

Nickel Oxide

Section 1. Identification of the Substance and Company

1.1 Product Identification:

Product Name: Nickel Oxide

Synonyms:

Nickel oxide sinter 5

FMW

Green nickel oxide

Japanese Nickel Oxide

Ni Oxide Chunks

NOS75

FEW

Nickel oxide (NiO)

TNOS

Sinter 75

Nickel (II) Oxide

FEN

Nickel monoxide

Bunsenite

EC No: 215-215-7 / 234-323-5

CAS No: 1313-99-1 / 11099-02-8

***REACH Registration number:* see Section 15**

1.2 Uses

Identified Uses:

Formulation or re-packing; Use of nickel oxide for the formulation of nickel oxide-containing catalysts and catalyst precursors

Use at industrial sites; Use of nickel oxide containing catalysts

Use at industrial sites; Intermediate use of nickel oxide-containing catalyst precursors for the manufacture of other nickel substances in catalysts

Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing powders

Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing frits

Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing inorganic pigments

Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing glass

Use at industrial sites; Intermediate use of nickel oxide sinter in carbonyl refining (nickel carbonyl process)

Use at industrial sites; Intermediate use of nickel oxide sinter in the production of stainless, special steels and special alloy

Use at industrial sites; Use of nickel oxide for the production of nickel-containing electronics and thermally functioning ceramics

Use at industrial sites; Use of nickel oxide powder for the production of nickel zinc ferrite cores

Service life (worker at industrial site); Service life of nickel-containing electronics/ferrite cores in industrial settings

Service life (professional worker); Service life of nickel-containing electronics/ferrite cores in professional settings

Service life (consumers); Service life of nickel-containing electronics/ferrite cores used by consumers

Use at industrial sites; Use of nickel oxide for the production of nickel oxide containing automotive catalysts

Service life (worker at industrial site); Production of vehicle exhaust systems in industrial settings

Service life (professional worker); Service life of vehicle exhaust systems in professional settings

Service life (consumers); Catalysis application in vehicles used by consumers

Uses Advised Against:

Use of nickel and nickel compounds in tattoo inks or permanent makeup products.

1.3 Company Identification

Manufactured by:

Vale Canada Limited
Ontario Operations
Sudbury, ON
Canada PoM 1No

Vale Japan Limited
Matsusaka Plant
345-52 Ryoshicho, Matsusaka City
Mie 515-0802, Japan

Distributed by:

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REACH Only Representative for Vale Japan:

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Imported by:

In North & South America

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U.S.A

In Asia (Except India & Pakistan)

Vale Base Metals Asia Pacific PTE. Ltd
One Temasek Avenue #39-01
Millenia Tower
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In Europe, Middle East, Africa, India & Pakistan

Vale International SA
Route de Pallatex 29
1162 Saint-Prex
Switzerland

For Fire, Spill, or chemical emergency call CHEMTREC: +1 703 527-3887

for Europe call CHEMTREC: +(44) 870 8200418

Section 2. Hazards Identification

2.1 Classification of the Substance:

Acute toxicity inhalation – Category 4
Skin Sensitization – Category 1
Respiratory Sensitization – Category 1
Carcinogenicity – Category 1A
Reproductive Toxicity – Category 1B
Specific Target Organ Toxicity, Repeated exposure – Category 1

Aquatic Chronic – Category 3

Hazard Pictograms:

GHS07 - Exclamation mark, GHS08 - Health Hazard,

Signal Word:

Danger

Hazard Statements:

H332 – Harmful if inhaled
 H317 - May cause an allergic skin reaction
 H334 – May cause allergy or asthma symptoms or breathing difficulties if inhaled
 H350 - May cause cancer by inhalation
 H360 – May damage fertility or the unborn child
 H372 - Causes damage to lungs through prolonged or repeated inhalation exposure
 H412 –Harmful to aquatic life with long lasting effects.

Precautionary Statements:

P201, P202, P260, P261, P264, P270, P271, P272, P273, P280, P284,
 P302+P352, P304+P340, P308+P313, P333+P313, P314, P321,
 P342+P311, P362+P364, P405, P501

2.2: Label elements

Product identifier: Nickel Oxide

CAS #: 1313-99-1 / 11099-02-8

Symbols:

GHS07 - Exclamation mark

GHS08 - Health Hazard



Signal Word:

Danger

Hazard Statements:

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 H350 - May cause cancer by inhalation
 H372 - Causes damage to lungs through prolonged or repeated inhalation exposure
 H412 –Harmful to aquatic life with long lasting effects.

