni/m ³ acture of negative { Unit mg Ni/kg/day mg Ni/cm ² /day mg Ni/kg/day mg Ni/m ³ mg Ni/m ³	mg Ni/m³ 0.05 acture of negative {Cd(OH)2 do Unit DNEL mg Ni/kg/day - mg Ni/kg/day - mg Ni/kg/day - mg Ni/cm²/day - mg Ni/m³ 16 mg Ni/m³ 0.7 mg Ni/m³ 0.7 mg Ni/m³ 0.05 unit DNEL mg Ni/m³ 0.7 mg Ni/m³ 0.05 unit DNEL mg Ni/m³ 0.05 mg Ni/m³ 0.0054	mg Ni/m³ 0.05 0.156 acture of negative {Cd(OH)2 doped with Ni(OH)2 Unit DNEL Exposure concentration Img Ni/kg/day - NR NR mg Ni/kg/day - NR mg Ni/m³ 0.00044 0.00001 mg Ni/m³ 0.7 0.006 mg Ni/m³ 0.7 0.006 mg Ni/m³ 0.05 0.002 e of pocket plate electrodes Unit DNEL Exposure concentration - mg Ni/kg/day - NR mg Ni/k	mg Ni/m³ 0.05 0.156 3.12 excl RPE1 By use of RPE (P3, APF 20): 0.156 By use of RPE (P3, APF 20): 0.156 acture of negative {Cd(OH)2 doped with Ni(OH)2 based} activ Unit DNEL Exposure concentration RCR mg Ni/kg/day - NR - mg Ni/m³ 0.00044 0.00001 0.023 mg Ni/m³ 0.7 0.006 3.75x10-4 mg Ni/m³ 0.7 0.006 3.6x10-3 mg Ni/m³ 0.05 0.002 0.04

ES 5.6

PROC 4, 8b & 26: Nickel electroplating {maintenance of NiSO4 electroplating solution & manufacture of electrode strip by nickel plating a steel strip}

	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/cm²/day	0.00044	0.00003	0.07	90 th percentile from MEASE modeling (PROC 4, enclosed, LEV, gloves)
Inholotion					
Acute systemic	mg Ni/m ³	16	0.0426	0.003	3 x the long term inhalation
Acute local	mg Ni/m ³	0.7	0.0426	0.061	
Long-term systemic and local	mg Ni/m ³	0.05	0.0142	0.3	The highest of 5 static exposure measurements for nickel electroplating from a NiSO4 rich solution
ES 5.7 PROC 0: Cleaning and main	tenance				
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.000018	4.1x10 ⁻³	90 th percentile from MEASE modeling (PROC 10, 4 h duration, GV, RPE, gloves)
Inholotion					
Acute systemic	mg Ni/m ³	16	1.026	0.002	3 x 75 th percentile personal, inhalable for raw materials handling in analogous process
Acute local	mg Ni/m ³	0.7	1.026	0.26	
Long-term systemic and local	mg Ni/m ³	0.05	0.342 0.017	6.84 0.34 By use of RPE (APF 20)	75 th percentile personal, inhalable for raw materials handling in analogous process

NR: Not relevant

¹ Estimated long term mean exposure concentrations for paste preparation operations are likely to exceed the DNEL and appropriate RPE fitted with a FFP3 filter should be used to reduce operator exposure to less than the DNEL and prevent the risk of respiratory cancer, respiratory toxicity or possible reproductive effects.

Acute local inhalation

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 (Clocal approach). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (Clocal approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.3.3.1 Summary of secondary poisoning exposure and risk characterisation assessments for the production of batteries using positive nickel electrodes

The methodology applied to assess secondary poisoning is extracted from the European Union Risk Assessment for Nickel (2008/2009). A detailed report on the methodology used to derive the PNEC_{oral} and bioaccumulation factors (BAF) are provided in <u>Appendix D3</u>.

Table 97. Freshwater aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (European Otter)

Selected exposure scenario	PEC _{local} water (mg/L)	PEC _{regional} water (mg/L)	PEC _{oral} mollusk (mg/kg wet mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1	PEC/PNEC Aquatic mammal (European Otter) PNEC=2.3 mg/kg; RAF=0.025
ES 1	0.0036	0.0029	0.88	0.07	0.01
ES 2	0.0030	0.0029	0.80	0.07	0.01

Table 98. Marine aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (Harbor seal). Two scenarios are assumed: C. edule present and C. edule absent

PEC _{local} water (mg/L)	PEC _{regional} water (mg/L)	PEC _{oral} mollusk (mg/kg wet mollusk)		PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1		PEC/PNEC Aquatic mammal (Harbor seal) PNEC=4.6 mg/kg; RAF=0.025	
		C. edule present	C.edule absent	C.edule present	<i>C.edule</i> absent	C.edule present	C.edule absent
		BAF=1631	BAF= 270	BAF=1631	BAF=270	BAF=1631	BAF=270
		L/kg	L/kg	L/kg	L/kg	L/kg	L/kg
0.0016	0.0003	0.25	1.52	0.02	0.12	0.001	0.008

Table 99. Terrestrial food chain: concentration, PECoral and risk characterisation for worm-eating birds and mammals

PEC in soil	Regional soil	PEC _{oral} local	PEC _{oral} local	PEC/PNEC	PEC/PNEC	PEC/PNEC
compartment	background	Tissue + gut	Tissue + gut	Birds	Mammals	Mammals
(mg/kg)	concentration	100% worms	30% worms	(starling)	(shrew)	(shrew)

	(mg/kg)	(mg/kg ww)	70% isopods (mg/kg ww)	PNEC=8.5 mg/kg RAF=1	100% worms PNEC=0.12 mg/kg RAF=0.036	30% worms 70% isopods PNEC=0.12 mg/kg RAF=0.025
16.21	16.20	2.4	0.98	0.28	0.72	0.20

9.3.3.2 Summary of porewater concentrations in the soil compartment for the production of batteries using positive nickel electrodes

The derived $PEC_{porewater}$ for the generic scenario is 0.025 mg Ni/L. More details for the calculation of the $PEC_{porewater}$ are provided in <u>Appendix D3</u>.

Table 100. Predicted Exposure Concentrations (PEC) in porewater

PEC _{local porewater} (mg/L)
0.025

9.3.3.3 Summary of the atmospheric compartment for the production of batteries using positive nickel electrodes

An overview of the local air concentrations and PEC in the air compartment are provided in the assessment for Man via the Environment below or <u>Appendix D5</u>.

9.3.3.4 Summary of exposure concentrations in on site waste water treatment plants (WWTP) for the production of batteries using positive nickel electrodes

Table 101 reports the calculated Ni concentration in the effluent of the on-site WWTP (see Appendix D3).

Selected exposure scenarios	Calculated effluent concentration in on-site WWTP (mg/L)
ES 1: freshwater	0.013
ES 2: freshwater	0.23
ES marine	0.23

Table 101. Concentrations in on-site waste water treatment plant

9.3.3.5 Summary of Man via Environment exposure and risk characterisation assessments for production of batteries using positive nickel electrodes

For each sector, an overview of the range of operational conditions (OCs) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared to 11.5 ng Ni/m³ or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m³. An assessment of predicted level of compliance for this sector based on site-specific measured or predicted exposures is provided in Section 5 of <u>Appendix D5</u>.

Table 102. Sector overview

	tonnage (T Ni/year)	daily emissions to air (kg Ni/d)	release factor to air (g Ni/T)	Emission days to air per site (d/y)	C _{local} , air* (ng Ni/m³)	PEC air\$ (ng Ni/m³)
min	175	<0.01	2	247	< 1	1
max	796	0.06	25	360	11	19
median	715	0.04	14	276	7	12

*: based on EUSES air model

s: based on measured values and C_{local} predicted + regional background depending on available information.

9.3.4 GES 6: PRODUCTION OF NICKEL SALTS FROM NICKEL SULPHATE

1. Title						
GES 6 Production of Ni salts from Ni sulphate						
Life cycle	End use - DU of Ni sulphate					
Free short title	Production of Ni salts from Ni sulphate					
	Production of Ni salts to be used in production of catalysts					
	SU: SU9 Manufacture of fine chemicals					
	PC: Not relevant					
	ERC: ERC ba: Industrial use resulting in manufacture of another sub-					
	stance (use of intermediates)					
Systematic title based on use descriptor	PROC: PROC 2: Use in closed, continuous process with occasional					
	controlled exposure					
	PROC 8b: Transfer of substance of preparation (charging/discharging)					
	ITOTI/IO VESSEIS/Iarge containers at dedicated facilities					
	PROC 20. Handling of solid inorganic substances at ambient temperature					
Brassass tasks activities severed						
(environment)	Production of Ni salts from Ni sulphate					
Processes, tasks, activities covered	Raw materials handling, reaction with other chemicals, filtering and drying of					
(workers)	product, packing, cleaning and maintenance					
2. Operational conditions and risk management measures						
2.1 Control of environmental exposure						
Environmental related free short title	Production of Ni salts from Ni sulphate					
Systematic title based on use descriptor	ERC 6a: Industrial use resulting in manufacture of another sub-stance (use					
(environment)	of intermediates)					
Processes, tasks, activities covered (environment)	Production of Ni salts from Ni sulphate					
Environmental Assessment Method	Estimates based on monitoring local and regional concentrations are used for calculation of PEC					
Product characteristics						
Ni sulphate solution: 10-50%, Ni sulphate salt:	100%					
Amounts used						
Maximum daily use at a site	5.36 tonnes/day (median 50th % emission days, 75th % tonnage)					
Maximum annual use at a site	1930 tonnes (75 th %, 2007)					
Frequency and duration of use						
Pattern of release to the environment	360 days per year (median 50 th %)					
Environment factors not influenced by risk management						
Receiving surface water flow rate	2xE6 m³/d					
Dilution capacity, freshwater	1000 (median)					
Dilution capacity, marine	100 (default)					
Other given operational conditions affecting environmental exposure						
Not given						
Technical conditions and measures at process level (source) to prevent release						
Not given						
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil						

