



UK Health
Security
Agency

Toluene diisocyanate

Incident management

This document provides information needed for response to a chemical incident, such as physicochemical properties, health effects and decontamination advice.

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Contents

Main points.....	3
General.....	3
Health.....	3
Casualty decontamination at the scene.....	3
Environment.....	3
Hazard identification.....	4
Physicochemical properties.....	7
Reported effect levels from authoritative sources.....	9
Published emergency response guidelines.....	10
Exposure standards, guidelines or regulations.....	11
Health effects.....	12
Decontamination at the scene.....	13
Chemical specific advice.....	13
Disrobe.....	13
Improvised decontamination.....	14
Improvised dry decontamination.....	14
Improvised wet decontamination.....	14
Additional notes.....	15
Interim wet decontamination.....	15
Decontamination at the scene references.....	16
Clinical decontamination and first aid.....	17
Important notes.....	17
Clinical decontamination following surface contamination.....	17
Dermal exposure.....	18
Ocular exposure.....	18
Ingestion.....	18
Inhalation.....	19
Clinical decontamination and first aid references.....	19
About the UK Health Security Agency.....	20

Main points

General

Toluene diisocyanate is a colourless-to-pale yellow liquid or crystals at room temperature which turn pale yellow on exposure to air. Toluene diisocyanate is combustible.

May react violently with acids, amines, alcohols, bases and warm water and should be considered an explosion hazard.

Products of combustion include carbon monoxide, carbon dioxide, oxides of nitrogen, and cyanides. Reacts with water to form carbon dioxide.

Health

Inhalation causes irritation and sensitisation; symptoms of irritation may be immediate or delayed for 4 to 8 hours and progress over a period of days. Dry throat, chest tightness, shortness of breath, coughing and wheezing may occur; neurological features reported include euphoria, anxiety, paraesthesia and ataxia.

Ingestion causes gastrointestinal irritation.

Dermal exposure causes inflammation, blisters, erythema and itching; sensitisation and allergic contact dermatitis may occur.

Ocular exposure to the vapour may cause pain, burning, lacrimation, superficial lesions and conjunctivitis.

Casualty decontamination at the scene

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


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 1. Standard (UK) dangerous goods emergency action codes for toluene diisocyanate

UN		2078	Toluene diisocyanate	
EAC		2Z	Use fine water spray. Wear normal fire kit in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters.	
APP		-	-	
Hazards	Class	6.1	Toxic substances	
	Sub-risks	-	-	
HIN		60	Toxic or slightly toxic substance	

Abbreviations

UN = United Nations number.

EAC = emergency action code.

APP = additional personal protection.

HIN = hazard identification number.








Notes to Table 1

Note 1: Normal firefighting clothing is appropriate i.e., self-contained open circuit positive pressure compressed air breathing apparatus conforming to BS EN 137 worn in combination with fire kit conforming to BS EN 469, fire fighters' gloves conforming to BS EN 659 and firefighters' footwear conforming to BS EN 15090 (Footwear for firefighters) type F3- Hazmat and structural firefighting [CH – marking for chemical resistance] or alternatively firefighters' boots conforming to Home Office Specification A29 (rubber boots) or A30 (leather boots). Leather footwear including those conforming to A30 may not provide adequate chemical resistance therefore caution should be exercised in the use of these boots.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. '[Dangerous Goods Emergency Action Code List](#)'. 2023 (viewed on 21 November 2024)

Table 2a. The GB classification, labelling and packaging (CLP) regulation for toluene diisocyanate

Hazard class and category	Carc. 2	Carcinogenicity, category 2	
	Acute Tox. 2	Acute toxicity (inhalation), category 2	
	Eye Irrit. 2	Eye irritation, category 2A	
	Resp. Sens. 1	Respiratory sensitisation, category 1	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	Skin Irrit. 2	Skin irritation, category 2	
	Skin Sens. 1	Skin sensitisation, category 1	
	Aquatic Chronic 3	Chronic hazards to the aquatic environment, category 3	-
Hazard statement	H315	Causes skin irritation	
	H317	May cause an allergic skin reaction	

	H319	Causes serious eye irritation
	H330	Fatal if inhaled
	H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled
	H335	May cause respiratory irritation
	H351	Suspected of causing cancer
	H412	Harmful to aquatic life with long lasting effects
Signal words	DANGER	

References

The Health and Safety Executive (HSE). '[GB CLP Regulation](#)' (viewed on 22 November 2024).

