



# Toluene Diisocyanate

## Incident Management

### Key Points

#### Fire

- combustible
- explosion hazard on reaction with water, acids, bases, amines and alcohols
- emits toxic fumes of cyanide, hydrogen chloride, sulphur oxides and oxides of nitrogen when heated to decomposition; reacts with water to form carbon dioxide
- in the event of a fire involving toluene diisocyanate, use fine water spray and normal fire kit with breathing apparatus

#### Health


- inhalation causes irritation and sensitisation; symptoms of irritation may be immediate or delayed for 4–8 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 with nausea, vomiting and abdominal pain
- 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

#### Environment






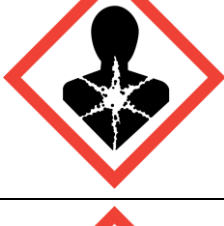

- avoid release to the environment; inform the Environment Agency of substantial incidents

## Hazard Identification

### Standard (UK) dangerous goods emergency action codes

<b>UN</b>		2078	Toluene diisocyanate	
<b>EAC</b>		2Z	Use fine water spray. Wear normal fire kit in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and surface and groundwaters	
<b>APP</b>		–	–	
<b>Hazards</b>	<b>Class</b>	6.1	Toxic substances	
	<b>Sub-risks</b>	–	–	
<b>HIN</b>		60	Toxic or slightly toxic substance	
<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 EN137 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><b>Reference</b>            Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015.</p>				

**Classification, labelling and packaging (CLP)\***

<b>Hazard class and category</b>	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	

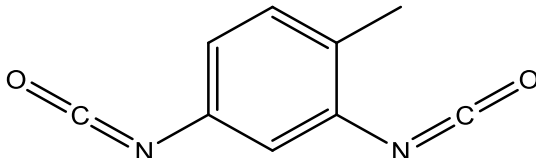
	Aquatic Chronic 3	Chronic hazards to the aquatic environment, category 3	–
<b>Hazard statement</b>	H351	Suspected of causing cancer	
	H330	Fatal if inhaled	
	H319	Causes serious eye irritation	
	H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	
	H335	May cause respiratory irritation	
	H315	Causes skin irritation	
	H317	May cause an allergic skin reaction	
	H412	Harmful to aquatic life with long lasting effects	
<b>Signal words</b>	DANGER		
* Implemented in the EU on 20 January 2009			
<b>Reference</b>			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <a href="http://echa.europa.eu/information-on-chemicals/cl-inventory-database">http://echa.europa.eu/information-on-chemicals/cl-inventory-database</a> (accessed 05/2015).			

### Specific concentration limits

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
<b>Reference</b>			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. <a href="http://echa.europa.eu/information-on-chemicals/cl-inventory-database">http://echa.europa.eu/information-on-chemicals/cl-inventory-database</a> (accessed 05/2015).			

## Physicochemical Properties

### 2,4-toluene diisocyanate

<b>CAS number</b>	584-84-9
<b>Molecular weight</b>	174.16
<b>Formula</b>	C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>
<b>Common synonyms</b>	2,4-diisocyanato-1-methylbenzene, 2,4-diisocyanatotoluene, 2,4-TDI
<b>State at room temperature</b>	Liquid, darkens on exposure to sunlight
<b>Volatility</b>	Vapour pressure = $8 \times 10^{-3}$ mmHg at 20°C
<b>Specific gravity</b>	1.22 (water = 1)
<b>Flammability</b>	Combustible
<b>Lower explosive limit</b>	0.9%
<b>Upper explosive limit</b>	9.5%
<b>Water solubility</b>	Reacts with water
<b>Reactivity</b>	May react violently with acids, amines, alcohols, bases and warm water and should be considered an explosion hazard
<b>Reaction or degradation products</b>	Products of combustion include oxides of nitrogen, cyanides, hydrogen chloride and sulphur oxides. Reacts with water to form carbon dioxide
<b>Odour</b>	Sharp, pungent odour
<b>Structure</b>	

#### References

2,4-Toluene diisocyanate (HAZARTEXT™ 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).

Hazardous Substances Data Bank [Internet]. Bethesda (MD): National Library of Medicine (US); [Last Revision Date 12/10/2012]. 2,4-Toluene diisocyanate; Hazardous Substances Databank Number: 874. Available from: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> (assessed 05/2015).

International Programme on Chemical Safety (IPCS). International Chemical Safety Card entry for 2,4-toluene diisocyanate, ISCS 0339, 1995. World Health Organization: Geneva.