Waste water: On site waste water treatment in a physico-chemical plant by chemical precipitation, sedimentation, filteration or a combination of methods.					
Efficiency up to 99.9% Release factor after on-site treatment: To freshwater and marine water: 91.2 g/T (75 th %)					
Air:					
Treatment of air emission in exhaust system with Efficiency 99.9%	ith fabric or bag	filters, ceramic filters or wet scrubbers.			
Release factor after on-site treatment: 59.6 g/T	(75 th %)				
Organizational measures to prevent/limit re	lease from site				
None					
Conditions and measures related to munici	pal sewage tre	atment plant			
Municipal Sewage Treatment Plant (STP)	No				
Discharge rate of the Municipal STP	Not relevant				
Incineration of the sludge of the Municipal STP	Not relevant				
Conditions and measures related to externa	al treatment of	waste for disposal			
Ni bearing waste shall be recovered or recycle	d if possible. Ni	bearing waste shall be considered hazardous if the Ni content			
is above the generic cutoffs (for mixtures) as st	ated in regulation	on (EC) No. 1272/2008. Ni bearing waste mixtures may be			
assessed as substances according to regulation	on (EC) No. 127	2/2008 criteria. Disposal of Ni bearing waste shall comply with			
local, state or national waste legislation and rei	mains the respo	onsibility of the waste treatment operator.			
Conditions and measures related to externa	al recovery of w	vaste			
2.2 Control of Workers exposure					
Workers related free short title	Draduction of N	li calte from Ni culphato			
workers related free short title	PROC 2: Use i	n closed, continuous process with occasional controlled			
Use descriptor covered	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 26: Handling of solid inorganic substances at ambient temperature PROC 0: Cleaning and maintenance				
Processes, tasks, activities covered	Raw materials handling, reaction with other chemicals, filtering and drying of product, packing, cleaning and maintenance				
Assessment Method	Estimation of e	xposure based on measured data			
Product characteristic					
Ni sulphate solution: 10-50%, Ni sulphate salt:	100%				
Amounts used					
Not relevant					
Frequency and duration of use/exposure					
8 hour shifts					
Human factors not influenced by risk mana	gement				
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		Not relevant			
Body weight		Not relevant			
Other given operational conditions affecting workers exposure					
Maintain clean workplace to prevent accumulation of powders and dusts on surfaces. Use of water or vacuum cleaner with HEPA filter to remove dust from workplace during cleaning and maintenance. Oral: Good workplace bygiene practice					
Technical conditions and measures at process level (source) to prevent release					
Processes shall be automated and enclosed. Enclosure of reaction, filtration and drying systems, automation and enclosure of packing dry product is required.					
Technical conditions and measures to control dispersion from source towards the worker					
I EV is required at work stations where dry now	ders are handle	ed			
Organisational measures to prevent /limit re	eleases, disper	rsion and exposure			
None					

Conditions and measures related to personal protection, hygiene and health evaluation

Inhalation: RPE is required for cleaning and maintenance operations and where exposure to dry powders and/or dust and/or spray solution is possible.

Dermal: For contact with Ni sulphate solution, gloves and other appropriate protective clothing suitable for working with aqueous solutions and acids are required.

For dermal contact with dried product, gloves and other suitable protective clothing suitable for handling powders are required

3. Exposure and risk estimation Environment

ERC 6a

Production of Ni salts from Ni sulphate

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<u>n:</u> N

Workers

Production of Ni salts from Ni su	Iphate				
	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/cm²/day	0.00044	0.0004	0.9	Worst case estimate for use of Ni sulphate in chemicals production. Use of gloves and other suitable protective clothing will minimise exposure level.
1.1.1.0					
	ma Ni/m3	16	1.0	0.062	10 x the researchie
Acute Systemic	mg Ni/m ³	10	1.0	0.003	
Acute IOCal	ing w/m-	0.7	1.0	With RPE: 0.07	mean concentration for handling of dry Ni sulphate powders with LEV in place. A factor of 10 takes account of the extreme variability in exposure concentration through time that arises during powder handling operations. Exposures would be 10 x lower for entirely automated

					and enclosed
					handling of powders
Long-term systemic and local	mg Ni/m ³	0.05	0.1	2 With enclosure and automation: 0.2	Reasonable worst case shift mean concentration based on expert judgement and experience in other industrial settings where powders are handled. LEV is assumed rather than enclosure and automation. Exposures would be 10 x lower for entirely automated and enclosed handling of powders

NR: Not Relevant

Acute local inhalation

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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.3.4.1 Summary of secondary poisoning exposure and risk characterisation assessments for the production of nickel salts from nickel sulphate

The methodology applied to assess secondary poisoning is extracted from the European Union Risk Assessment for Nickel (2008/2009). A detailed report on the methodology used to derive the $PNEC_{oral}$ and bioaccumulation factors (BAF) are provided in <u>Appendix D3</u>.
Table 103. Freshwater aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (European Otter)

PEC _{local} water (mg/L)	PEC _{regional} water (mg/L)	PEC _{oral} mollusk (mg/kg wet mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1	PEC/PNEC Aquatic mammal (European Otter) PNEC=2.3 mg/kg; RAF=0.025
0.0031	0.0029	0.81	0.07	0.01

Table 104. Marine aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (Harbor seal). Two scenarios are assumed: C. edule present and C. edule absent

PEC _{local} water (mg/L)	PECregional water	PEC _{oral} (mg/kg we	mollusk et mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1		PEC/PNEC Aquatic mammal (Harbor seal) PNEC=4.6 mg/kg; RAF=0.025	
	(mg/∟)	<i>C. edule</i> present BAF=1631	C.edule absent BAF= 270	C.edule present BAF=1631	C.edule absent BAF=270	C.edule present BAF=1631	<i>C.edule</i> absent BAF=270
		L/kg	L/kg L/kg		L/kg	L/kg	L/kg
0.002	0.0003	1.9	0.31	0.15	0.03	0.01	0.003

Table 105. Terrestrial food chain: concentration, PECoral and risk characterisation for worm-eating birds and mammals

PEC in soil compartment (mg/kg)	Regional soil background concentration (mg/kg)	PEC _{oral} local Tissue + gut 100% worms (mg/kg ww)	PEC _{oral} local Tissue + gut 30% worms 70% isopods (mg/kg ww)	PEC/PNEC Birds (starling) PNEC=8.5 mg/kg RAF=1	PEC/PNEC Mammals (shrew) 100% worms PNEC=0.12 mg/kg RAF=0.036	PEC/PNEC Mammals (shrew) 30% worms 70% isopods PNEC=0.12 mg/kg RAF=0.025
16.24	16.20	2.40	0.98	0.28	0.72	0.20

9.3.4.2 Summary of porewater concentrations in the soil compartment for the production of nickel salts from nickel sulphate

The derived $PEC_{porewater}$ for the generic scenario is 0.03 mg Ni/L. More details for the calculation of the $PEC_{porewater}$ are provided in <u>Appendix D3</u>.

Table 106. Predicted Exposure Concentrations (PEC) in porewater
PEC _{local porewater} (mg/L)
0.03

9.3.4.3 Summary of atmospheric compartment for the production of nickel salts from nickel sulphate

An overview of the local air concentrations and PEC in the air compartment are provided in the assessment for Man via the Environment below or <u>Appendix D5</u>.

9.3.4.4 Summary of exposure concentrations in on site waste water treatment plants for the production of nickel salts from nickel sulphate

Table 107 reports the calculated and measured Ni concentration in the effluent of the on-site WWTP.

Table 107. Concentrations in on-site waste water treatment plant

Information type	Calculated effluent concentration in on-site WWTP (mg/L)
Selected for GES Freshwater	0.24
Selected for GES Marine	0.24

9.3.4.5 Summary of Man via Environment exposure and risk characterisation assessments for production of nickel salts from nickel sulphate

For each sector, an overview of the range of operational conditions (OCs) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared to 11.5 ng Ni/m³ or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m³. An assessment of predicted level of compliance for this sector based on site-specific measured or predicted exposures is provided in Section 5 of <u>Appendix D5</u>.

Table 108. Sector overview

	tonnage (T Ni/year)	daily emissions to air (kg Ni/d)	release factor to air (g Ni/T)	Emission days to air per site (d/y)	C _{local} , air* (ng Ni/m³)	PEC air ^{\$} (ng Ni/m³)
min	177	<0.01	1	200	< 1	9
max	51113	4.93	72	365	31	40
median	967	0.11	20	355	2	11

*: based on different air models (EUSES, GPM, IFDM)

\$: based on C_{local} predicted + regional background

9.4 New generic exposure scenarios for 2012 updates

This section contains two new generic exposure scenario for the use of nickel sulphate. These uses were reported after the 2010 registration.