Table 2b. Specific concentration limits for toluene diisocyanate

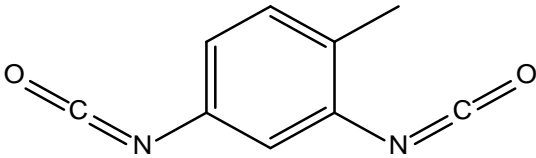
Concentration	Hazard class and category	Hazard statement	
C ≥ 0.1%	Resp. Sens 1	H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled

References

The Health and Safety Executive (HSE). '[GB CLP Regulation](#)' (viewed 22 November 2024).

Physicochemical properties

Table 3. Physicochemical properties

CAS number	584-84-9 (2,4 toluene diisocyanate) 26471-62-5 (isomer mixture)
Molecular weight	174.2
Formula	$C_9H_8N_2O_2^{-2}$, $C_9H_8N_2O_2$, $CH_3C_6H_3(NCO)_2$
Common synonyms	Toluene di-isocyanate 2,4-Toluene diisocyanate 2,4-TDI, 2,4-Diisocyanatotoluene 2,4-Diisocyanato-1-methylbenzene
State at room temperature	Colourless-to-pale yellow liquid or crystals. Turns pale yellow on exposure to air.
Volatility	0.008 mmHg at 20°C
Relative density	1.2 (water = 1) 6.0 (air = 1)
Flammability	Combustible
Lower explosive limit	0.9%
Upper explosive limit	9.5%
Water solubility	Reacts with water
Reactivity	May react violently with acids, amines, alcohols, bases and warm water and should be considered an explosion hazard. Products of combustion include carbon monoxide, carbon dioxide, oxides of nitrogen, and cyanides. Reacts with water to form carbon dioxide.
Odour	Sharp, pungent odour
Structure	

References

World Health Organization. International Programme on Chemical Safety '[International Chemical Safety Card entry for 2,4-Toluene Diisocyanate](#)' ICSC 0339, 2021 (viewed on 22 November 2024)

Compendium of chemical hazards: Toluene diisocyanate

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information. '[PubChem Compound Summary for CID 21584847, Toluediisocyanate](#)' (viewed on 22 November 2024)

Reported effect levels from authoritative sources

Table 4. Exposure by inhalation

ppm	mg/m ³	Signs and symptoms	Reference
0.005-0.01	0.035-0.7	Eyes and nose irritation, burning nose and throat, choking sensation	a
0.01-0.5	0.7-3.5	Irritation, cough and chest discomfort, secretions in the eyes and nose	a
1.9	13.57	Burning eyes and nose	a
3.9	27.8	Severe irritation of eyes and respiratory tract	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. International Programme on Chemical Safety (IPCS). '[Environmental Health Criteria 75, Toluene Diisocyanates](#)', 1987. World Health Organization: Geneva. (viewed on 22 November 2022)

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]	0.020	0.020	0.020	0.010	0.010
AEGL-2 [note 2]	0.24	0.17	0.083	0.021	0.021
AEGL-3 [note 3]	0.65	0.65	0.51	0.32	0.16

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 on 22 November 2024)

Exposure standards, guidelines or regulations

Table 6. Occupational standards for isocyanates, all (as -NCO) except methyl isocyanate

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m ³	ppm	mg/m ³
WEL	-	0.02	-	0.07

Abbreviations

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 Fourth Edition](#)' 2020 (viewed on 22 November 2024)

Table 7. Public health standards and guidelines

Drinking water standard	No value specified
WHO guideline for drinking water quality	No value specified
UK indoor air quality guideline	No value specified
WHO indoor air quality guideline	No value specified
WHO air quality guideline	No value specified

Health effects

Isocyanates are irritants to the mucous membranes, strong sensitisers of the respiratory tract, and may cause irritation to the eyes and skin.

