Public Health England

Protecting and improving the nation's health

Sodium Hydroxide

Incident Management

Key Points

Fire

- non-flammable, hygroscopic, generates heat on mixing with acids
- sodium hydroxide solution attacks some metals such as aluminium, tin, lead and zinc to form hydrogen gas, causing a fire hazard
- emits toxic fumes of carbonates, peroxides and sodium oxides when heated to decomposition
- in the event of a fire involving sodium hydroxide, use fine water spray and liquid-tight chemical protective clothing with breathing apparatus

Health

- inhalation causes irritation of the eyes and nose with sore throat, cough, chest tightness, wheeze, headache, tachycardia and confusion; pulmonary oedema may take up to 36 hours to develop
- ingestion causes burning in the mouth, throat and stomach, followed by dysphagia, drooling, abdominal pain, vomiting, haematemesis and dyspnoea; haemorrhagic or hypovolemic shock and airway obstruction may occur in severe cases
- dermal exposure causes deep, full thickness burns
- ocular exposure causes pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia, in severe cases corneal burns, glaucoma and cataracts may occur, **alkali burns to the eyes should be considered an ophthalmic emergency**

Environment

- avoid release to the environment, inform the Environment Agency of substantial incidents

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Hazard Identification

Standard (UK) dangerous goods emergency action codes

Sodium hydroxide, solid

UN		1823	Sodium hydroxide, solid	
EAC		2W	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 surface and groundwaters	
APP		–	–	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive substance	

Sodium hydroxide solution

UN		1824	Sodium hydroxide solution	
EAC		2R	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off may be washed to drains with large quantities of water, though care must, still be taken to avoid unnecessary pollution to surface and groundwaters	
APP		–	–	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive substance	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid tight connections for whole body (type 3) conforming to relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN137

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015.

Classification, labelling and packaging (CLP)*

Hazard class and category	Skin Corr. 1A	Skin corrosion, category 1A	
Hazard statement	H314	Causes severe skin burns and eye damage	
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 05/2015).

Specific concentration limits

Concentration	Hazard class and category	Hazard statement	
C ≥ 5%	Skin Corr. 1A	H314	Causes severe skin burns and eye damage
2% ≤ C < 5%	Skin Corr. 1B	H314	Causes severe skin burns and eye damage
0.5% ≤ C < 2%	Skin Irrit. 2	H315	Causes skin irritation
0.5% ≤ C < 2%	Eye Irrit. 2	H319	Causes serious eye irritation

* 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 05/2015).

Physicochemical Properties

CAS number	1310-73-2
Molecular weight	40.1
Formula	NaOH
Common synonyms	Caustic soda, sodium hydrate, soda lye
State at room temperature	Colourless solid or liquid (solution)
Volatility	1 mm Hg at 739°C
Specific gravity	2.13 at 20°C (water = 1)
Flammability	Non-flammable
Lower explosive limit	No data available
Upper explosive limit	No data available
Water solubility	Highly soluble
Reactivity	Reacts with water in air. When wet or in solution attacks metals such as aluminium, tin, lead and zinc Also generates heat on exposure to acids or water. Aqueous solutions react violently with acids
Reaction or degradation products	May decompose on heating to liberate corrosive/toxic fumes, including carbonates, peroxides and sodium oxides. May liberate hydrogen gas on reaction with metals. Reacts with ammonia salts to produce ammonia, causing fire hazard. Readily reacts with atmospheric carbon dioxide to form sodium carbonate
Odour	Odourless

References

International Programme for Chemical Safety (IPCS). International Chemical Safety Card entry for sodium hydroxide, ISCS 0360, 2010. World Health Organization: Geneva.

Sodium Hydroxide (HAZARDTEXT™ Hazard Management). In: Klasco RK (Ed): TOMES® System. Truven Healthcare Analytics Inc., Greenwood Village, Colorado, USA. (electronic version). RightAnswer.com, Inc., Midland, MI, USA, Available at: http://www.rightanswerknowledge.com (assessed 05/2015).

Reported Effect Levels from Authoritative Sources

Exposure by skin

%	Signs and symptoms	Reference
0.5–4	Skin irritation	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

Reference

a Sodium Hydroxide. SIDS Initial Assessment Report for SIAM 14, 2002.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (mg/m^3)
ERPG-1*	0.5
ERPG-2†	5
ERPG-3‡	50

* 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

† 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

‡ 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

Reference

American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf (accessed 09/2015).

Acute exposure guideline levels (AEGLs)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	Data not available				
AEGL-2†					
AEGL-3‡					

* Level of the chemical in air at or above which the general population could experience notable discomfort

† 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

‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death

Exposure Standards, Guidelines or Regulations

Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	No guideline value specified		–	2

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 (second edition, published 2011).