9.4.1. GES 7: USE OF NICKEL SULPHATE IN THE MANUFACTURING OF MICRONUTRIENT ADDITIVES FOR BIOGAS PRODUCTION

1. Title GES 7: Use of nickel sulphate in the manufacturing of micronutrient additives for biogas production							
Life cycle	Use of nickel sulphate in the manufacturing of micronutrient additives for biogas production						
Free short title	Use of nickel sulphate in the manufacturing of micronutrient additives for biogas production						
Systematic title based on use descriptor	SU: SU 1: Agriculture PC: PC 12: fertilizer ERC: ERC 2: Formulation of preparations						

	PROC: 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 8b:Transfer of substance or preparation
	(charging/discharging) from/to vessels/large containers at dedicated
	facilities
	PROC 9: Transfer of chemicals into small containers (dedicated
	filling line)
	PROC 0 – Cleaning and maintenance
Processes, tasks, activities covered	Use of nickel sulphate in the manufacturing of micronutrient additives for
(environment)	biogas production
	Contributing exposure scenario ES 7.1:
	PROC 4 and PROC 8b: Nickel sulfate reception
	Contributing exposure scenario ES 7.2:
	PROC 3 Preparing the additive powder
Processes, tasks, activities covered	Contributing exposure scenario ES 7.3:
(workers)	Proc 9: Packaging
	Contributing exposure scenario ES 7.4:
	PROC 3 Palletising
	Contributing exposure scenario ES 7.5:
	PROC 0: Cleaning and Maintenance
2. Operational conditions and risk manageme	ent measures
2.1 Control of environmental exposure	
Environmental related free short title	Use of nickel sulphate in the manufacturing of micronutrient additives for biogas production
Systematic title based on use descriptor (environment)	ERC2 – Formulation of preparations
Processes, tasks, activities covered	Manufacture of Ni sulphate-containing micronutrient additives for biogas
(environment)	production
Environmental Assessment Method	Not Relevant (no release to water or air)
Product characteristics	
Powder and liquid (solution of NiSO ₄)	
Amounts used	
Maximum daily use at a site	25 kg
Maximum annual use at a site	1-10 tonnes
Frequency and duration of use	
Pattern of release to the environment	No appreciable release to the environment
Environment factors not influenced by risk m	anagement
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 proces	ss level (source) to prevent release
There is no discharge to sewer or river. A dust a	aspiration system used to collect particles that are directed back to the
mixing system (thus no release to air).	
Technical onsite conditions and measures to	reduce or limit discharges, air emissions and releases to soil
Waste water:	
There are no discharges to a sewer or river.	
Air:	
Technical aspiration is present to avoid dust emi	ssions to the environment. A filtration system is present that re-circulates
particles back to the mixing system. When the f	Iter elements are reaching their end of life they are replaced.
Organizational measures to prevent/limit rele	ase from site
None	
Conditions and measures related to municipation	al 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	Not relevant
STP	ποιτοισνατιί

Conditions and measures related to external	treatment of v	vaste for disposal					
Ni bearing waste shall be recovered or recycled	if possible. Ni b	bearing waste shall be considered hazardous if the Ni content					
is above the generic cutoffs (for mixtures) as stat	ted in regulatio	n (EC) No. 1272/2008. Ni bearing waste mixtures may be					
assessed as substances according to regulation (EC) No. 1272/2008 criteria. Disposal of Ni bearing waste shall comply with							
local, state or national waste legislation and remain	ains the respor	nsibility of the waste treatment operator.					
Conditions and measures related to external	recovery of w	aste					
Waste water is collected in a separate waste IBC	and removed	by an authorized waste company.					
2.2 Control of workers exposure for contribut	ing exposure	scenario 7.1					
Nickel sulfate reception							
Workers related free short title	Use of nickel sulphate in the manufacturing of micronutrient additives for						
workers related nee short title	biogas production						
	PROC 4: Use	in batch and other process (synthesis) where					
Use descriptor severed	opportunity for	exposure arises					
	PROC 8b:Trar	sfer of substance or preparation (charging/discharging)					
	from/to vessels	s/large containers at dedicated facilities					
Processes tasks activities covered	NiSO ₄ powder	and solution are obtained ready for processing and placed in					
FIOCESSES, IdSKS, activities covered	a dispensing b	in.					
Assessment Method	Estimation of e	exposure using a Tier 1 model (MEASE)					
Product characteristic							
Hydrated nickel sulphate hexahydrate, NiSO46H	2O (solid powd	er), or in solution					
Amounts used							
Not relevant							
Frequency and duration of use/exposure							
Duration of exposure is considered to be less that	an 4 hours per	day for nutrient manufacture especially when this production					
process is not continuous and where this produc	t line is one of	a range of products manufactured on site for the agricultural					
or energy etc. sectors.							
Human factors not influenced by risk manage	ement						
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m ³ /d					
Room size and ventilation rate		Not relevant					
Area of skin contact with the substance under co	onditions of	180. cm ²					
use							
Body weight		70 kg					
Other given operational conditions affecting	workers expo	sure					
All activities are carried out manually by the work	ker.						
The reactor is charged by tipping NiSO4 powder	or pouring NiS	D ₄ solution into the dispensing bin.					
Technical conditions and measures at proces	ss level (sourc	e) to prevent release					
None given							
Technical conditions and measures to contro	I dispersion f	rom source towards the worker					
None given							
Organisational measures to prevent /limit rele	eases, dispers	ion and exposure					
Training to reinforce good practice and hygiene i	ssues are perfe	ormed.					
The reception of raw materials for the manufactu	ring of micronu	trient additives is a non-continuous operation and/or takes					
place for no more than 4 hours per day							
Conditions and measures related to personal	protection, h	ygiene and health evaluation					
Air-assisted filtering visor, masks or hood with P3	3 filter element	(Assigned Protection Factor = 40 based on use of powered					
respirator meeting EN12492 requirement or equi	valent suitable	P3 level protection) is required for charging the dispensing					
bin where exposure to NiSO4 containing mist or o	dust is possible).					
Chemical gloves with EN 374, protection level 6	are required to	control dermal exposure when charging the dispensing bin.					
2.3 Control of workers exposure for contribut	ing exposure	scenario 7.2					
Preparing the additive (for biogas production) po	wder or solutio	ns					
Workers related free short title	Use of nickel s biogas product	ulphate in the manufacturing of micronutrient additives for ion					
Use descriptor covered	PROC 3: Use	in closed batch process (synthesis or formulation)					
Processes, tasks, activities covered	Preparing the	additive (for biogas production) powder or solutions					
Assessment Method	Estimation of e	exposure using a Tier 1 model (MEASE)					
Product characteristic							
Hydrated nickel sulphate hexahydrate. NiSO₄6H	20 (solid powd	er). or in solution. NiSO4					
Amounts used							

Not relevant						
Frequency and duration of use/exposure						
Duration of exposure is considered to be less that	an 4 hours per	day for nutrient manufacture especially when this production				
process is not continuous and where this produc	t line is one of	a range of products manufactured on site for the agricultural				
or energy etc. sectors.						
Human factors not influenced by risk manage	ement					
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m ³ /d				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance under c	onditions of	240 cm ²				
use Dody weight		70 kg				
Other given energianal conditions offecting	workers expe					
Other given operational conditions affecting	workers expos	sure				
All activities are largely full from a control room		wired to inspect or intervene in the process and make any				
adjustments from the control booth or on the fac	tory floor based	aned to inspect of intervene in the process and make any				
The NiSO $_4$ solution is nined from the dispensing	bin to the blen	der This activity is automated and enclosed				
Technical conditions and measures at process	s level (sourc	re) to prevent release				
Transfer and mixing systems shall be enclosed y	with high level of	of containment				
Technical conditions and measures to control	dispersion f	rom source towards the worker				
I EV shall be used to extract the particulate durin	a the mixing a	nd transferring operations				
Organisational measures to prevent /limit rel	eases dispers	sion and exposure				
Training to reinforce good practice and hygiene i						
Conditions and measures related to personal	protection, h	voiene and health evaluation				
Air-assisted filtering visor masks or hood with P	3 filter element	(Assigned Protection Eactor ~20 based on use of powered				
respirator meeting EN12492 requirement or equi	ivalent suitable	P3 level protection) is required for entry into the production				
area for inspections/emergency situations where	exposure to N	liSO4 containing mist or dust is possible.				
Chemical gloves with EN 374, protection level 6,	are required for	or entry into the production area for inspections/emergency				
situations in order to control dermal exposure wh	nere exposure t	o NiSO4 containing mist or dust is possible.				
2.4 Control of workers exposure for contribut	ting exposure	scenario 7.3				
Packaging	- ·					
Workers related free short title	Use of nickel s	ulphate in the manufacturing of micronutrient additives for				
	blogas product	ogas production				
Use descriptor covered	(dedicated fillir	ing line, including weighing)				
Processes, tasks, activities covered	Packaging					
Assessment Method	Estimation of e	exposure using a Tier 1 model (MEASE)				
Product characteristic						
Ni/NiSO ₄ -containing powder						
Amounts used						
Not relevant						
Frequency and duration of use/exposure						
Duration of exposure is considered to be less that is required during the packaging operation but m	an 1 hour per d ay be longer w	ay for nutrient manufacture where some manual intervention hen operating a fully automated packaging line or if wearing				
RPE.						
Human factors not influenced by risk manage	ement					
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m ³ /d				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance under c	onditions of	480 cm ²				
use						
Body weight		70 kg				
Other given operational conditions affecting	workers expo	sure				
All activities except filled bag removal from the p containment.	ackaging (valve	e bag filling) station are automated with a high level of				
Technical conditions and measures at proces	ss level (sourd	e) to prevent release				
Filled bag self-seals through an internal valve sy	stem and this p	prevents dust escaping from the bag.				
Technical conditions and measures to contro	l dispersion f	rom source towards the worker				
LEV is required to control inhalation exposure to	particulates du	ring product release into the packaging and sealing of the				
filled packaging.	-					

