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.

Thank you for visiting the compendium of chemical hazards. Please take our short survey to help us make improvements.

# Contents

# 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.<br>Wear normal fire kit in combination with breathing apparatus [note 1].<br>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**

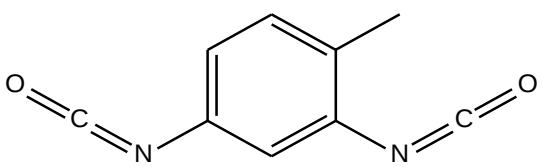
| Concentration | Hazard class and category | Hazard statement | |
|---|---|---|---|
| C ≥ 0.1% | Resp. Sens 1 | H334 | May cause allergy or asthma symptoms or breathing difficulties if inhaled |

## 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)<br>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<br>2,4-Toluene diisocyanate<br>2,4-TDI, 2,4-Diisocyanatotoluene<br>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)<br>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.<br><br>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)

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information. ‘PubChem Compound Summary for CID 21584847, Toluenediisocyanate’ (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** | The vapour is a respiratory irritant and sensitiser. Acute exposure to high concentrations can cause long-term pulmonary damage.<br><br>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.<br><br>**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.<br><br>**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. |
| **Ingestion** | Gastrointestinal irritation is likely |
| **Eyes** | Vapours may cause pain, burning, lacrimation, superficial lesions and conjunctivitis. Symptoms may persist for months after exposure. |
| **Dermal** | Inrritation 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.


First published: October 2015
Update to Health Effects, Decontamination at the Scene & Clinical Decontamination and First Aid sections: November 2016
Full document update: November 2024

For queries relating to this document, please contact chemcompendium@ukhsa.gov.uk or enquiries@ukhsa.gov.uk

Publishing reference: GOV-17745