Precautionary Statements:

P202 – Do not handle until all safety precautions have been read and understood
 P261 - Avoid breathing dust or fume; Wear respiratory protective equipment if fine dusts are generated

P273 - Avoid release to the environment.
 P302+P352 - If on skin: Wash with plenty of soap and water.
 P501 - Dispose of contents/container in accordance to local/regional/national/international regulations

(Note: P-statements have been reduced)
 For full text of Precautionary statements see section 15.

Section 3. Composition

Substance **Mixture**
 Typical Analysis:

Hazardous Ingredients	Typical Composition (%)	C.A.S. Number	EINECS/EC Label No.
Nickel Oxide (NiO)	90-96	1313-99-1	215-215-7
Copper Oxide (CuO)	0.2-9.0	1317-38-0	215-269-1
Cobaltous Oxide (CoO)	0.5- 1.5	1307-96-6	215-154-6
Nickel hydroxide	0 – 0.5	12054-48-7	235-008-05

Section 4. First Aid Measures

Ingestion: No specific first aid required.

Inhalation: No specific first aid required.

Skin: Remove contaminated clothing, and wash affected areas thoroughly with soap and water. If skin irritation or rash occurs: Get medical advice/attention. Show label if possible.

Eyes: Irrigate eyeball thoroughly with water for at least 10 minutes. If discomfort persists seek medical attention.

Most important symptoms and affects, both acute and delayed
 Skin contact: Rash
 Eye contact: Redness

Indication of immediate medical attention and special treatment needed
 No special requirements

Section 5. Fire Fighting Measures

Suitable extinguishing media: Any, type to be selected according to materials stored in the immediate neighbourhood.

Special risks: Non-flammable. Extinguish surrounding fires with appropriate methods.

Special protective equipment for fire fighting: None needed. Wear protective equipment if required for other materials within the immediate vicinity.

Section 6. Accidental Release Measures

Person related precautionary measures: Avoid generation of dusty atmospheres. Do not inhale dusts. Contaminated work clothing should not be allowed out of the workplace. Use personal protective equipment as required. Wash hands, and face thoroughly after handling.

Environmental Protection measures: Spillages and uncontrolled discharges must be prevented from entering waterways.

Procedures for cleaning/absorption: Pick up and replace in original container. Nickel-containing material is normally collected to recover nickel values.

Section 7. Handling and Storage

Precautions for Safe Handling: Prevent the generation of inhalable dusts e.g. by the use of suitable ventilation. Do not inhale dust. Wear appropriate nationally approved respirators if handling is likely to cause the concentration limits of airborne nickel to exceed the locally prescribed exposure limits. Wear suitable protective clothing and gloves. Contaminated work clothing should not be allowed out of the workplace

Conditions for Safe Storage: Keep in the container supplied, and keep container closed when not in use. Local regulations should be followed regarding the storage of this product.

Section 8. Exposure Controls / Personal Protection

8.1.1 Exposure Limits:

Nickel Oxide (NiO) – CAS 1313-99-1		
	Exposure Limit (mg/m ³)	Year
ACGIH TLV-TWA ¹	0.2 * ‡ as Ni	2008
UK WEL ²	0.5 as Ni	2011
Japan	1 as Ni	2012
Korea	0.1 as Ni	2006
China	1 as Ni	2007

* Inhalable fraction

‡ Insoluble inorganic fraction

DNEL's

	Unit	DNEL
Dermal		
Long-term local	mgNi/cm ² /day	0.035
Inhalation		
Acute local	mgNi/m ³	11.9
Long-term systemic	mgNi/m ³	0.05
Long-term local	mgNi/m ³	0.05

8.1.2 Environmental Limits:

PNEC's

Compartment	Unit	PNEC
Freshwater	µg Ni/L (bioavailable)	7.1
Sediment (freshwater)	mg Ni/kg	109
Marine water	µg Ni/L	8.6
Sediment (marine)	mg Ni/kg	109
Agricultural soil	mg Ni/kg	29.9

8.2.1 Occupational exposure controls:

Do not inhale dust. Mechanical extraction ventilation may be required if user operations change it to other physical or chemical forms, whether as end products, intermediates or fugitive emissions, which are inhalable. Maintain airborne nickel levels as low as possible. Avoid repeated skin contact.

