



Nickel and Nickel Compounds

Incident Management

Key Points

Fire

- finely dispersed particles may form explosive mixtures in air
- emits toxic fumes and vapours of nickel carbonyl when heated to decomposition
- hydrogen gas is evolved when nickel undergoes reactions with acids
- In the event of a fire involving nickel or other nickel compounds, use fine water spray and normal fire kit with breathing apparatus

Health

- dyspnoea, pulmonary fibrosis and pulmonary oedema have been reported following inhalation
- nausea, vomiting, abdominal pain and diarrhoea occur within two hours of significant ingestions
- severe gastrointestinal irritation and kidney injury may follow ingestion of large amounts
- skin irritant, sensitised individuals may develop irritation and allergic contact dermatitis
- also irritating to the eyes; nickel metal may cause mechanical injury as a foreign body



Environment

- hazardous to the environment; inform the Environment Agency of substantial incidents where appropriate


Hazard Identification

Standard (UK) dangerous goods emergency action codes




Nickel carbonyl

UN		1259	Nickel carbonyl	
EAC		2WE	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses. There may be a public safety hazard outside the immediate area of the incident [†]	
APP		A(fl)	Gas-tight chemical protective suit with breathing apparatus [‡] Flammable liquid	
Hazards	Class	6.1	Toxic substance	
	Sub-risks	3	Flammable liquid	
HIN		663	Highly toxic substance, flammable (flash-point not above 60°C inclusive)	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137</p> <p>[†] People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident</p> <p>[‡] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2, thermal-resistant gloves should be worn such as those conforming to BS EN 511:2006 or BS EN 407:2004</p> <p>Reference</p> <p>Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p>				







Batteries, nickel-metal hydride

UN		3496	Batteries, nickel-metal hydride	
EAC		2Y ⁽¹⁾	Use fine water spray. Wear normal fire kit in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses	
APP		-	-	
Hazards	Class	9	Miscellaneous dangerous substance and articles	
	Sub-risks	-	-	
HIN		-	-	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* Normal firefighting clothing is appropriate, ie breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, firefighters' gloves conforming to BS EN 659 and firefighters' boots conforming to home office specification A29 or A30</p> <p>(1) Not applicable to carriage of dangerous goods under RID or ADR</p> <p>Reference</p> <p>Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p>				

Classification, labelling and packaging (CLP)***Nickel powder [particle diameter < 1 mm]**

Hazard class and category	Skin Sens. 1	Skin sensitizer, category 1	
	Carc. 2	Carcinogen, category 2	
	STOT RE 1	Specific target organ systemic toxicity following repeated exposure, category 1	
	Aquatic Chronic 3	Hazardous to the aquatic health, chronic category 3	
Hazard statement	H317	May cause an allergic skin reaction	
	H351	Suspected of causing cancer	
	H372	Causes damage to organs through prolonged or repeated exposure	
	H412	Harmful to aquatic life with long lasting effects	
Signal words	Danger		
<p>* Implemented in the EU on 20 January 2009</p> <p>Reference European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 08/2018).</p>			

Tetracarbonylnickel (Nickel carbonyl)









Hazard class and category	Flam. Liq. 2	Flammable liquid, category 2	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
	Carc. 2	Carcinogen, category 2	
	Aquatic Acute 1	Hazardous to the aquatic health, acute category 1	
	Aquatic Chronic 1	Hazardous to the aquatic health, chronic category 1	
	Repr. 1B	Reproductive toxicity, category 1B	
Hazard statement	H225	Highly flammable liquid or vapour	
	H330	Fatal if inhaled	
	H351	Suspected of causing cancer	
	H400	Very toxic to aquatic life	
	H410	Very toxic to aquatic life with long lasting effects	
	H360D	May damage the unborn child	
Signal words	Danger		



* Implemented in the EU on 20 January 2009

Reference

European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <http://echa.europa.eu/information-on-chemicals/cl-inventory-database> (accessed 08/2018).