Organisational measures to prevent /limit rel	eases, dispers	sion and exposure				
Training to reinforce good practice and hygiene	issues					
Conditions and measures related to persona	I protection, h	ygiene and health evaluation				
None reported.						
2.5 Control of workers exposure for contribu	ting exposure	scenario 7.4				
Palletising						
Workers related free short title	Use of nickel s biogas product	ulphate in the manufacturing of micronutrient additives for ion				
Use descriptor covered	PROC 3: Use i	in closed batch process (synthesis or formulation)				
Processes, tasks, activities covered	Palletising and	wrapping of filled bags of biogas nutrient				
Assessment Method	Estimation of e	exposure using a Tier 1 model (MEASE)				
Product characteristic						
Solid or solution						
Amounts used						
Not relevant						
Frequency and duration of use/exposure						
Prequency and utration of use/exposure	on 1 hour por d	av for putriant manufacture consciently when this production				
process is not continuous and where this produc	all Thous per u	ay for numeric manufacture especially when this production				
process is not continuous and where this produc		a range of products manufactured on site for the agricultural				
or energy etc. sectors						
Human factors not influenced by risk manage	ement	Light to an allow bound in mosting to us do the loss 40 m ² /d				
Respiration volume under conditions of use		Light to medium level work is routinely undertaken ~10 m³/d				
Room size and ventilation rate		Not relevant				
Area of skin contact with the substance under c	conditions of	240 cm ²				
use		70.1				
Body weight		70 kg				
Other given operational conditions affecting	workers expos	sure				
The structure of bag used for packaging the mic	ronutrients limit	s dust released from filled bags and hence exposure.				
Activities involve handling the filled bags of biog	as nutrient pow	der which are considered a leak-proof packaging system.				
Technical conditions and measures at proce	ss level (sourc	ee) to prevent release				
None reported						
Technical conditions and measures to control	ol dispersion f	rom source towards the worker				
Technical conditions and measures to contro None reported	ol dispersion f	rom source towards the worker				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel	ol dispersion f eases, dispers	rom source towards the worker ion and exposure				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene	ol dispersion f eases, dispers issues and exp	rom source towards the worker sion and exposure osure				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona	bl dispersion f eases, dispers issues and exp I protection, h	rom source towards the worker sion and exposure osure ygiene and health evaluation				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P	eases, dispersion f eases, dispers issues and exp I protection, h 3 filter element	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ	eases, dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection).				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6	eases, dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags.				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6 2.5 Control of workers exposure for contribu	eases, dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to ting exposure	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags. scenario 7.5				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6 2.5 Control of workers exposure for contribut Cleaning and Maintenance	eases, dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to ting exposure	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags. scenario 7.5				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6 2.5 Control of workers exposure for contribu Cleaning and Maintenance Workers related free short title	bl dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to ting exposure Use of nickel s biogas product	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags. scenario 7.5 ulphate in the manufacturing of micronutrient additives for ion				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6 2.5 Control of workers exposure for contribu Cleaning and Maintenance Workers related free short title Use descriptor covered	bl dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to ting exposure Use of nickel s biogas product PROC 0 – Cle	rom source towards the worker sion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags. scenario 7.5 ulphate in the manufacturing of micronutrient additives for ion aning and maintenance				
Technical conditions and measures to contro None reported Organisational measures to prevent /limit rel Training to reinforce good practice and hygiene Conditions and measures related to persona Air-assisted filtering visor, masks or hood with P respirator meeting EN12492 requirement or equ Chemical gloves with EN 374, protection level 6 2.5 Control of workers exposure for contribu Cleaning and Maintenance Workers related free short title Use descriptor covered Processes, tasks, activities covered	bl dispersion f eases, dispers issues and exp I protection, h 3 filter element ivalent suitable are required to ting exposure Use of nickel s biogas product PROC 0 – Cle Cleaning and I	rom source towards the worker ion and exposure osure ygiene and health evaluation (Assigned Protection Factor ~20 based on use of powered P3 level protection). control dermal exposure when palletising the filled bags. scenario 7.5 ulphate in the manufacturing of micronutrient additives for ion aning and maintenance Maintenance				
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Body weight 70 kg									
Other given op	Other given operational conditions affecting workers exposure								
None									
Fechnical conditions and measures at process level (source) to prevent release									
None	None								
Fechnical conditions and measures to control dispersion from source towards the worker									
None									
Organisational	measures f	o prevent /l	imit release	s, dis	persion and	d exposu	re		
Training to reinf	orce good pr	actice and h	ygiene issue	s					
Conditions and	d measures	related to p	ersonal pro	tectio	n, hygiene	and healt	h eva	aluation	
Air-assisted filte	ring visor, m	asks or hood	d with P3 filte	er elen	nent (Assigr	ned Protec	tion I	Factor ~20 based on use of p	owered
respirator meeti	ng EN12492	requirement	t or equivale	nt suit	able P3 leve	el protectio	on).		
Chemical gloves	s with EN 37	4, protection	level 6 are r	equire	ed to control	dermal ex	xposi	ıre	
Inhalation to mis	sts and partic	culates and s	kin exposure	e to m	ists, liquids	splashes a	and p	articulates shall be controlled	d by RPE
and gloves whe	n undertakin	g maintenan	ce and clear	ning w	ork.				
3. Exposure an	d risk estim	ation							
Environment									1
ERC 2									
			DF0	_					
compartment	Unit	PNEC	PECRegional	Cloca	PEC	RCR	Me	thods for calculation of	
							en	vironmental concentration	
Freshwater	µg/L	3.6	-	-	-	-	-		
Marine	µg/L	8.6	-	-	-	-	-		
Terrestrial	mg/kg	29.9	-	-	-	-	-		
SIP	ivig/kg	0.33	-	-	-	-	-		
Workers									
ES 7.1									
PROC 4 and F	YRUC 8D: NI	ckel sulfate r	eception						
	Unit	DNEL	Exposure		RCR			Methods for calculation of	
			concentra	tion				exposure	
Dermal									
Acute	mg	-	NR						
systemic	Ni/kg/day								
Acute local	mg	-	NR						
	Ni/cm²/day								
Long-term	mg	-	NR						
systemic	Ni/kg/day	0.00044	0.000040		0.044			Madallad averaging data va	
Long-term	mg Ni/ama2/day	0.00044	0.000018		0.041			Modelled exposure data us	sing
local	NI/Cm²/day							MEASE for PROC 80 (Incl	
								exposure, duration 4 nours	, GV,
								gioves)	
Inhalation									
	ma Ni/m3	16	0.078		0.0040			3 x long torm modeled esti	mata
Acule	IIIY IN/III°	10	0.070		0.0049			with use of PDE (ADE 10)	male
Aguto logal	ma Ni/m3	0.7	0.078		0.11				
Acute local	IIIg INI/III°	0.7	0.070		0.11				
Long term	ma Ni/m ³	0.05	1.026		20 52 (ove	Judina PP		90th percentile exposure es	timato
systemic	ing in/in-	0.05	1.020		20.32 (670		∟)	using MEASE for PROC 1	Sumate
and local					By use of	RPF (APF		lincidental exposure durat	ion 4
ana loodi			0.026		40) 0.52			hours RPF (APF=40) glov	/es}
ES 7.2			1 0.020						
PROC 3: Pren	aring the ad	ditive (for bio	gas product	ion) pa	owder or sol	utions			
~	Unit	DNEL	Exposure	. / ٣	RCR	· · · •		Methods for calculation of	
			concentra	tion				exposure	
Dermal									
Acute	mg	-	NR						
-		•	•						

systemic	Ni/kg/day				
Acute local	mg Ni/cm²/day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.00003	0.068	Modelled exposure data using MEASE for PROC 3 {incidental exposure, enc, LEV, duration 4 hours, gloves}
Inhalation	NII ()	10			
Acute systemic	mg Ni/m ³	16	0.141	0.009	estimate
Acute local	mg Ni/m ³	0.7	0.141	0.201	00
Long-term systemic and local	mg Ni/m ³	0.05	0.047	0.94	90 th percentile exposure estimate using MEASE for PROC 3 {incidental exposure, enc, LEV, duration 4 hours, gloves}
ES 7.3 PROC 9: Pacl	kaging				
	Ŭniť	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.00086	1.95 0.98 for 4 h exposure duration and when this duration is exceeded worker would have to wash hands and replace gloves in order to continue working	Read across 75 th percentile for personal exposure measurement (face) reported for an analogous operation for packaging of NiSO46H ₂ O and nickel hydroxycarbonate
Inholotion					
	ma Ni/m ³	16	0.23	0 0144	10 x long-term inhalable read-
systemic	ing i wi	10	0.20	0.0144	across estimate. A factor of 10 was
Acute local	mg Ni/m ³	0.7	0.23	0.33	used because of the substantial short term variability of exposure concentrations during powder handling operations
Long-term systemic and local	mg Ni/m ³	0.05	0.023	0.46	Read across 75 th percentile for personal exposure measurements reported for an analogous operation for packaging of NiSO ₄ 6H ₂ O and nickel hydroxycarbonate
ES 7.4 PROC 3: Palle	etising				
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					

Acute systemic	mg Ni/kɑ/day	-	NR		
Acute local	mg Ni/om²/day	-	NR		
Long-term systemic	mg Ni/kg/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.000002	<0.01	90 th percentile exposure estimate using MEASE for PROC 3 {incidental exposure, duration 4 hours, gloves}
Inholation					
	ma Ni/m3	16	0.060	0.004	10 x long term inheleble read
systemic	mg Ni/m°	10	0.069	0.004	across estimate. A factor of 10 was
Acute local	mg Ni/m ³	0.7	0.069	0.099	used because of the substantial short term variability of exposure concentrations during powder handling operations
Long-term systemic and local	mg Ni/m ³	0.05	0.023	0.46	90 th percentile exposure estimate using MEASE for PROC 3 {incidental exposure, duration 4 hours, gloves}
ES 7.5					<u> </u>
PROC 0: Clea	ning and Main	tenance			
	Unit	DNEL	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR		
Acute local	mg Ni/cm²/day	-	NR		
Long-term systemic	mg Ni/kq/day	-	NR		
Long-term local	mg Ni/cm²/day	0.00044	0.000006	0.014	90 th percentile exposure estimate using MEASE for PROC 10 {incidental exposure, duration 1 hour, general ventilation, RPE, gloves}
Inholation		1			
Acute	mg Ni/m ³	16	0.0972	0.006	3 x long-term inhalable modeled
Acute local	ma Ni/m ³	0.7	0.0972	0 14	
Long-term	ma Ni/m ³	0.05	0.324	6.5 (excluding RPE)	90 th percentile exposure estimate
systemic and local			0.0324	By use of RPE (APF 10) 0.65	using MEASE for PROC 10 {incidental exposure, duration 1 hour, general ventilation, RPE, gloves}
NR: Not Relev	ant				
Acute local inf	nalation				

Based on respirable size aerosols. Equivalent inhalable fraction levels expected to be at least 3-fold higher **4. Guidance to evaluate whether a site 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). See <u>Appendix D1</u>