Table 8. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	<p>The vapour is a respiratory irritant and sensitiser. Acute exposure to high concentrations can cause long-term pulmonary damage.</p> <p>Neurological features have also been reported, with euphoria, anxiety, ataxia and paraesthesia occurring in the early stages. Delayed features can include poor memory, headache, anxiety and confusion. Muscle aches and elevated creatine phosphokinase have been reported.</p> <p>Irritant effects: onset of symptoms may be immediate or delayed for 4 to 8 hours, and progress over a period of days. Dry throat, chest tightness, shortness of breath, coughing and wheezing may occur. There may also be nausea, vomiting and abdominal pain. High concentrations may cause bronchitis, severe asthmatic symptoms and pulmonary oedema.</p> <p>Sensitiser: a single exposure can result in sensitisation, with subsequent re exposure causing a delayed severe asthma-like attack. Airway responses can be immediate (onset of symptoms within 30 minutes), late (after 1 hour or more) or dual, with both immediate and late onset of symptoms. Hypersensitivity pneumonitis has been reported but is rare. Occasionally, a mixed picture of alveolitis and asthma is observed.</p>
Ingestion	Gastrointestinal irritation is likely
Eyes	Vapours may cause pain, burning, lacrimation, superficial lesions and conjunctivitis. Symptoms may persist for months after exposure.
Dermal	Irritation is likely and there may be inflammation, erythema, itching and blisters. Sensitisation and allergic contact dermatitis may occur. Isocyanates may also be absorbed across the skin, and skin contact can lead to asthma.

Reference

National Poisons Information Service (NPIS). TOXBASE '[Toluene diisocyanate](#)' 2024 (viewed on 22 November 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.

Following disrobe, improvised dry decontamination should be considered for an incident involving toluene diisocyanate 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 the UK Health Security Agency (UKHSA) Radiation, Chemicals, Climate and Environmental Hazards 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

Improvised dry decontamination should be considered for an incident involving toluene diisocyanate unless casualties are demonstrating obvious signs of chemical burns or skin irritation.

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

Wet decontamination should be used if contamination with a caustic chemical substance is suspected.

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 2015 (viewed on 22 November 2024)

National Health Service England. [‘Emergency Preparedness, Resilience and Response \(EPRR\): Guidance for the initial management of self-presenters from incidents involving hazardous materials’](#) 2019 (viewed on 22 November 2024)

Joint Emergency Service Interoperability Programme. [‘Initial Operational Response IOR to Incidents Suspected to Involve Hazardous Substances or CBRN Materials’](#) 2024 (viewed on 22 November 2024)

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.

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 soap and water under low pressure for at least 10 to 15 minutes.

Pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears.

The earlier irrigation begins, the greater the benefit.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

If features of systemic toxicity are present, manage as per inhalation.

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

Ocular exposure

Remove contact lenses if present.

Anaesthetise the eye with a topical local anaesthetic (e.g. oxybuprocaine, amethocaine or similar).

However, do not delay irrigation if local anaesthetic is not immediately available.

Immediately irrigate the affected eye thoroughly with 1000 mL 0.9% saline or equivalent crystalloid (for example via 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.

There is experimental evidence that commercially available amphoteric, hypertonic, chelating solutions lowers tissue pH more than water or saline and may be used if available. The evidence for improved clinical outcomes is limited.

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 intervals after irrigation and use further irrigation if necessary.

Any particles lodged in the conjunctival recesses should be removed.

Other measures as indicated by the patient's clinical condition

Ingestion

Do not attempt gastric lavage.

A glass of milk or water to drink may provide symptomatic improvement provided the airway can be protected.

If features of systemic toxicity are present, manage as per inhalation.

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

Inhalation

Maintain a clear airway and ensure adequate ventilation.

If possible, remove from exposure and give oxygen.

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.

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

Clinical decontamination and first aid references

National Poisons Information Service (NPIS). TOXBASE '[Toluene diisocyanate](#)' 2024 (viewed on 22 November 2024)

National Poisons Information Service (NPIS). TOXBASE '[Chemicals Splashed or Sprayed into the Eyes - features and management](#)' 2020 (viewed on November 2024)

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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