Nickel sulphate

Hazard class and category	Acute Tox. 4	Acute toxicity (inhalation, ingestion), category 4	
	Skin Irrit. 2	Skin irritant, category 2	
	Skin Sens. 1	Skin sensitizer, category 1	
	Resp. Sens. 1	Respiratory sensitizer, category 1	
	Muta. 2	Germ cell mutagen, category 2	
	STOT RE 1	Specific target organ toxicity following repeated exposure, category 1	
	Aquatic Acute 1	Hazardous to the aquatic health, acute category 1	
	Aquatic Chronic 1	Hazardous to the aquatic health, chronic category 1	

	Carc. 1A	Carcinogen, category 1A	
	Repr. 1B	Reproductive toxicity, category 1B	
Hazard statement	H302	Harmful if swallowed	
	H315	Causes skin irritation	
	H317	May cause an allergic skin reaction	
	H332	Harmful if inhaled	
	H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	
	H341	Suspected of causing genetic defects	
	H372	Causes damage to organs through prolonged or repeated exposure	
	H400	Very toxic to aquatic life	
	H410	Very toxic to aquatic life with long lasting effects	
	H350i	May cause cancer by inhalation	
	H360D	May damage the unborn child	
Signal words	Danger		
* Implemented in the EU on 20 January 2009			
Reference			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 08/2018).			

Specific concentration limits

Concentration	Hazard class and category	Hazard statement	
C ≥ 0,01 %	Skin Sens. 1	H317	May cause an allergic skin reaction
C ≥ 1 %	STOT RE 1	H372	Causes damage to organs through prolonged or repeated exposure
C ≥ 20 %	Skin Irrit. 2	H315	Causes skin irritation
0,1 % ≤ C < 1 %	STOT RE 2	H373	May cause damage to organs through prolonged or repeated exposure

* Implemented in the EU on 20 January 2009

Reference

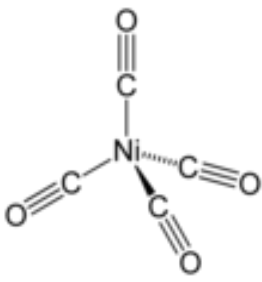
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <http://echa.europa.eu/information-on-chemicals/cl-inventory-database> (accessed 08/2018).

Physicochemical Properties

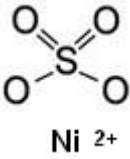
Nickel, elemental

CAS number	7440-02-0
Molecular weight	58.7
Formula	Ni
Common synonyms	-
State at room temperature	Silvery metal
Volatility	1 mm Hg at 1,810°C
Specific gravity Vapour density	8.9 (water = 1)
Flammability	Flammable as dust
Lower explosive limit	-
Upper explosive limit	-
Water solubility	Insoluble
Reactivity	Finely dispersed particles may form explosive mixtures in air
Reaction or degradation products	Emits toxic fumes and vapours of nickel carbonyl when heated to decomposition. Highly flammable hydrogen gas is evolved when nickel undergoes reactions with acids
Odour	Odourless
Structure	-
References	
<p>Hazardous Substances Data Bank. Nickel HSDB No. 1096 (last revision date 23/08/2005). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 08/2018)</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Nickel. ICSC 0062, 2017. World Health Organization, Geneva.</p>	

Nickel carbonyl

CAS number	13463-39-3
Molecular weight	170.7
Formula	C ₄ NiO ₄
Common synonyms	Nickel tetracarbonyl
State at room temperature	Colourless to yellow liquid
Volatility	400 mm Hg at 25.8°C
Specific gravity Vapour density	1.3 (water=1) 5.9 (air=1)
Flammability	Flammable
Lower explosive limit	2%
Upper explosive limit	34%
Water solubility	Insoluble in water
Reactivity	May explode on heating at 60°C. The substance may spontaneously ignite on contact with air. Reacts violently with oxidants causing fire and explosion hazard
Reaction or degradation products	Decomposes on contact with acids to produce carbon monoxide. Oxidizes in air forming deposits which become peroxidised causing fire hazard
Odour	Musty or sooty
Structure	
References	<p>Hazardous Substances Data Bank. Nickel carbonyl HSDB No.1663 (last revision date 23/06/2005). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 08/2018)</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Nickel carbonyl. ICSC 0064, 2017. World Health Organization, Geneva.</p>

Nickel sulphate

CAS number	7786-81-7
Molecular weight	154.76
Formula	NiSO ₄
Common synonyms	Nickelous sulphate Nickel(2+) sulphate
State at room temperature	Pale green to yellow crystals
Volatility	-
Specific gravity	3.7 (at 20°C)
Flammability	Non-flammable
Lower explosive limit	-
Upper explosive limit	-
Water solubility	Freely soluble in water
Reactivity	Reacts with oxidants generating fire and explosion hazard
Reaction or degradation products	Emits fumes of sulphur trioxide and nickel monoxide when heated to decomposition. The solution is a weak acid in water
Odour	Odourless
Structure	
References	
<p>Hazardous Substances Data Bank. Nickel sulphate HSDB No.1114 (last revision date 14/02/2003). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 08/2018)</p> <p>International Programme on Chemical Safety. International Chemical Safety Card entry for Nickel (II) sulphate. ICSC 0063, 2017. World Health Organization, Geneva.</p>	