PPE

Respiratory protection: If required, use an approved respirator with particulate filters.

Eye protection: None

Hand & Skin Protection: Wear suitable protective clothing and gloves, which should be selected specifically for the working place, depending on concentration and quantity of the hazardous material (overalls and leather/rubber gloves). Wash skin thoroughly after handling and before eating, drinking or smoking. Change contaminated clothing frequently. Launder clothing and gloves as needed. Use of skin-protective barrier cream advised.

Section 9. Physical and Chemical Properties

Solid, granular dark grey material.

Physical state at 20°C and 101.3 kPa	Solid
Melting / freezing point	>1900°C
Boiling point	Not applicable
Decomposition temperature	Not applicable
Relative density	6.75g/cm ³ at 20°C
Vapour pressure	Not applicable
Vapour density	Not applicable
Surface tension	Not applicable
Water solubility	3.52x10 ⁻⁵ g/l at 20°C (green nickel oxide) 2.26x10 ⁻³ g/l at 20°C (black nickel oxide)
pH	Not applicable
Evaporation rate	Not applicable
Partition coefficient n-octanol/water (log value)	Not applicable
Flash point	Not applicable
Flammability	Non-flammable
Explosive properties	Not applicable
Self-ignition temperature	>400°C
Oxidising properties	Non-oxidising
Granulometry	<0.1% of particles with a diameter <100µm
Stability in organic solvents and identity of relevant degradation products	Not applicable
Dissociation constant	Not applicable
Viscosity	Not applicable
Packaged density	See relative density

Section 10. Stability and Reactivity

Reactivity:

Stable under normal conditions.

Chemical stability:

Stable under normal conditions.

Possibility of hazardous reactions:

Stable under normal conditions.

Conditions to avoid:

None.

Incompatible materials:

None.

Hazardous Decomposition Product(s):

No information available

Section 11. Toxicological Information³

As a mixture the toxicological properties of this product are unknown. The toxicology of the reported ingredients is summarized below.

Nickel Oxide

Acute Toxicity:

- a) *Oral:* Non-toxic - LD₅₀ ORAL RAT >11,000 mg/kg (green); 9,990 (black)
- b) *Inhalation:* Non-toxic - LD₅₀ INHAL RAT >5.08 mg/m³ (green); >5.15 mg/m³ (black)
- c) *Dermal:* No information available.

Corrosivity/Irritation:

- a) *Respiratory Tract:* No classification
- b) *Skin:* Not corrosive/irritating.
- c) *Eyes:* Mildly irritating.

Sensitization:

- a) *Respiratory tract:* Nickel metal induced asthma is very rare. 3 case reports are available; the data is not sufficient to conclude that nickel metal is classified as a respiratory sensitizer.
- b) *Skin:* Nickel oxide is currently classified as a dermal sensitizer according to the 1st ATP to the CLP Regulation. Recent studies evaluating the bioaccessibility of a series of nickel compounds in synthetic sweat indicated very low nickel ion release from nickel oxide suggesting very low or no sensitization potency. Early Guinea pig maximization and Beuhler test results show low potential for nickel oxide to act as a dermal sensitizer.
- c) *Pre-existing conditions:* Individuals known to be allergic to nickel should avoid contact with nickel whenever possible to reduce the likelihood of nickel allergic contact dermatitis reactions (skin rashes). Repeated contact may result in persistent chronic palmar/hand dermatitis in a smaller number of individuals, despite efforts to reduce or avoid nickel exposure.

Chronic toxicity:

- a) *Oral:* No information available
- b) *Inhalation:* Exposure related toxicities were noted following 13 weeks and two years of exposure to nickel oxide in both rats and mice in the US NTP chronic rat inhalation study. Adverse effects in rodents were primarily limited to the lung (*e.g.*, increased tissue weight, inflammation, macrophage hyperplasia). The LOAEC from the chronic study in rats was 0.6 mg NiO/m³ or 0.5 mg Ni/m³.
- c) *Dermal:* No information available.

