UK Health Security Agency

Chlorine

Incident management

Contents

Main points

General

Chlorine is a yellow-green gas at room temperature with a pungent odour of bleach. It is stored as compressed gas or in aqueous solutions.

Chlorine is corrosive and a strong oxidant. It is non-combustible but enhances the combustion of other substances. It may combine with water or steam to produce toxic and corrosive fumes of hydrochloric acid.

Health

Inhalation and ocular exposure are the most common routes of exposure.

Chlorine is irritating to the eyes, respiratory system and skin

Inhalation of chlorine gas may cause sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion.

Dermal exposure may cause erythema, pain, irritation and cutaneous burns. Liquid chlorine may cause cutaneous burns. Gaseous chlorine will irritate the skin and may cause burns in high concentrations.

Casualty decontamination at the scene

Chlorine is a volatile gas at room temperature, therefore decontamination may not be required. However, gaseous chlorine will irritate the skin at high concentrations and liquid chlorine may cause cutaneous burns. This should be considered in the risk assessment when deciding on the need for disrobe and decontamination.

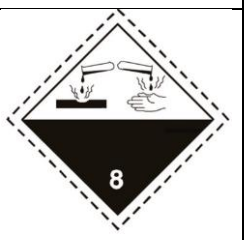
Environment

Inform the Environment Agency where appropriate and avoid release into the environment.

Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters

Hazard identification

Table 1a. Standard (UK) dangerous goods emergency action codes for chlorine

UN		1017	Chlorine	
EAC		2XE	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. There may be a public safety hazard outside the immediate area of the incident [note 2]	
APP		A(c)	Fire kit with gas tight chemical protective suit with breathing apparatus [note 3] Liquefied gas with boiling point below -20°C	
Hazards	**Class**	2.3	Toxic gas	
	Sub-risks	8	Corrosive substance	
		5.1	Oxidising substance	
HIN		265	Toxic gas, oxidising (fire-intensifying)	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1

Note 1: 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 conforming to BS EN 137.

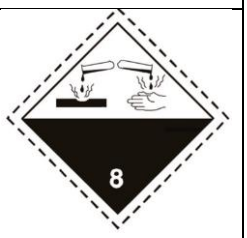
Note 2: People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and ventilation stopped. Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.

Note 3: Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137. Suitable thermal resistant gloves should be worn, such as those conforming to BS EN511 or BS EN407.

Reference

‘Dangerous Goods Emergency Action Code List’. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023)

Table 1b. Standard (UK) dangerous goods emergency action codes for chlorine, adsorbed

UN		3520	Chlorine, adsorbed	
EAC		2XE [note 4]	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. There may be a public safety hazard outside the immediate area of the incident [note 2]	
APP		B	Gas tight chemical protective suit with breathing apparatus [note 3]	
Hazards	**Class**	2.3	Toxic gas	
	Sub-risks	8	Corrosive substance	
		5.1	Oxidising substance	
HIN		-	-	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1

Note 1: 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 conforming to BS EN 137.

Note 2: People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and ventilation stopped. Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.

Note 3: Chemical protective clothing should be gas-tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

Note 4: Not applicable to the carriage of dangerous goods under Regulations Concerning the International the International Carriage of Dangerous Goods by Road (ADR)

Reference

‘Dangerous Goods Emergency Action Code List’. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023)

Table 2. The GB classification, labelling and packaging (CLP) regulation for chlorine

Hazard class and category	Press. Gas	Gasses under pressure	
	Ox. Gas 1	Oxidising gases, category 1	
	Skin Irrit. 2	Skin irritation, category 2	
	Eye Irrit. 2	Eye irritation, category 2	
	Acute Tox. 3	Acute toxicity (inhalation), category 3	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	Aquatic Acute 1	Acute hazard to the aquatic environment, category 1	
Hazard statement	H270	May cause or intensify fire; oxidiser	
	H315	Causes skin irritation	
	H319	Causes serious eye irritation	

	H331	Toxic if inhaled
	H335	May cause respiratory irritation
	H400	Very toxic to aquatic life
Signal words	DANGER	

References

The Health and Safety Executive (HSE). 'GB CLP Regulation' (viewed September 2024)