**2,6-toluene diisocyanate**

<b>CAS number</b>	91-08-7
<b>Molecular weight</b>	174.16
<b>Formula</b>	C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>
<b>Common synonyms</b>	Toluene-2,6-diisocyanate, 2,6-diisocyanato-1-methylbenzene, tolylene 2,6-diisocyanate, 2,6-TDI
<b>State at room temperature</b>	Liquid
<b>Volatility</b>	Vapour pressure = 0.02 mmHg at 25°C
<b>Specific gravity</b>	1.22 (water = 1)
<b>Flammability</b>	Combustible
<b>Lower explosive limit</b>	0.9%
<b>Upper explosive limit</b>	9.5%
<b>Water solubility</b>	Reacts with water
<b>Reactivity</b>	May polymerise under the influence of water, acids, bases and heat to generate a fire or explosion hazard. Reacts violently with alcohols and amines
<b>Reaction or degradation products</b>	Products of combustion include oxides of nitrogen, cyanides, hydrogen chloride and sulphur oxides. Reacts with water to form carbon dioxide
<b>Odour</b>	Sharp, pungent odour
<p><b>References</b></p> <p>2,6-Toluene diisocyanate (HAZARTEXT™ 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: <a href="http://www.rightanswerknowledge.com">http://www.rightanswerknowledge.com</a> (assessed 05/2015).</p> <p>Hazardous Substances Data Bank [Internet]. Bethesda (MD): National Library of Medicine (US); [Last Revision Date 12/10/2012]. 2,6-Toluene diisocyanate; Hazardous Substances Databank Number: 5272. Available from: <a href="http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB">http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB</a> (assessed 05/2015).</p> <p>International Programme on Chemical Safety (IPCS). International Chemical Safety Card entry for 2,6-toluene diisocyanate, ISCS 1301, 1998. World Health Organization: Geneva.</p>	

## Reported Effect Levels from Authoritative Sources

### Exposure by inhalation

ppm	mg/m <sup>3</sup>	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.

#### Reference

a International Programme on Chemical Safety (IPCS). Environmental Health Criteria 75, Toluene Diisocyanates, 1987. World Health Organization: Geneva.

## Published Emergency Response Guidelines

### Emergency response planning guideline (ERPG) values (see note)

	Listed value (ppm)	Calculated value (mg/m <sup>3</sup> )
ERPG-1*	0.01	0.07
ERPG-2 <sup>†</sup>	0.15	1.07
ERPG-3 <sup>‡</sup>	0.6	4.27

**Note:** There is no known or accepted threshold level at which people sensitised to diisocyanates can be exposed to toluene diisocyanate without potentially experiencing a respiratory-related effect. Therefore, the ERPGs may not offer protection for those who are sensitised to diisocyanates.

\* 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

<sup>†</sup> 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

<sup>‡</sup> 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*	0.020	0.020	0.020	0.010	0.010
AEGL-2 <sup>†</sup>	0.24	0.17	0.083	0.021	0.021
AEGL-3 <sup>‡</sup>	0.65	0.65	0.51	0.32	0.16

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

<sup>†</sup> Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or an impaired ability to escape

<sup>‡</sup> 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. Acute Exposure Guideline Levels.  
<http://www.epa.gov/oppt/aegl/pubs/chemlist.htm> (accessed 05/2015).



## Exposure Standards, Guidelines or Regulations

### Occupational standards (see note)

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>
<b>WEL</b>	–	0.02	–	0.07
<p><b>Note:</b> Values relate to all isocyanates  WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p><b>Reference</b>  Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits (second edition, 2011).  <a href="http://www.hse.gov.uk/pubns/priced/eh40.pdf">http://www.hse.gov.uk/pubns/priced/eh40.pdf</a> (accessed 06/2015).</p>				

### Public health guidelines

<b>Drinking water standard</b>	No guideline value specified
<b>Air quality guideline</b>	No guideline value specified
<b>Soil guideline values and health criteria values</b>	No guideline value specified

## Health Effects

### Major route of exposure

- inhalation, ingestion, dermal and ocular exposure

### Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
<b>Inhalation</b>	<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><b>Irritant effects:</b> onset of symptoms may be immediate or delayed for 4–8 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><b>Sensitiser:</b> 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>
<b>Ingestion</b>	Gastrointestinal irritation is likely, with nausea, vomiting and abdominal pain
<b>Dermal</b>	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
<b>Ocular</b>	The vapour may cause pain, burning, lacrimation, superficial lesions and conjunctivitis. Symptoms may persist for months after exposure
<b>Reference</b>	
TOXBASE. Toluene diisocyanate, 2015. <a href="http://www.toxbase.org">http://www.toxbase.org</a> (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.

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.**

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 persons individually.

Detailed information on clinical management can be found on TOXBASE – [www.toxbase.org](http://www.toxbase.org).

### Important notes

- secondary carers should not need to wear PPE other than routine precautions against secondary contamination with vomit and body fluids

### 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
- 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
- **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
- if features of systemic toxicity are present, manage as for 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 (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 discussed **urgently** with an ophthalmologist
- other measures as indicated by the patient's clinical condition

### Inhalation

- maintain a clear airway and ensure adequate ventilation
- remove from exposure if appropriate and give oxygen
- other supportive 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 for inhalation
- other measures as indicated by the patient's clinical condition

### Clinical decontamination and first aid references

TOXBASE	<a href="http://www.toxbase.org">http://www.toxbase.org</a> (accessed 11/2016)
TOXBASE	Toluene diisocyanate, 2015
TOXBASE	Isocyanates – features and management, 2013
TOXBASE	Chemicals splashed or sprayed into the eyes, 2014

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.

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For queries relating to this document, please contact: [generaltox@phe.gov.uk](mailto:generaltox@phe.gov.uk)

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