Mutagenicity /

Reproductive toxicity: Not classified for reproductive/developmental toxicity. Not classified for mutagenicity.

Carcinogenicity:

a) Ingestion: No information available. Not classified

b) Inhalation: Cat. 1A; Human epidemiological and animal data suggest that at least some forms of nickel oxide can be carcinogenic to the respiratory tract of humans after inhalation.

Cobaltous Oxide (CoO)

Acute toxicity oral: LD₅₀ ORAL RAT: 202 mg/kg

Inhalation: Causes irritation to the respiratory tract, symptoms may include coughing, shortness of breath, and nausea. Respiratory hypersensitivity, asthma may appear. Inhalation of cobalt dust and fumes is associated with an increased incidence of lung disease.

Ingestion: Causes abdominal pain, nausea, vomiting, flushing of the face and ears, mild hypotension, rash, and ringing in the ears. May have cumulative toxic action where elimination cannot keep pace with absorption. Large amounts depress erythrocyte production.

Skin Contact: May cause dermatitis. Cause irritation to skin. Symptoms include redness, itching, and pain.

Eye Contact: Causes irritation, redness, and pain.

Chronic Exposure: Repeated oral administration may produce goitre and reduced thyroid activity. Prolonged or repeated skin exposure may cause dermatitis. Chronic exposure associated with kidney, heart and lung damage.

Respiratory or skin Sensitisation: According to the EC Regulation No. 1272/2008 and subsequent regulations, cobalt oxide is classified as Category 1; H317. Cobalt oxide has no harmonized classification for respiratory. However, the Cobalt Institute have self-classified as Category IB; H334.

Carcinogenicity: Cobalt oxide has no harmonized CLP Classification. However, recent test-work conducted by the Cobalt Institute as shown that it behaves similarly to Co metal powder and Co sulphate. According to the industry grouping methodology cobalt oxide is predicted to resemble Co metal powder and Co sulphate with respect to chronic inhalation toxicity. As a result, the decision has been made to self-classify as Carc. 1B; H350i.

Reproductive toxicity: Cobalt oxide is self-classified as a reproductive toxicant (H360Fd). Therefore, nickel oxide (with cobalt oxide impurity) is classified as Repro Tox. 1B (H360), triggered by ≥0.3% cobalt oxide impurity.

Pre-existing

Conditions:

Persons with pre-existing skin disorders or eye problems, or impaired liver, kidney or respiratory function may be more susceptible to the effects of the substance. Persons with allergies or sensitivity to cobalt may also be more susceptible to the effects of the substance.

Nickel Hydroxide

No information currently available.

Copper Oxide

Acute toxicity oral: LD₅₀ ORAL RAT: >2500 mg/kg

Inhalation:

Copper fume, dusts and mists from copper ore smelting and related metallurgical operations have been associated with irritations of the respiratory tract and metal fume fever. Symptoms of metal fume fever include chills, fever and sweating.

Ingestion:

No data available

Skin Contact:

Not classified for skin irritation or corrosion

Eye Contact:

Causes immediate irritation and conjunctival inflammation, which will subside without permanent damage soon after the eye is cleansed by irrigation

Pre-existing

Conditions:

Wilson's disease can occur in certain individuals with a rare, inherited metabolic disorder characterized by retention of excessive amounts of copper in the liver, brain, kidneys and corneas. These deposits eventually lead to tissue necrosis and fibrosis, causing a variety of clinical effects, especially liver (i.e. hepatic) disease and neurologic changes. Wilson's disease is progressive and, if untreated, leads to fatal liver (i.e. hepatic) failure.

Section 12. Ecological Information

Toxicity

Aquatic Chronic 3. May cause long lasting harmful effects to aquatic life.

Persistence and degradability

The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances, such as nickel oxide.
The methods for determining the biological degradability are not applicable to inorganic substances.

Bioaccumulative potential

Nickel does not tend to bioaccumulate or biomagnify in aquatic or terrestrial systems.

Mobility in soil

The substance is essentially insoluble in water.

Results of PBT and vPvB assessment

Not classified as PBT or vPvB.

Other adverse effects

None anticipated.

Section 13. Disposal Considerations

Waste treatment methods Recover or recycle if possible. Dispose of contents in accordance with local, state or national legislation.