Reported Effect Levels from Authoritative Sources

No appropriate effect levels from authoritative sources could be identified.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
ERPG-1*	Not given	
ERPG-2 [†]		
ERPG-3 [‡]		
<p>* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour</p> <p>[†] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action</p> <p>[‡] Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects</p>		

Acute exposure guideline levels (AEGLs)

Nickel carbonyl

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2 [†]	0.10	0.072	0.036	0.009	0.0045
AEGL-3 [‡]	0.46	0.32	0.16	0.04	0.02
<p>* Level of the chemical in air at or above which the general population could experience notable discomfort</p> <p>[†] Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape</p> <p>[‡] Level of the chemical in air at or above which the general population could experience life-threatening health effects or death</p> <p>NR Not recommended due to insufficient data</p> <p>Reference</p> <p>US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 08/2018).</p>					

Exposure Standards, Guidelines or Regulations

Occupational standards

WEL	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m ³	ppm	mg/m ³
water-soluble nickel compounds (as Ni)	-	0.1	-	-
nickel and water-insoluble nickel compounds (as Ni)	-	0.5	-	-
Tetracarbonylnickel (as Ni)	-	-	0.1	0.24

WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

Reference

Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 2nd Edition, 2011.

Public health guidelines

Drinking water standard WHO guideline value	20 µg/L 70 µg/L
Air quality guideline	Concentrations corresponding to an excess life time risk of 1: 10000, 1: 100000 and 1:1000000 are 250, 25 and 2.5 ng/m ³ , respectively

Reference

World Health Organisation (WHO), Guidelines for drinking-water quality: fourth edition incorporating the first addendum. 2017: Geneva.

The Water Supply (Water Quality) Regulations 2016

The Private Water Supplies (England) Regulations 2016 and The Private Water Supplies (Wales) Regulations 2017

Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000.

Health Effects

Nickel and Nickel Salts (Solid)

Major route of exposure

- inhalation, ingestion and dermal absorption

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Dyspnoea, pulmonary fibrosis and pulmonary oedema have been reported. In severe cases acute respiratory distress syndrome (ARDS) may occur
Ingestion	Small ingestions of dilute solutions may produce no symptoms. Nausea, vomiting, abdominal pain and diarrhoea occur within two hours in more significant ingestions, possibly associated with headache, fatigue, dizziness and myalgia Severe gastrointestinal irritation may follow ingestion of large amounts. Acute kidney injury is likely
Dermal	Skin irritant. Sensitised individuals may develop irritation and contact dermatitis with a burning sensation and pruritis followed by erythema. There may be ulceration and eruptions may spread to related areas
Ocular	Irritant to the eyes. Nickel metal may cause mechanical injury as a foreign body
Reference TOXBASE. Nickel and Nickel Salts (Solid), 11/2015. https://www.toxbase.org (assessed 08/2018)	

Nickel Carbonyl

Major route of exposure

- inhalation of fume or vapour .

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	<p>Immediate – headache, dizziness, respiratory tract irritation, cough, pharyngitis, chest pain, paraesthesia, nausea, vomiting and abdominal pain. Confusion and convulsions are reported in some cases.</p> <p>Immediate symptoms may resolve rapidly on removal from exposure but delayed effects can occur between 12 hours and 5 days later.</p> <p>Delayed – may be up to a week after exposure. Symptoms may initially resemble a flu-like illness. Nausea, cough, dyspnoea, chest pain, cyanosis, tachycardia and pyrexia leading to interstitial pneumonitis, ARDS and cerebral oedema.</p>
Ocular	Nickel carbonyl can be severely irritating to the eye.
<p>Reference TOXBASE. Nickel carbonyl 11/2015. https://www.toxbase.org (assessed 08/2018)</p>	

Decontamination at the Scene

Summary

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

Following disrobe, improvised dry decontamination should be considered for an incident involving nickel or nickel compounds, **unless casualties are demonstrating signs or symptoms of exposure to caustic or corrosive substances.**

People who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination.

Emergency services and public health professionals can obtain further advice from Public Health England (Centre for Radiation, Chemical and Environmental Hazards) using the 24-hour chemical hotline number: 0344 892 0555.

Disrobe

The disrobe process is highly effective at reducing exposure to HAZMAT/CBRN material when performed within 15 minutes of exposure.

Therefore, disrobe must be considered the primary action following evacuation from a contaminated area.