Physicochemical properties

Table 3. Physicochemical properties

CAS number	7782-50-5
Molecular weight	70
Formula	Cl_2
Common synonyms	-
State at room temperature	Yellow-green gas
Volatility	Vapour pressure = 5,830 mmHg at 25°C
Specific gravity	2.5 (air = 1)
Flammability	Non-combustible but enhances combustion of other substances
Lower explosive limit	N/A
Upper explosive limit	N/A
Water solubility	0.7 g/100 mL at 20°C
Reactivity	Reacts violently with bases. Chlorine is corrosive and a strong oxidant. Reacts violently with combustible substances and reducing agents. Will react with most organic and inorganic compounds, causing fire and explosion hazard. Attacks metals, some forms of plastic, rubber and coatings.
Reaction or degradation products	May combine with water or steam to produce toxic and corrosive fumes of hydrochloric acid
Odour	Pungent odour of bleach

References

International Programme on Chemical Safety. International Chemical Safety Card entry for Chlorine. ICSC 0126, 2009. World Health Organization: Geneva. (viewed September 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004-. PubChem Compound Summary for CID 24526, Chlorine. (viewed September 2024)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

ppm	mg/m^3	Signs and symptoms	Reference
1 to 3	2.9 to 8.7	Mild mucous membrane irritation, tolerable for up to 1 hour	a
5	14.5	Eye irritation	a
5 to 15	14.5 to 43.5	Eye and more general moderate irritation	a
<20	<58	General irritation but no serious long-term respiratory effects expected	a
30	87	Respiratory effects, immediate chest pain, dyspnoea and cough	a
40 to 60	116 to 174	Toxic pneumonitis and pulmonary oedema	a
430	1,247	Fatal over 30 minutes	a
1,000	2,900	Fatal within minutes	a

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

References

a. Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological profile for Chlorine. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Published emergency response guidelines

Table 5. Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1 [note 1]	0.50	0.50	0.50	0.50	0.50
AEGL-2 [note 2]	2.8	2.8	2.0	1.0	0.71
AEGL-3 [note 3]	50	28	20	10	7.1

Notes to Table 5

Note 1: Level of the chemical in air at or above which the general population could experience notable discomfort.

Note 2: 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.

Note 3: Level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

Reference

US Environmental Protection Agency (EPA) ‘Acute Exposure Guideline Levels’ (viewed April 2024)

Exposure standards, guidelines or regulations

Table 6. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	**mg/m³**	**ppm**	**mg/m³**
WEL	-	-	0.5	1.5

Abbreviations

WEL = workplace exposure limit.
LTEL = long-term exposure limit.
STEL = short-term exposure limit.

Reference

HSE. 'EH40/2005 Workplace Exposure Limits . Fourth Edition' (2020)

Table 7. Public health standards and guidelines

Drinking water standard	No value specified
WHO guideline for drinking water quality	5 mg/L
WHO air quality guideline	No value specified

Reference

World Health Orgnaization. 'Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda', 2022.

Health effects

Due to its gaseous nature, inhalation and ocular exposure to chlorine are the most likely routes of exposure.

Dermal features usually occur only from exposure to concentrated chlorine gas or in the immediate vicinity of a release of pressurised liquid.

Significant ingestion is unlikely because chlorine is a gas at room temperature.

Table 8. Signs or symptoms of acute exposure

Route	Signs and symptoms
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 acute inhalation. In serious cases, corrosive damage to the mucous membranes of both the upper and lower respiratory tract occurs. Serious inhalation injuries may result in persistent hoarseness, pulmonary fibrosis and chronic obstructive pulmonary disease.
Ocular	Splashes in the eye may cause significant damage
Dermal	Dermal exposure may cause erythema, pain, irritation and cutaneous burns. Liquid chlorine may cause cutaneous burns. Gaseous chlorine will irritate the skin and may cause burns in high concentrations.

Reference

TOXBASE. Chlorine, April 2023 (viewed September 2024)

Decontamination at the scene

Chemical specific advice

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.

Chlorine is a volatile gas at room temperature, therefore decontamination may not be required. However, gaseous chlorine will irritate the skin at high concentrations and liquid chlorine may cause cutaneous burns. This should be considered in the risk assessment when deciding on the need for disrobe and decontamination.

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 the UK Health Security Agency (UKHSA) Radiation, Chemicals and Environment Directorate 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, disrobing should be conducted at the scene and by the casualty themselves. Disrobing should be systematic to prevent transfer of contaminant from clothing to skin. Clothing should not be pulled over the head if possible.