Additional Information No information available.

Section 14. Transport Information

International Maritime Dangerous Goods Code	Not regulated.
International Civil Aviation Organization Technical Instructions for the Carriage of Dangerous Goods by Air	Not regulated.
U.S. Dept. of Transportation Regulations	Not regulated.
Canadian Transportation of Dangerous Goods Act	Not regulated.
European Agreement Concerning the International Carriage of Dangerous Goods by Road	Not regulated.

MARPOL Annex V

Under the 7 Criteria contained within the MARPOL Annex V, This material is classified as:

	Harmful to the Marine Environment (HME)
X	Not Harmful to the Marine Environment (non-HME)

Section 15. Regulatory Information

Europe:

REACH Registration #'s:

01-2119467172-41-XXXX – Vale Europe Limited

01-2119467172-41-XXXX – Vale Japan Limited (H2 Compliance acting as Only Representative)

Exposure Scenarios: See Annex 1

Classification according to Part 3 of Annex VI of EU Regulation No. 1272/2008

Acute toxicity inhalation – Category 4

Skin Sensitization – Category 1

Respiratory Sensitization – Category 1
Carcinogenicity – Category 1A
Reproductive Toxicity – Category 1B
Specific Target Organ Toxicity, Repeated exposure – Category 1
Aquatic Chronic – Category 3

Symbols:

GHS07 - Exclamation mark

GHS08 - Health Hazard



Signal Word:

Danger

Hazard Statements:

H332 – Harmful if inhaled
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H334 – May cause allergy or asthma symptoms or breathing difficulties if inhaled
H350 - May cause cancer by inhalation
H360 – May damage fertility or the unborn child
H372 - Causes damage to lungs through prolonged or repeated inhalation exposure
H412 –Harmful to aquatic life with long lasting effects.

Precautionary Statements:

Prevention:
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust or fume
P261 - Avoid breathing dust or fume; Wear respiratory protective equipment if fine dusts are generated.
P264 - Wash hands, and face thoroughly after handling.
P270 - Do not eat, drink or smoke when using this product.
P271 – Use only outdoors or in a well-ventilated area
P272 - Contaminated work clothing should not be allowed out of the workplace.
P273 - Avoid release to the environment.
P280 - Wear protective gloves and protective clothing
P284 – [In case of inadequate ventilation] wear respiratory protection

Response:

P302+P352 - If on skin: Wash with plenty of soap and water.
P308+P313 - If exposed or concerned: Get medical advice/attention

P304+P340 – IF INHALED: remove person to fresh air and keep comfortable for breathing
P333+P313 - If skin irritation or rash occurs: Get medical advice/attention.
P314 - Get medical advice/attention if you feel unwell.
P321 - See Safety Data Sheet for specific treatment
P342+P311 – If experiencing respiratory symptoms: Call a POISON CENTER/doctor
P362+P364 – Take off contaminated clothing and wash it before reuse

Storage:
P405 - store locked up

Disposal:
P501 - Dispose of contents/container in accordance to local/regional/national/international regulations

Canada:

WHMIS 2015 Classification:

Acute toxicity inhalation – Category 4

Skin Sensitization – Category 1

Respiratory Sensitization – Category 1

Carcinogenicity – Category 1A

Reproductive Toxicity – Category 1B

Specific Target Organ Toxicity, Repeated exposure – Category 1

United States of America:

Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200)

This product contains NICKEL which is subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 and of 40 CFR 372. Refer to the Hazardous Ingredients section of this MSDS for the appropriate CAS numbers and percent by weight.

All components are listed on the US Toxic Substances Control Act (TSCA) inventory

Australia:

Classified as Hazardous according to ASCC criteria

All components are listed on the Australian Inventory of Chemical Substances (AICS)

P.R. Korea:

All components are listed in the Korean Toxic Substances Control Act inventory; KE-25818

Philippines:

All components are listed in the Philippine Inventory of Chemicals and Chemical Substances (PICCS)

Japan:

All components are listed in the Japanese Handbook of Existing and New Chemical Substances.

P.R. China:

All components are listed in the Inventory of Existing Substances in China (IECSC).