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.4.1.1 Summary of the secondary poisoning exposure and risk characterisation assessment for nickel sulphate production

Not relevant

9.4.1.2 Porewater concentrations in the soil compartment for the use of nickel sulphate in the manufacturing of micronutrient additions for biogas production

Not relevant

9.4.1.3 Atmospheric compartment for the manufacturing of micronutrient additions for biogas production

Not relevant

9.4.1.4 Exposure concentrations in on site waste water treatment plants (WWTP) for the manufacturing of micronutrient additions for biogas production

Not relevant

9.4.1.5 Man via Environment exposure and risk characterisation assessments the manufacturing of micronutrient additions for biogas production

Not relevant

9.4.2 GES 8: PRODUCTION OF NICKEL-CONTAINING PIGMENTS FROM NICKEL SULPHATE

1. Title							
GES 8 Production of nickel-containing pigments							
Life cycle	Formulation – DU of NiSO4						
Free short title	Production of nickel-containing inorganic pigments from NiSO ₄						
Systematic title based on use descriptor	SU: SU 3 Industrial use						

	PC:	Not relevant						
	ERC:	ERC 2: Formulation of preparations						
		ERC 5: Industrial use resulting in includsion into or onto a matrix						
		ERC 6a: Industrial use resulting in manufacture of another						
		substance (use of intermediates)						
	SPERC fo	or the production and formulation stage of metal compounds						
	PROC:							
	PROC 2 l	Jse in closed, continuous process with occasional controlled						
	exposure	(e.g. sampling)						
	PROC 4 L	Jse in batch and other process (synthesis) where opportunity for						
	exposure	arises						
	PROC 5 I	Alixing or blending in batch processes for formulation of						
		Transfer of substance or properties (charging/discharging)						
	from/to vessels/large containers at dedicated facilities							
	PROC 9 Transfer of substance or preparation into small containers							
	(dedicated	d filling line, including weighing)						
	PROC 22: Potentially closed processing operations with minorals/ma							
	elevated t	emperature						
	PROC 24	High mechanical energy workup of substances bound in materials						
	or articles							
	PROC 26	Handling of solid inorganic substances at ambient temperature						
	Productio	n of inorganic pigments:						
Processes, tasks, activities covered	Dosing an	d mixing; Drying (if wet mixing); Calcination (charge); Calcination						
(environment)	(discharge	e); Milling (dry or wet); Washing (optional); Drying (if washed);						
	Mixing an	d/or packaging; Laboratory; Cleaning and maintenance						
	Contributi	ng exposure scenario ES 8.1						
	PROC 8b	: Raw materials handling						
	Contributi	ng exposure scenario ES 8.2						
	PROC 2,	PROC 5, PROC 26: Mixing raw materials						
	Contributi	ng exposure scenario ES 8.3						
	PROC 4,	PROC 9, PROC 22: Drying and Calcining product						
Processes, tasks, activities covered	Contributi	ng exposure scenario ES 8.4						
(workers)	PROC 24	: Dry milling						
		ng exposure scenario ES 8.5						
	PRUC 22	, PROC 24: Wet milling, washing and Drying						
		ny exposure scenario ES 0.0 Blanding and nackaging						
	Contributi	ng exposure scenario ES 8.7						
	PROC 0.	Cleaning and maintenance						
2. Operational conditions and risk manager	nent meas	sures						
2.1 Control of environmental exposure								
Environmental related free short title	Productio	n of nickel-containing inorganic pigments from NiSO4						
	ERC2: Fo	rmulation of preparations						
Systematic title based on use descriptor	SPERC d	ata for metals and metal compounds for the production and						
(environment)	formulatio	n stage of metal compounds such as pigments.						
	Productio	n of inorganic pigments:						
Processes, tasks, activities covered	Dosing an	d mixing; Drying (if wet mixing); Calcination (charge); Calcination						
(environment)	(discharge	e); Milling (dry or wet); Washing (optional); Drying (if washed);						
	Mixing an	d/or packaging; Laboratory; Cleaning and maintenance						
	Estimates	based on monitoring local and regional concentrations are used						
Environmental Assessment Method	for calcula	ation of PEC.						
	SPERCS	data for metal and metal compounds are used in order to estimate						
	releases t	o wastewater for a generic ES with discharge to municipal STP.						
Product characteristics								
The tonnage is based on Ni originating from th	e use of Ni	O as well as other Ni compounds used at same sites.						
Amounts used	0.47							
Maximum daily use at a site	0.4 tonne	es (median 50th % emission days, max tonnage)						
Maximum annual use at a site	136 tonne	s (max, 2007)						
Frequency and duration of use								

	351 dave por v	par par site (median 50th %)							
Tation of release to the environment [55 r days per year per site (median 50 7/6)									
Environment factors not influenced by risk	management	(OTD 000 000 - 2/1							
Receiving surface water flow rate	ES 1 Discharge ES 2 Direct dis	e to STP: 200,000 m³/d charge: 175,000 m³/d (50 th %)							
	ES 1 Discharge	e to STP: 100							
Dilution capacity, freshwater	ES 2 Direct dis	charge: 1000 (max)							
Dilution capacity, marine	100 (default)	5 (/							
Other given operational conditions affectin	a environment								
None									
Technical conditions and measures at process level (source) to prevent release									
Technical conditions and measures at proc	ess ievei (sour	ce) to prevent release							
None									
lechnical onsite conditions and measures	to reduce or lin	hit discharges, air emissions and releases to soil							
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 (90 th % 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)									
None	lease nom site								
Conditions and massures related to munici	nal aguraga tra	atmost plant							
Conditions and measures related to municipal Services Treatment Plant (CTD)	Ves for EC 1 D								
municipal Sewage Treatment Plant (STP)	Tes IOI ES I D								
Discharge rate of the Municipal STP	2000 m³/d (def								
Incineration of the sludge of the Municipal The sludge is applied to agricultural soil									
Incineration of the sludge of the Municipal STP	The sludge is a	pplied to agricultural soil							
Incineration of the sludge of the Municipal STP Conditions and measures related to externa	The sludge is a all treatment of	pplied to agricultural soil waste for disposal							
Incineration of the sludge of the Municipal STP Conditions and measures related to extern Ni bearing waste shall be recovered or recycle is above the generic cutoffs (for mixtures) as s assessed as substances according to regulation local, state or national waste legislation and re	The sludge is a al treatment of d if possible. Ni tated in regulation on (EC) No. 127 mains the response	pplied to agricultural soil waste for disposal bearing waste shall be considered hazardous if the Ni content on (EC) No. 1272/2008. Ni bearing waste mixtures may be 2/2008 criteria. Disposal of Ni bearing waste shall comply with nsibility of the waste treatment operator.							
Incineration of the sludge of the Municipal STP Conditions and measures related to extern Ni bearing waste shall be recovered or recycle is above the generic cutoffs (for mixtures) as s assessed as substances according to regulation local, state or national waste legislation and re Conditions and measures related to externation	The sludge is a al treatment of d if possible. Ni tated in regulation on (EC) No. 127 mains the respo al recovery of v	pplied to agricultural soil waste for disposal bearing waste shall be considered hazardous if the Ni content on (EC) No. 1272/2008. Ni bearing waste mixtures may be 2/2008 criteria. Disposal of Ni bearing waste shall comply with nsibility of the waste treatment operator. vaste							
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Area of skin contact with the substance under o								
	Area of skin contact with the substance under conditions of 480 cm ²							
Body weight		Not relevant						
Other given operational conditions affecting	workers exp							
Manual opening of NiSO/ bags and manual tipping or automatic discharge of NiSO/ powders and other ingredients								
including water, into the reactor								
Oral: Good workplace hydrene practice								
Fechnical conditions and measures at process level (source) to prevent release								
Inhalation: The manual opening of bags and tipping of the NiSO4 powder from the bags into the reactor is likely to give rise								
o significant exposures to inhalable NiSO4.								
The automated closed conveying of NiSO4 feedstock into reactors and wetting or dissolving of this powder is unlikely to give								
rise to significant exposures to inhalable NiSO4.								
<u>Dermal</u> : The manual opening of bags and tipping of the NiSO4 powder from the bags into the reactor is likely to give rise to								
significant dermal exposures to NiSO ₄ dust.								
Technical conditions and measures to contr	ol dispersion	from source towards the worker						
LEV is required for processes that are not fully e	enclosed and a	are likely to give rise to NISO4 dust, such as opening of bags,						
charging of reactors or preparing solutions of Ni	SO4.							
Organisational measures to prevent /ilmit re	leases, dispe	rsion and exposure						
None		humiana and haalth avaluation						
Londitions and measures related to personal	a protection,	nygiene and nearth evaluation						
<u>initialitation</u> . RFE (FFF1, 2 of 3) (approved with the area likely to give rise to Ni dust or fumos	egaru to EN 12	13} is required at process steps that are not fully enclosed and						
Dermal: Suitable gloves (PVC or equivalent) ac	adles and she	cial safety clothing are required						
2.3 Control of workers exposure for contribu	iting exposure	a scanario ES 8 2						
Mixing raw materials	ing exposure							
Workers related free short title	Production of r	nickel-containing inorganic nigments from NiSO4						
	PROC 2: Use i	n closed, continuous process with occasional controlled						
	exposure (e.g. sampling)							
	PROC 5: Mixir	g or blending in batch processes for formulation of						
Use descriptor covered	preparations a	nd articles (multistage and/or significant con-tact)						
	PROC 26:Han	dling of solid inorganic substances at						
1	ambient tempe	erature						
Processes, tasks, activities covered	Wet or dry auto	omatic mixing of raw materials						
Assassment Mathad	Estimation of i	nhalation exposure based on measured data.						
Assessment wethou	Assessment Method							
Product characteristic	Estimation of c							
Product characteristic NiSO4 in a solution and/or wet powder mixture	Estimation of c							
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used	Estimation of c							
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used	Estimation of c							
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure	Estimation of c							
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts								
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag	ement							
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use	ement	Not relevant						
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate	ement	Not relevant Not relevant						
Product characteristic NiSO ₄ in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of	ement	Not relevant Not relevant						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use	ement	Not relevant Not relevant 1980 cm ²						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight	ement	Not relevant Not relevant 1980 cm ² Not relevant						
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Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi	ement conditions of workers expo xing together of	Not relevant Not relevant 1980 cm ² Not relevant Desure of all raw materials in a closed reactor						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi Oral: Good workplace hygiene practice.	ement conditions of workers expo xing together of	Not relevant Not relevant 1980 cm ² Not relevant osure of all raw materials in a closed reactor						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi Oral: Good workplace hygiene practice. Technical conditions and measures at proce	ement conditions of workers expr xing together of ss level (sour	Not relevant Not relevant 1980 cm ² Not relevant Discrete Soure S						
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Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi Oral: Good workplace hygiene practice. Technical conditions and measures at proce Inhalation: The automated closed conveying of exposures to inhalable NiSO4. Automated open exposures to inhalable NiSO4. Dermal: Containment of the processes should b Technical conditions and measures to eact	ement conditions of workers expr xing together of rss level (sour product mix fro conveying of p e used where ol diepersion	Not relevant Not relevant 1980 cm ² Not relevant Osure Soure Sour						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under of use Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi Oral: Good workplace hygiene practice. Technical conditions and measures at proce Inhalation: The automated closed conveying of exposures to inhalable NiSO4. Automated open exposures to inhalable NiSO4. Dermal: Containment of the processes should b Technical conditions and measures to contr LEV is required for processes that are not exiter	ement conditions of workers expr xing together of ess level (sour product mix fro conveying of p e used where ol dispersion	Not relevant Not relevant 1980 cm² Not relevant osure of all raw materials in a closed reactor rce) to prevent release om the wet process is unlikely to give rise to significant product mix from the dry process may give rise to significant possible to eliminate dermal contact from source towards the worker						
Product characteristic NiSO4 in a solution and/or wet powder mixture Amounts used Frequency and duration of use/exposure 8 hour shifts Human factors not influenced by risk manag Respiration volume under conditions of use Room size and ventilation rate Area of skin contact with the substance under couse Body weight Other given operational conditions affecting Dry or wet (stirring suspensions or solutions) mi Oral: Good workplace hygiene practice. Technical conditions and measures at proce Inhalation: The automated closed conveying of exposures to inhalable NiSO4. Automated open exposures to inhalable NiSO4. Dermal: Containment of the processes should b Technical conditions and measures to contr LEV is required for processes that are not autor convexing of dry product mix	ement conditions of workers expo xing together of ess level (sour product mix fro conveying of p e used where ol dispersion nated or enclo	Not relevant Not relevant 1980 cm² Not relevant of all raw materials in a closed reactor rce) to prevent release om the wet process is unlikely to give rise to significant possible to eliminate dermal contact from source towards the worker sed and are likely to give rise to NiSO4 dust, such as open						