Public health guidelines

Drinking water standard	No guideline value specified
Air quality guideline	No guideline value specified
Soil guideline values and health criteria values	No guideline value specified

Health Effects

Major route of exposure

- ingestion, inhalation, dermal and ocular exposure

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Ingestion	Immediate pain with burning in the mouth, throat and stomach, which may be followed by abdominal pain, vomiting, haematemesis and dyspnoea. Pain and oedema may make swallowing difficult, causing drooling. Acids can damage the stomach causing ulceration, gangrene, haemorrhage and perforation. In severe cases extensive areas of the gastrointestinal tract may be involved Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases Stridor and respiratory complications (including pneumonitis, pulmonary oedema, ARDS and pulmonary necrosis) can develop following aspiration of corrosive materials **Systemic effects** include circulatory collapse, metabolic acidosis, hypoxia, respiratory failure, acute renal failure, haemolysis and disseminated intravascular coagulation (DIC)
Inhalation	Irritation of eyes and nose with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion. Chemical pneumonitis, tachypnoea, dyspnoea and stridor due to laryngeal oedema may follow Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36 hours to develop Optic neuropathy has been reported following both acute and chronic inhalation Severe inhalation injuries may result in persistent hoarseness, pulmonary fibrosis and chronic obstructive airway disease Prolonged exposure may cause systemic effects

Dermal	Symptoms are more likely to occur following direct contact with solid or liquid corrosive materials, although features can also occur through contact with corrosive gases and fumes Alkalis can directly damage tissue by the saponification of fats and the solubilisation of proteins and collagen. This causes liquefaction burns and necrosis with a softening of the tissues which can further lead to deep tissue penetration and full thickness burns Dermal alkali injuries may be initially painless leading to a delay in treatment. Alkali injuries can also progress over several hours and it can be difficult to assess the extent of the resulting burn due to quickly developing skin discolouration Large or prolonged exposure may result in systemic effects
Ocular	May cause pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia. Alkaline solutions in particular may penetrate all layers of the eye, causing iritis, anterior and posterior synechiae, corneal opacification, cataracts, glaucoma and retinal atrophy. **Alkali burns to the eyes should be considered an ophthalmic emergency**

Reference

TOXBASE. Sodium hydroxide, 07/2014. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Corrosives – inhalation, 02/2012. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Corrosives – ingestion, 06/2016. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Skin decontamination – corrosives, 06/2010. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Chemical splashed or sprayed into the eyes, 02/2014. http://www.toxbase.org (accessed 11/2016).

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.

Sodium hydroxide is corrosive. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

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
- 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

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

- 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
- carry out decontamination after resuscitation; resuscitate the patient according to standard guidelines

Clinical decontamination following surface contamination

- carry out decontamination after resuscitation
- this should be performed in a well-ventilated area, preferably with its own ventilation system
- do **not** apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns, and increase injury
- contaminated clothing should be removed, double-bagged, sealed and stored safely
- decontaminate open wounds first and avoid contamination of unexposed skin
- any particulate matter adherent to skin should be removed and the patient washed with copious amounts of water under low pressure for at least 10–15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5–6, although it may be closer to 7 in children, or after irrigation). **The earlier irrigation begins, the greater the benefit**
- 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
- following decontamination recheck the pH of affected areas after a period of 15–20 minutes and repeat irrigation if abnormal; burns with strong solutions may require irrigation for several hours or more
- once the pH is normal and stabilised, treat as for a thermal injury
- burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns
- moderate/severe chemical burns should be reviewed by a burns specialist

- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- remove contact lenses if present
- anaesthetise the eye with a topical local anaesthetic (eg oxybuprocaine, amethocaine or similar); **however, do not delay irrigation if local anaesthetic is not immediately available**
- immediately irrigate the affected eye thoroughly with 1,000 mL 0.9% saline (eg by an infusion bag with a giving set). A Morgan Lens may be used if anaesthetic has been given. Irrigate for 10–15 minutes irrespective of initial conjunctival pH. Aim for a final conjunctival pH of 7.5–8.0. The conjunctivae may be tested with indicator paper. Retest 20 minutes after irrigation and use further irrigation if necessary
- repeated instillation of local anaesthetics may reduce discomfort and help more thorough decontamination; however, prolonged use of concentrated local anaesthetics is damaging to the cornea
- patients with corneal damage, those who have been exposed to strong acids or alkalis and those whose symptoms do not resolve rapidly should be referred **urgently** to an ophthalmologist
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and ensure adequate ventilation
- give oxygen if required
- perform a 12 lead ECG
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- **maintain airway and establish haemodynamic stability**
- in severely affected patients critical care input is essential. Urgent assessment of the airway is required. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction
- do **not** attempt gastric lavage
- do **not** give neutralising chemicals as heat produced during neutralisation reactions may increase injury
- The use of water or milk (maximum initial volume = 100 - 200 mL in an adult; 2 mL/kg in a child) as diluents in the management of corrosive ingestion may be of some symptomatic benefit (but caution is necessary following large ingestions where mucosal damage / perforation may have already developed). There is experimental evidence to

suggest that early dilution therapy with water or milk reduces acute alkali injury of the oesophagus but administration of large volumes of fluid should be avoided as they may induce vomiting and increase the risk of oedema

- monitor blood pressure, pulse and oxygen saturation
- perform a 12 lead ECG in all patients who require assessment
- other supportive measures as indicated by the patient's condition

Health effects and decontamination references

TOXBASE http://www.toxbase.org (accessed 11/2016)

TOXBASE Sodium hydroxide, 07/2014

TOXBASE Skin decontamination – corrosives, 06/2010

TOXBASE Chemicals splashed or sprayed into the eyes, 02/2014

TOXBASE Corrosives – inhalation, 02/2012

TOXBASE Corrosives – ingestion, 06/ 2016

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

For queries relating to this document, please contact: generaltox@phe.gov.uk

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