Section 16. Other Information

Indications of Change

- 1.0 – Original Document
- 2.2 – Formatting Changes
- 3.0 – Added new GES title to Annex I, Update P-Statements
- 4.0 – Removal of classification according to Directive 67/538/EEC, update of DNELs
- 4.1 – Corrections in DNEL table
- 5.0 – Updated exposure scenarios and for compliance with EU CLP/WHMIS 2015
- 6.0 – Classification update for cobalt oxide impurity for acute toxicity and respiratory sensitisation
- 6.1 – Updated exposure scenarios
- 6.2 - Updated Only Representative for Vale Japan
- 6.3 - Update of identified uses and Appendix 1-Exposure Scenarios. Added uses advised against.
- 6.4 - Update of Reproductive Toxicity classification (H360) because of cobalt oxide impurity. Update toxicology information for cobalt oxide and update of uses and exposure scenarios.

The following acronyms may be found in this document:

ACGIH	American Conference of Governmental Industrial Hygienists
DNEL	Derived No Effect Level
LTEL	Long Term Exposure Limit
LR	Lead Registrant
MMAD	Mass Median Aerodynamic Diameter
NIOSH	National Institute of Occupational Safety and Health
OEL	Occupational Exposure Limits
OR	Only Representative
OSHA	Occupational Safety and Health Administration
PBT	PBT: Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
STEL	Short Term Exposure Limit
STOT	Specific Target Organ Toxicity
TLV-TWA	Threshold Limit Value – Time Weighted Average



vPvB very Persistent and very Bioaccumulative
WEL Workplace Exposure Limit (UK HSE EH40)

Safety Data Sheet prepared by:
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SDS available online at <http://www.vale.com/canada/en/business/mining/nickel/pages/default.aspx>

Note:

Vale Canada Limited believes that the information in this Safety Data Sheet is accurate. However, Vale Canada makes no express or implied warranty as to the accuracy of such information and expressly disclaims any liability resulting from reliance on such information.

1. Threshold Limit Values of the American Conference of Governmental Industrial Hygienists. 2016
2. Maximum Exposure Limit of the Health and Safety Executive in the U.K. in EH40/2005.
3. Describes possible health hazards of the product supplied. If user operations change it to other chemical forms, whether as end products, intermediates or fugitive emissions, the possible health hazards of such forms must be determined by the user.

ANNEX 1 – Exposure Scenarios

Exposure Scenarios can be obtained by clicking on the following link:

<http://www.vale.com/canada/EN/business/mining/product-safety-information/reach-scenarios-oxide/Pages/default.aspx>

If you are unable to retrieve the document or have difficulties, please use the following email address for assistance: msds@vale.com

- ES 1: Formulation or re-packing; Use of nickel oxide for the formulation of nickel oxide-containing catalysts and catalyst precursors
- ES 2: Use at industrial sites; Use of nickel oxide containing catalysts
- ES 3: Use at industrial sites; Intermediate use of nickel oxide-containing catalyst precursors for the manufacture of other nickel substances in catalysts
- ES 4: Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing powders
- ES 5: Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing frits
- ES 6: Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing inorganic pigments
- ES 7: Use at industrial sites; Intermediate use of nickel oxide for the manufacture of nickel-containing glass
- ES 8: Use at industrial sites; Intermediate use of nickel oxide sinter in carbonyl refining (nickel carbonyl process)
- ES 9: Use at industrial sites; Intermediate use of nickel oxide sinter in the production of stainless, special steels and special alloy
- ES 10: Use at industrial sites; Use of nickel oxide for the production of nickel-containing electronics and thermally functioning ceramics
- ES 11: Use at industrial sites; Use of nickel oxide powder for the production of nickel zinc ferrite cores
- ES 12: Service life (worker at industrial site); Service life of nickel-containing electronics/ferrite cores in industrial settings
- ES 13: Service life (professional worker); Service life of nickel-containing electronics/ferrite cores in professional settings
- ES 14: Service life (consumers); Service life of nickel-containing electronics/ferrite cores used by consumers
- ES 15: Use at industrial sites; Use of nickel oxide for the production of nickel oxide containing automotive catalysts
- ES 16: Service life (worker at industrial site); Production of vehicle exhaust systems in industrial settings
- ES 17: Service life (professional worker); Service life of vehicle exhaust systems in professional settings
- ES 18: Service life (consumers); Catalysis application in vehicles used by consumers