Organisational measures to prevent /limit re	eleases, disper	sion and exposure						
None								
Conditions and measures related to personal protection, hygiene and health evaluation								
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								
2 / Control of workers exposure for contributing exposure scenario ES 8.3								
Drving and calcining of product	ating exposure							
Markers related free short title	Draduction of n	ickel containing increanic nigments from NiCO.						
workers related free short title	Production of n	ickel-containing inorganic pigments from NISO4						
	PROC 4 Use in	batch and other process (synthesis) where opportunity for						
	exposure arises	S						
Use descriptor covered	PROC 9 Transf	er of substance or preparation into small containers						
	(dedicated filling	g line, including weighing)						
	PROC 22: Pote	intially closed processing operations with minerals/metals at						
	elevated temperature							
Processes, tasks, activities covered	Drying and calcining of wet product mix or calcining of dry product mix							
Assessment Mathed	Estimation of in	halation exposure based on measured data.						
Assessment Method	Estimation of de	ermal exposure based on Tier 1 model.						
Product characteristic								
Wet granules of or dry NiSO4-containing suspe	ension/mixture							
Amounts used								
Frequency and duration of use/expecting								
A hour obitto								
Human factors not influenced by risk mana	gement							
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	420 cm ²						
use		420 CIII-						
Body weight		Not relevant						
Other given operational conditions affecting	g workers expo	sure						
Continuous and automated drving and calcinin	g operation can	be performed in tunnel ovens or rotary kilns. During operation						
of the 'discontinuous' drving and calcining pro	cesses, the mixt	ure 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	in gener men							
Oral: Good workplace hygiene practice								
Technical conditions and measures at proc	ass lavel (sour	ce) to prevent release						
Inhalation: The calcining of product mix where	ovens are not fu	illy onclosed and where there are manual interventions is						
likely to give rise to significant exposures to int		utempted and where there are manual interventions is						
likely to give rise to significant exposures to inheleble N		atomated open conveying of product from the calciner may						
give rise to significant exposures to innatable r	NISU4.	he wood where possible to eliminate downed context						
Dermal: Automation and containment of the pr	ocesses snould	be used where possible to eliminate dermal contact						
lechnical conditions and measures to cont	rol dispersion f	from source towards the worker						
LEV is required for processes not fully enclose	d and likely to gi	ive rise to NiSO4 dust, such as calcining the product in						
crucibles in a tunnel oven								
Organisational measures to prevent /limit re	eleases, disper	sion and exposure						
None								
Conditions and measures related to person	al protection, h	lygiene and health evaluation						
Inhalation: RPE (FFP1) {approved with regard	I to EN 149} at p	rocess steps that are not fully enclosed and are likely to give						
rise to Ni containing dust . e.a. handling of the	final product. W	hen handling powders of particle diameter below 10 um. RPE						
(FEP2) {approved with regard to EN 149} is reg	auired.	5						
Dermal: Suitable gloves (PVC or equivalent)	nongles and sper	cial safety clothing are required						
2.5 Control of workers exposure for contrib	uting exposure	scenario FS 8.4						
Dry milling	and orboould							
Workers related free short title	Production of n	ckel containing inorganic nigmonts from NiCO.						
אטותפוס ופומנפט ווכב סווטוג נונוב		mochanical anorgy workup of substances hound in metaricle						
Use descriptor covered	or ortiolog	mechanical energy workup of substances bound in materials						
Processes, tasks, activities covered	ivilling of calcine							
Assessment Method	Estimation of in	nalation exposure based on measured data.						
	Estimation of de	ermai exposure based on Tier 1 model.						

Product characteristic								
Solid Ni-containing calcined product								
Amounts used								
Frequency and duration of use/exposure								
Human factors not influenced by risk manageme	ent							
Respiration volume under conditions of use	۲ ۲	Not	relevant					
Room size and ventilation rate	l'ille a contra							
use	aitions of	1980 cm ²						
Body weight	1	Not	relevant					
Other given operational conditions affecting workers exposure								
The dry calcined product is milled in an enclosed ba	all mill and c	onv	eyed to packaging.					
Oral: Good workplace hygiene practice.								
Technical conditions and measures at process I	level (sourc	:e) f	o prevent release					
Inhalation: Not fully enclosed powder transfer opera	ations are lik	ely	to give rise to significant exposures to inhalable Ni					
Dermal: Automation of processes should be used w	here possib	ole to	o eliminate dermal contact.					
lechnical conditions and measures to control d	lispersion fi	rom	source towards the worker					
LEV is required for processes not fully enclosed and	d that are lik	ely	to give rise to NISO4 containing dust					
Organisational measures to prevent /limit releas	ses, dispers	sion	and exposure					
None								
Conditions and measures related to personal pr	otection, hy	ygie	and health evaluation					
Innalation: RPE (FFP1) (approved with regard to EP	N 149} at pro	oces	ss steps that are not fully enclosed and are likely to give					
(FED2) (approved with regard to EN 140) is required	product. wn	ien	nandling powders of particle diameter below 10 µm, RPE					
[(FFP2) {approved with regard to EN 149} is required	u. oc and choo	ا من	safaty alathing are optional					
2.6 Control of workers exposure for contributing	es anu spec							
Wet milling Washing and Drying	gerhosuie	300						
Workers related free short title	Production	ofr	nickel-containing inorganic nigments from NiSO					
	PROC 22 P	2 Potentially closed processing operations with minerals/metals						
	at elevated temperature							
Use descriptor covered	PROC 24 H	liah	mechanical energy workup of substances bound in					
	materials or	aterials or articles						
	Calcined Ni	iSO	4 products containing salts are ground wet, washed to					
Processes, tasks, activities covered	eliminate ex	xce	ess of soluble salts and dried					
Assessment Mathed	Estimation	of ir	halation exposure based on measured data.					
Assessment Method	Estimation	of d	ermal exposure based on Tier 1 model.					
Product characteristic								
Solid Ni-containing calcined product								
Amounts used								
Frequency and duration of use/exposure								
8 hour shifts								
Human factors not influenced by risk manageme	ent							
Respiration volume under conditions of use			Not relevant					
Room size and ventilation rate			Not relevant					
Area of skin contact with the substance under cond	ditions of use	е	1980 cm ²					
Body weight Not relevant								
Other given operational conditions affecting wo	rkers expos	sur	9					
The dry calcined product is milled wet then washed Oral: Good workplace hygiene practice.	and dried (a	ator	nisers, jet drier)					
Technical conditions and measures at process I	level (sourc	ce) f	o prevent release					
Inhalation: Not fully enclosed operations for powder	r drying and	l tra	nsfer are likely to give rise to significant exposures to					
inhalable Ni								
Dermal: Automation of processes should be used w	/here possib	ole t	o eliminate dermal contact.					
Technical conditions and measures to control d	lispersion fi	rom	source towards the worker					
LEV is required for processes not fully enclosed and	d likely to giv	ve r	ise to NiSO ₄ -containing dust					
Organisational measures to prevent /limit releas	ses, dispers	sion	and exposure					