Where possible, disrobe at the scene should be conducted by the casualty themselves and should be systematic to avoid transferring any contamination from clothing to the skin. Consideration should be given to ensuring the welfare and dignity of casualties as far as possible.

Improvised decontamination

Improvised decontamination is an immediate method of decontamination prior to the use of specialised resources. This should be performed on all contaminated casualties, unless medical advice is received to the contrary. Improvised dry decontamination should be considered for an incident involving chemicals **unless the agent appears to be corrosive or caustic.**

Improvised dry decontamination

- any available dry absorbent material can be used such as kitchen towel, paper tissues (eg blue roll) and clean cloth
- exposed skin surfaces should be blotted and rubbed, starting with the face, head and neck and moving down and away from the body

- rubbing and blotting should not be too aggressive, or it could drive contamination further into the skin
- all waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage

Improvised wet decontamination

- water should only be used for decontamination where casualty signs and symptoms are consistent with exposure to caustic or corrosive substances such as acids or alkalis
- wet decontamination may be performed using any available source of water such as taps, showers, fixed installation hose-reels and sprinklers
- when using water, it is important to try and limit the duration of decontamination to between 45 and 90 seconds and, ideally, to use a washing aid such as cloth or sponge
- improvised decontamination should not involve overly aggressive methods to remove contamination as this could drive the contamination further into the skin
- where appropriate, seek professional advice on how to dispose of contaminated water and prevent run-off going into the water system

Additional notes

- following improvised decontamination, remain cautious and observe for signs and symptoms in the decontaminated person and in unprotected staff
- if water is used to decontaminate casualties this may be contaminated, and therefore hazardous, and a potential source of further contamination spread
- all materials (paper tissues etc) used in this process may also be contaminated and, where possible, should not be used on new casualties
- the risk from hypothermia should be considered when disrobe and any form of wet decontamination is carried out
- people who are contaminated should not eat, drink or smoke before or during the decontamination process and should avoid touching their face
- consideration should be given to ensuring the welfare and dignity of casualties as far as possible. Immediately after decontamination the opportunity should be provided to dry and dress in clean robes/clothes

Interim wet decontamination

Interim decontamination is the use of standard fire and rescue service (FRS) equipment to provide a planned and structured decontamination process prior to the availability of purpose-designed decontamination equipment.

Decontamination at the scene references

National Ambulance Resilience Unit. Joint Emergency Services Interoperability Programme (JESIP). Initial operational response to a CBRN incident. Version 1.0, September 2013.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Chemical incidents: planning for the management of self-presenting patients in healthcare settings. April 2015.

Clinical Decontamination and First Aid

Clinical decontamination is the process where trained healthcare professionals using purpose-designed decontamination equipment treat contaminated people individually.

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important note

- **once body surface contaminants have been removed or if your patient was exposed by ingestion or inhalation the risk that secondary care givers may become contaminated is very low.** Secondary carers should wear standard hospital PPE as a precaution against secondary contamination from vomit and body fluids
- if the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves. The area should be well ventilated

Clinical decontamination following surface contamination

- avoid contaminating yourself with this product and wash any exposed area
- any particulate matter adherent to skin should be removed and the patient washed with soap and water under low pressure for at least 10 – 15 minutes
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- decontaminate (as above) the patient following surface contamination
- other supportive measures as indicated by the a patients clinical condition

Ocular exposure

- if symptomatic immediately irrigate the affected eye thoroughly
- for patients at home, use lukewarm tap water, trickled into the eye or in a small cup held over the eye socket
- in hospital – immediately irrigate eye thoroughly with 1000 mL 0.9% saline or equivalent crystalloid (for example via an infusion bag with a giving set) for minimum of 10 - 15 minutes. Amphoteric solutions are available and may be used. A Morgan Lens may be used if anaesthetic has been given
- refer for ophthalmological assessment if there is doubt regarding the management of corneal damage
- other supportive measures as indicated by the patient's clinical condition

Inhalation/inhalation

- maintain a clear airway and ensure adequate ventilation
- give oxygen
- monitor vital signs and check capillary blood sugar
- other supportive measures as indicated by the patient's clinical condition

Health effects and decontamination references

TOXBASE	http://www.toxbase.org (accessed 08/2018)
TOXBASE	Nickel and nickel salts – features and management, 11/2015
TOXBASE	Nickel carbonyl, 11/2015
TOXBASE	Skin decontamination - irritants, 05/2012
TOXBASE	Eye irritants – features and management, 01/2016
TOXBASE	Personal protective equipment and decontamination at the scene or in hospital

This information contained in this document from the PHE Centre for Radiation, Chemical and Environmental Hazards is correct at the time of its publication.

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