Clothing stuck to the casualty by the contaminant should not be forcefully removed, as this risks causing further harm.

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 or clothes.

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.

Unprotected first responders and members of the public should not approach casualties incapacitated by exposure to administer improvised decontamination, as they may be exposed to contaminants and become a casualty themselves.

Important note: Improvised decontamination should continue until more structured interventions such as Interim or Specialist Operational Response are present.

Improvised dry decontamination

Any available dry absorbent material can be used such as kitchen towel, paper tissues (for example blue roll) and clean cloth.

Exposed skin surfaces should be blotted first and then rubbed, starting with the face, head, and neck, and moving down and away from the body.

Blotting and rubbing should not be too aggressive, as it could drive contamination further into the skin.

Casualties should also blow their nose to remove contaminants from the nasal cavities.

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 copious amounts of water from any available source such as taps, showers, water bottles, fixed installation hose-reels and sprinklers to gently rinse the affected skin. Other natural sources of water may be considered unless this creates greater risks to the individuals affected. Wet wipes or baby wipes may be used as an effective alternative.

Improvised decontamination should not involve overly aggressive methods to remove contamination as this could further damage affected tissues and 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 and so on) 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.

When vulnerable people are affected by a hazardous substance, they may need additional support to remove themselves, their clothing or the substance.

Casualties should remain in the area and should not leave to seek care at a hospital, as this presents a contamination risk. Further care will be administered on site by the appropriate emergency services.

Interim wet decontamination

Interim decontamination is the use of standard Fire and Rescue Service equipment to provide a planned and structured decontamination process prior to the availability of purpose-designed decontamination equipment.

Decontamination at the scene references

Home Office. ‘Initial operational response to a CBRN incident.’ Version 2.0 (July 2015)

NHS England. ‘Emergency Preparedness, Resilience and Response (EPRR): Guidance for the initial management of self-presenters from incidents involving hazardous materials.’ (February 2019)

JESIP. ‘Initial Operational Response IOR to Incidents Suspected to Involve Hazardous Substances or CBRN Materials’ (January 2023)

Clinical decontamination and first aid

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

Detailed information on clinical management can be found on TOXBASE.

Important notes

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.

For comprehensive clinical advice consult TOXBASE directly.

Clinical decontamination following surface contamination

Avoid contaminating yourself.

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 the 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 to 15 minutes, or until pH of skin is normal (pH of the skin is 4.5 to 6 although it may be closer to 7 in children, or after irrigation). The earlier irrigation begins, the greater the benefit.

Pay special attention to skin folds, fingernails and ears.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Recheck pH of affected areas after a period of 15 to 20 minutes and repeat irrigation if abnormal. Burns with strong solutions may require irrigation for several hours or more. Attention should be paid to avoiding hypothermia during prolonged irrigation with cool fluids.

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 or severe chemical burns should be reviewed by a burns specialist as excision or skin grafting may be required.

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 (for example, oxybuprocaine, amethocaine or similar). However, do not delay irrigation if local anaesthetic is not immediately available.

Immediately irrigate the affected eye thoroughly with 1,000mL 0.9% saline or equivalent crytalloid (for example, by an infusion bag with a giving set) for a minimum of 10 to 15 minutes irrespective of initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given.

Aim for a neutral conjunctival pH of 7 to 7.2. The conjunctivae may be tested with indicator paper. Retest at 15 to 30 minutes after irrigation and use further irrigation if necessary.

Any particles lodges in the conjunctival recesses should be removed.

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 discussed urgently with an ophthalmologist.

Other supportive measures as indicated by the patient's clinical condition.

Inhalation

Maintain a clear airway and ensure adequate ventilation.

Administer oxygen to achieve adequate oxygenation.

Monitor vital signs and cardiac rhythm; check the capillary blood glucose.

Check and record pupil size.

Perform a 12-lead ECG in all patients who require assessment.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction.

Children are at increased risk of airway obstruction and treating clinicians should have a low threshold for establishing a protected airway.

Other supportive measures as indicated by the patient's clinical condition.

Clinical decontamination and first aid references

TOXBASE (viewed September 2024).

TOXBASE Chlorine (2023)

TOXBASE Chemicals splashed or sprayed into the eyes – Features and clinical management (2020)

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

This document from the UKHSA Radiation, Chemicals and Environment Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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