None									
Conditions and measures related to personal	protection, hygi	ene and health evaluation							
Inhalation: RPE (FFP1,) {approved with regard to EN 149} is minimum required for handling final product.									
Dermal: Suitable gloves (PVC or equivalent), goggles and special safety clothing are optional.									
2.7 Control of workers exposure for contributing exposure scenario ES 8.6									
Blending and packaging									
Workers related free short title	Production of	nickel-containing inorganic pigments from NiSO4							
Lles descriptor sovered	PROC 9 Trans	sfer of substance or preparation into small containers							
Use descriptor covered	(dedicated filling	ng line, including weighing)							
Processes tasks activities covered	The calcined p	owder product is blended with additives and packed							
Frocesses, lasks, activities covered	(bags or big ba	ags)							
	Estimation of i	nhalation exposure based on measured data.							
Assessment Method	Estimation of dermal exposure based on read across from similar								
	process for Ni	SO ₄ powder.							
Product characteristic									
Ni-containing powder pigment									
Amounts used									
Frequency and duration of use/exposure									
8 hour shifts									
Human factors not influenced by risk manager	nent								
Respiration volume under conditions of use		Not relevant							
Room size and ventilation rate		Not relevant							
Area of skin contact with the substance under con	nditions of use	Not relevant							
Body weight		Not relevant							
Other given operational conditions affecting w	orkers exposur	9							
Oral: Good workplace hygiene practice									
Technical conditions and measures at process	s level (source)	to prevent release							
Inhalation: Automated drum and big bag filling wit	h some manual ii	nterventions (such as loading of empty /unloading of full							
drums, closing of lids and manually adding or rem	oving pellets to a	chieve the correct mass) during the filling of drums with							
NiSO4 powder) are likely to give rise to significant	exposures to NiS	SO4 powder and dust							
Dermal: Automation of processes should be used	where possible t	o eliminate dermal contact.							
Technical conditions and measures to control	dispersion from	n source towards the worker							
LEV is required for processes not fully enclosed a	nd that are likely	to give rise to NiSO ₄ -containing dust							
Organisational measures to prevent /limit relea	ases, dispersior	and exposure							
None									
Conditions and measures related to personal	protection, hygi	ene and health evaluation							
Inhalation: RPE (FFP1,) {approved with regard to	EN 149} is minim	num required for handling final product. When handling							
powders of particle diameter below 10 μ m, RPE (I	FFP2) {approved	with regard to EN 149} is required.							
<u>Dermal</u> : Suitable gloves (PVC or equivalent), gog	gles and special	safety clothing are required.							
2.8 Control of workers exposure for contributing	ng exposure sce	enario ES 8.7							
Cleaning and maintenance									
Workers related free short title	Production of nic	kel-containing inorganic pigments from NiSO ₄							
Use descriptor covered	PROC 0: Cleanir	ig and maintenance							
	Cleaning and ma	intenance operations are regularly performed on-site.							
Processes, tasks, activities covered	This involves cle	aning and maintenance of equipment and installations							
	used for handling	of raw materials and final product							
Assessment Method	Estimation of inh	alation exposure and dermal exposure based on Tier 1							
	model.								
Product characteristic									
Variable includes powders and more coarse resid	ues								
Amounts used									
Frequency and duration of use/exposure									
8 hour shifts									
Human factors not influenced by risk manager	nent								
		INTER STREET							
Respiration volume under conditions of use		Not relevant							

Area of skin cont	tact with the	substance u	nder	condition	is of	use	Not rele	vant			
Body weight							Not rele	vant			
Other given operational conditions affecting workers exposure											
None				<u>g</u>							
Technical condi	Technical conditions and measures at process level (source) to prevent release										
None											
Technical condi	tions and r	neasures to	con	trol dispe	ersio	n from	source to	wards the	wor	ker	
Local and genera	l exhaust v	entilation									
Organisational r	neasures t	o prevent /lir	nit r	eleases	disn	ersion	and expo	SIIRA			
Oral: Good work	Organisational measures to prevent /infinit releases, dispersion and exposure										
Ural. Guod workplace hygiene produce Conditions and measures related to personal protection, bygiene and health evaluation											
Inhalation: DDE (Londitions and measures related to personal protection, hygiene and health evaluation										
Dermal: Suitable	alovos (DV)	20) is require	;u. nt) c	nonalos a	nd ci	nocial ea	foty cloth	ina ara rac	nuirod		
Derman: Suitable gloves (PVC or equivalent), goggles and special safety clothing are required.											
Environment	I IISK EStill										
			lion	and form	Intin	n of mot		unde			
Production of ni	ekol contai	ERC. FIUUUC		monte froi	nauu m Ni		ai compo	unus			
Comportment			, pigi			<u> </u>	DEC	DCD	Ma	thada for calculation of	
Compartment	Unit	FNEC	ΓĽ	CRegional		cal	FEG	RUR	env	rironmental concentrations	
Freshwater ES1	µg Ni/L	3.55	2.9		0.1	7	3.07	0.86	Me	asured values, Tier 3-RWC	
Discharge to STP											
Freshwater	µg Ni/L	3.55	2.9)	0.0	8	2.98	0.84	1		
ES2 Direct	P3 · ··· =					-					
discharge											
Marine	ua Ni/L	8.6	0.3	0.3		2	1.12	0.13			
ES1 and ES2	M3.11		•.•	0.0		-		••			
Terrestrial	ma Ni/ka	29.9	16.	2	0 73		16.93	0.57			
ES1				-	•	•					
Discharge to											
STP											
Terrestrial	ma Ni/ka	29.9	16	2	0.0	02	16.2	0.54	-		
ES2 Direct	ing tung	2010		-	0.0			0.01			
discharge											
STP	ma Ni/ka	0.33	-		-		0.023	0.07			
Workers	ing ning	0.00					0.020	0.01			
FS 8 1											
PROC 8h: Raw	Materials F	landling (rece	ntin	n & dissol	ution	of NiS	04)				
11100 00.114			puo		ulioi		04)				
		Unit		DNEL		Exposi	ure	RCR		Methods for calculation of	
				NiSO ₄		concer	ntration			exposure	
Dermal											
Acute syst	emic	mg Ni/kg/da	y	-		NR		-			
Acute lo	cal	mg		-		NR		-			
		Ni/cm ² /day									
Long-term sy	/stemic	mg Ni/kg/da	у	-		NR		-			
				0.00044		0 10	<u>^</u>	0.014			
Long-term	local	mg		0.00044		6 x 10-	0	0.014		90 ^m percentile from MEASE	
		NI/cm²/day								modeling (PROC 8b,	
										enclosed, LEV, <1 h	
										auration, gloves)	
Inhalation											
Acute syst	emic	mg Ni/m ³		16		0.018		1.13 >	(10-	Estimated as 3 x the long-	
								3		term value.	
Acute lo	cal	mg Ni/m ³		0.7		0.018		0.026			
Long-term sy	/stemic	mg Ni/m ³		0.05		0.006		0.12		Based on 7 personal	

									exposure measurements			
Long-term local	mg Ni /m ³		0.05		0.006		0.1	2	for dosing and mixing			
ES 8.2												
PROC 2, PROC 5 & PF	ROC 26: Mixing ((pre	eparation	of gra	anular pigment	precu	rsor)					
	Unit	D	NEL	Exp	osure	RCF	२	Metho	ds for calculation of			
		N	iSO4	con	centration	exposure		ure				
Dermal												
Acute systemic	mg Ni/kg/day	-		NR	NR -							
Acute local	mg Ni/cm²/day	-		NR		-						
Long-term systemic	mg Ni/kg/day	-		NR		-						
Long-term local	mg Ni/cm²/day	0.	00044	6 x	6 x 10 ⁻⁶		0.014 90 th po model LEV.,		ercentile from MEASE ling (PROC 5, enclosed, <1 h duration, gloves)			
	ma Ni/m ³	1/	2	0.00	10	5.62)	Ectim	ated as 2y the lens term			
Acute systemic		11		0.00	19	5.63 x10	4	value.	ated as 3x the long-term			
Acute local	mg Ni/m ³	0.	7	0.00)9	0.01	3					
Long-term systemic	mg Ni/m ³	0.	0.05 0.0		0.0		6	Based on 8 personal exposure measurements for dosing and				
Long-term local	mg Ni /m ³	0.	.05 0.00		0.00		3 mixing					
	•											
ES 8.3												
PROC 22: Drying and ca	lcining product											
	Unit		DNEL NiSO4		Exposure concentration		RC	R	Methods for calculation of exposure			
Dermal												
Acute systemic	mg Ni/kg/day	y	-		NR		-					
Acute local	mg Ni/cm²/day		-		NR		-					
Long-term systemic	mg Ni/kg/day	y	-		NR		-					
Long-term local	mg Ni/cm²/day		0.00044		0.00005	0.1		14	90 th percentile from MEASE modelling (PROC22, LEV, duration >4 h, with manual intervention as incidental handling, gloves)			
Inhalation	_											
	ma Nii/m3		16		0.06		2.0.402		3 x long term expecture			
Acute systemic	mg Ni/m°		10		U.U0		3.8	x I U⁻₃	S X 1011g term exposure			
Acute local	mg Ni/m ³		0.7		0.06		0.0	9	the crucibles.			
Long-term systemic	mg Ni/m ³		0.05		0.02		0.4		Based on 8 personal			
Long-term local	mg Ni /m ³		0.05		0.02		0.4		assigned to charging the crucibles.			
ES 8.4 PROC22: Dry Milling									·			
, , ,	Unit		DNEL NiSO4		Exposure concentration		RC	R	Methods for calculation of exposure			
Dermal												

Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	ma	-	NR	-	
	Ni/cm ² /day				
Long-term systemic	mg Ni/kg/dav	-	NR	-	
Long-term local	ma	0.00044	0.00003	0.07	90th percentile from MEASE
J	Ni/cm ² /day				modelling (PROC22,
					enclosed, duration > 4 h.
					automated, gloves)
Inhalation					
Acute systemic	mg Ni/m ³	16	0.12	7.5 x10 ⁻³	Estimated as 3x the long-
,	J. J				term value. A factor of 3
Acute local	mg Ni/m ³	0.7	0.12	0.17	was considered sufficient to
	-				account for the limited
					dataset.
Long-term systemic	mg Ni/m ³	0.05	0.04	0.8	Based on a single personal
Long-term local	mg Ni /m ³	0.05	0.04	0.8	exposure measurement,
					reported for milling.
					Assumed to be inhalable
					fraction.
ES 8.5					
PROC 24: Wet milling, was	shing and drying	DUE		Dep	
	Unit	DNEL	Exposure	RCR	Methods for calculation of
		NISO4	concentration	_	exposure
Dermal				_	
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg	-	NR	-	
	Ni/cm²/day			_	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/ama2/alau	0.00044	0.00003	0.07	90 ^m percentile from MEASE
	NI/Cm²/day				modelling (PROC24,
					enclosed, duration > 4 h,
					automateu, gioves)
Inhalation					
	ma Ni/m ³	16	0.012	7.5 x10-3	Estimated as 3x the long-
Addie Systemie	ing N/m	10	0.012	1.5 ×10	term value A factor of 3
Acute local	ma Ni/m ³	0.7	0.012	0.017	was considered sufficient to
	ing Nam	0.7	0.012	0.017	account for the limited
					dataset.
Long-term systemic	ma Ni/m ³	0.05	0.004	0.08	Based on a single personal
Long-term local	ma Ni /m ³	0.0	0.004	0.08	exposure measurement for
5	5				drying final product
ES 8.6					
PROC 9: Mixing and/or pa	ckaging				
	Unit	DNEL	Exposure	RCR	Methods for calculation
		NiSO ₄	concentration		of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg	-	NR	-	
	Ni/cm ² /day				
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg	0.00044	0.00086	1.95	Read across 75 th
	Ni/cm ² /day				percentile for personal
					exposure measurement
			0.00043	0.98 for	(face) reported for an
				4 h	analogous operation for
				exposure	packaging of NISO46H2O

				duration and when this duration is exceeded worker would have to wash hands and replace gloves in order to continue working	and nickel hydroxycarbonate
lah alati sa					
Acute systemic	mg Ni/m ³	16	0.3	0.02	10 x long term exposure
Acute local	mg Ni/m ³	0.7	0.3	0.43	handling powders during packaging. A factor of 10 was considered sufficient to account for the limited dataset.
Long-term systemic	mg Ni/m ³	0.05	0.03	0.6	Based on 5 personal
Long-term local	mg Ni /m³	0.05	0.03	0.6	exposure measurements for mixing and/or packaging
ES 8.7 PROC 0: Cleaning and Ma	intenance				
	Unit	DNEL NiSO4	Exposure concentration	RCR	Methods for calculation of exposure
Dermal					
Acute systemic	mg Ni/kg/day	-	NR	-	
Acute local	mg Ni/cm²/day	-	NR	-	
Long-term systemic	mg Ni/kg/day	-	NR	-	
Long-term local	mg Ni/cm²/day	0.00044	0.00003	0.07	90 th percentile from MEASE modelling (PROC10, no direct handling, non dispersive techniques, < 4 hours, gloves)
Inhalation					
Acute systemic	mg Ni/m ³	16	1.026	0.064	3 x read across exposure
Acute local	mg Ni/m ³	0.7	1.026	1.47 excl. RPE By use of RPE (P3, APF 10): 0.15.	
Long-term systemic	mg Ni/m ³	0.05	0.342	6.84 excl. RPE By use of RPE (P3,	Based on a read across from an solution/suspension preparation operation in the catalyst industry

				APF 20):	
				0.34	
Long-term local	mg Ni /m ³	0.05	0.342	6.84	
-	-			excl.	
				RPE	
				By use of	
				RPE (P3,	
				APF 20):	
				0.34	

NR: Not Relevant

Acute local inhalation

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). See <u>Appendix D1</u>.

Scaling of the PNEC for soil compartment by using a tiered approach for correction for bioavailability and background concentration (C_{local} approach). See <u>Appendix D1</u>.

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. See <u>Appendix D6</u> for site-specific guidance on exposure data collection and <u>Appendix C2</u> for further details on DNEL derivation.

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.org/exposure-scenario-library.html

9.4.2.1 Summary of secondary poisoning exposure and risk characterisation assessments for production of nickel containing pigments from nickel sulphate

The methodology applied to assess secondary poisoning is extracted from the European Union Risk Assessment for Nickel (2008-2009). A detailed report on the methodology used to derive the PNEC_{oral} and bioaccumulation factors (BAF) are provided in <u>Appendix D3</u>.

Table 109. Freshwater aquatic f	ood chain: concentration	, PECoral and risk	characterisation [•]	for mollusk-eating birds
(Oystercatcher) and mammals (European Otter)			-

Selected exposure Scenario	PEC _{local} water (mg/L)	PEC _{regional} water (mg/L)	PEC _{oral mollusk} (mg/kg wet mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1	PEC/PNEC Aquatic mammal (European Otter) PNEC=2.3 mg/kg; RAF=0.025
Selected for ES 1 Freshwater – to STP	0.0031	0.0029	0.80	0.07	0.009
Selected for ES 2 Freshwater –	0.0030	0.0029	0.79	0.07	0.009

direct discharge to			
water			

Table 110. Marine aquatic food chain: concentration, PECoral and risk characterisation for mollusk-eating birds (Oystercatcher) and mammals (Harbor seal). Two scenarios are assumed: C. edule present and C. edule absent.

PEC _{local} water	PEC _{regional} water (mg/L)	PECora (mg/kg we	ıl mollusk t mollusk)	PEC/PNEC Aquatic bird (Oystercatcher) PNEC=12.3 mg/kg; RAF=1		PEC/PNEC Aquatic mammal (Harbor seal) PNEC=4.6 mg/kg; RAF=0.025	
(iiig/L)		C. edule	C. edule	C. edule	C. edule	C. edule	C. edule
		present BAF=1631	absent BAF=270	present BAF=1631	absent BAF=270	present BAF=1631	absent BAF=270
		L/kg	L/kg	L/kg	L/kg	L/kg	L/kg
0.0011	0.0003	1.13	0.19	0.092	0.015	0.0061	0.0010

Table 111. Terrestrial food chain: concentration,	PECoral and risk characterisation for worm-eating birds and
mammals	

PEC in soil compartment (mg/kg)	Regional soil background concentration (mg/kg)	PEC _{oral local} Tissue + gut 100% worms (mg/kg ww)	PEC _{oral local} Tissue + gut 30% worms 70% isopods (mg/kg ww)	PEC/PNEC Birds (starling) PNEC=8.5 mg/kg RAF=1	PEC/PNEC Mammals (shrew) 100% worms PNEC=0.12 mg/kg RAF=0.036	PEC/PNEC Mammals (shrew) 30% worms 70% isopods PNEC=0.12 mg/kg RAF=0.025
Selected for Exposure Scenario 1 – STP scenario sludge application	16.93	16.20	2.45	1.00	0.29	0.74
Selected for Exposure Scenario 2 no sludge application	16.20	16.20	2.40	0.98	0.28	0.72

9.4.2.2 Summary of porewater concentrations in the soil compartment for production of nickel containing pigments from nickel sulphate

The derived $PEC_{porewater}$ for the generic scenario is 0.025 mg Ni/L. More details for the calculation of the $PEC_{porewater}$ are provided in <u>Appendix D3</u>.

Table 112. Predicted Exposure Concentrations (PEC) in porewater

Exposure scenario selected	PEC local porewater (mg Ni/L)
Selected for Exposure Scenario 1 – STP scenario sludge application	0.026
Selected for Exposure Scenario 2 no sludge application	0.025

9.4.2.3 Summary of atmospheric compartment for production of nickel containing pigments from nickel sulphate

An overview of the local air concentrations and PEC in the air compartment are provided in the assessment for Man via the Environment below or <u>Appendix D5</u>.

9.4.2.4 Summary of exposure concentrations in on site waste water treatment plants (WWTP) for production of nickel containing pigments from nickel sulphate

Table 113 reports the calculated Ni concentration in the effluent of the on-site WWTP (see Appendix D3).

Table 113. Concentrations in on-site waste water treatment plant					
Selected exposure scenarios	Calculated effluent concentration in on-site WWTP (mg Ni/L)				
Selected for ES 2 Freshwater – direct discharge to water	0.11				
Selected for ES Marine	0.11				

9.4.2.5 Summary of Man via Environment exposure and risk characterisation assessments for production of nickel containing pigments from nickel sulphate

For each sector, an overview of the range of operational conditions (OCs) and predicted C_{local} air and PEC air are given below. To assess whether a site is compliant with the GES, the predicted C_{local} needs to be compared to 11.5 ng Ni/m³ or the measured PEC needs to be compared to the DNEL of 20 ng Ni/m³. An assessment of predicted level of compliance for this sector based on site-specific measured or predicted exposures is provided in Section 5 of <u>Appendix D5</u>.

	tonnage (T/year)	daily emissions to air (kg/d)	release factor to air (g/T)	Emission days to air per site (d/y)	C _{local} , air* (ng Ni/m³)	PEC air ^{\$} (ng Ni/m³)
min	257	0.01	7	200	1	10
max	1840	0.21	72	365	8	16
median	690	0.14	68	350	2	11

Table 114. Sector overview

*: based based on different air models (EUSES, GPM, IFDM) \$: based on C_{local} predicted + regional background.

10. RISK CHARACTERISATION (CSR SECTION 10 IS COMBINED WITH CSR SECTION 9 ABOVE)

The content regarding Risk Characterisation was combined with the Exposure Assessment content located in CSR Section 9. Please refer to CSR Section 9 for Risk Characterisation.