UK Health Security Agency

Toluene

Incident management

Contents

Main points

General

Toluene is a highly flammable liquid, with a sweet pungent odour.

Toluene vapour is explosive when exposed to heat or flame and emits acrid smoke and irritating fumes when heated to decomposition.

It reacts violently with strong oxidants. This generates fire and explosion hazard.

Health

Toxicity occurs typically following inhalation or ingestion.

Inhalation of toluene causes irritation to the eyes, nose, throat and respiratory tract.

Ingestion causes abdominal pain, and oropharyngeal and gastric irritation with vomiting.

Systemic features include initial euphoria and hallucinations then drowsiness, confusion, ataxia, tremor, headache, slurred speech, coma, respiratory failure, convulsions and death.

Dermal exposure causes irritation, dryness, erythema, defatting, blistering and necrotic skin burns if contact is extensive or prolonged.

Ocular exposure causes burning, irritation, conjunctivitis and reversible corneal injury.

Casualty decontamination at the scene

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

Environment

Inform the Environment Agency where appropriate.

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

UN		1294	Toluene	
EAC		3YE	Use normal foam, that is protein-based foam that is not alcohol resistant. Wear normal fire kit in combination with breathing apparatus [note 1]. Substance can be violently or explosively reactive. 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		–	–	
Hazards	**Class**	3	Flammable liquids and desensitized liquid explosives	
	Sub-risks	-	-	
HIN		33	Highly flammable liquid (flash-point below 23°C)	

Abbreviations

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

Note to Table 1

Note 1: Normal firefighting clothing is appropriate: 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 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.
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 250m away from the incident.

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 toluene

Hazard class and category	Flam. Liq. 2	Flammable liquids, category 2	
	Repr. 2	Reproductive toxicity, category 2	
	Asp. Tox. 1	Aspiration hazard, category 1	
	STOT RE 2	Specific Toxicity Organ Toxicity Repeated Exposure, category 2	
	Skin Irrit. 2	Skin corrosion/irritant, category 2	
	STOT SE 3	Specific Target Organ Toxicity, Single Exposure, category 3	
Hazard statement	H225	Highly flammable liquid and vapour	
	H361 (d)	Suspected of damaging the unborn child	
	H304	May be fatal if swallowed and enters airways	
	H373	May cause damage to organs through prolonged or repeated exposure	
	H315	Causes skin irritation	
	H336	May cause drowsiness or dizziness	

Signal words	DANGER

Reference

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

Physicochemical properties

Table 3. Physicochemical properties

CAS number	108-88-3
Molecular weight	92
Formula	C_7H_8
Common synonyms	Toluene, methylbenzene, toluol, penylmethane
State at room temperature	Liquid
Volatility	Vapour pressure = 28.4 mm Hg at 25°C
Specific gravity	(Water = 1) 0.87 (Air = 1) 3.1
Flammability	Highly flammable, vapour/air mixtures are explosive
Lower explosive limit	1.1%
Upper explosive limit	7.1%
Water solubility	Insoluble
Reactivity	Reacts violently with strong oxidants. This generates fire and explosion hazard; vapour is explosive when exposed to heat or flame. Emits acrid smoke and irritating fumes when heated to decomposition.
Odour	Characteristic sweet, pungent benzene-like odour

References

International Programme on Chemical Safety. International Chemical Safety Card entry for toluene. ICSC 0078, 2002. World Health Organization (WHO) Geneva (viewed April 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004. PubChem Compound Summary for CID 1140, Toluene (viewed April 2024)

Reported effect levels from authoritative sources

Table 4a. Exposure by inhalation

ppm	mg/m^3	Signs and symptoms	Reference
50-100	188-375	CNS effects – dizziness, headache, fatigue, respiratory tract irritation.	b
100-200	376-753	Eye, nasal, and throat irritation (6 hour exposure) Headaches, dizziness, intoxication, decreased manual performance and colour perception. Drowsiness, confusion, weakness (3-8 hour exposure).	a
500-600	1875-2250	Anorexia, staggering gait, nausea, nervousness, momentary loss of memory, significant reduction in reaction time.	c
1500	5625	Extreme weakness.	c
1862	7016	Sinus tachycardia, sinus bradycardia, liver enlargement, eye irritation (2-3 hour exposure).	a
4000	15000	Rapid impairment of reaction time and coordination. Exposures of one hour or longer may lead to narcosis and possibly death.	c
10,000-30,000	37,500-112,500	Loss of consciousness. Onset of narcosis within minutes; longer exposures may be lethal.	b,c

Table 4b. Exposure by ingestion

mL	mg/kg	Signs and symptoms	Reference
60	625	Lung congestion and hemmorhage, necrosis of myocardial fibres, acute tubular necrosis, severe central nervous system depression, death.	a,b

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. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Toluene 2017 (viewed May 2024)
b. TOXBASE Toluene, December 2022 (viewed May 2024)
c. International Programme on Chemical Safety Environmental Health Criteria 52: Toluene 1986 (viewed May 2024)

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]	67	67	67	67	67
AEGL-2 [note 2]	1400*	760	560	310	250
AEGL-3 [note 3]	10,000**	5,200*	3,700*	1,800*	1,400*

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.
For toluene concentrations denoted *, safety consideration against the hazards of explosions must be considered due to the explosive nature of the compound.
For values denoted as ** extreme safety considerations against the hazards of explosions must be taken into account.

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	50	191	100	384

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

UK drinking water standard	No guideline value specified
WHO guideline for drinking water quality	700 µg/L
WHO air quality guideline	0.26 mg/m³ (weekly average)
UK indoor air quality guideline	Short term value: 15 mg/m³ (8 hr average) Long-term value: 2.3 mg/m³ (1 day average)

Reference

WHO. Guidelines for Drinking-water Quality, 4th Edition Incorporating First and Second Addendum 2022 WHO: Geneva (viewed April 2024)

Public Health England (PHE). Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK 2019

WHO Regional Office for Europe. Air Quality Guidelines for Europe, European Series, No. 91, 2nd Edition 2000. WHO: Copenhagen

Health effects

Toluene is readily absorbed via the lungs and GI tract, but is only slowly absorbed through intact skin. It is unusual for toluene to cause systemic toxicity via the dermal route; patients with clinically significant dermal exposure are also likely to have concomitant inhalational exposure.

Table 8. Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Inhalation may cause irritation to the eyes, nose, throat and respiratory tract. Respiratory complications include acute bronchitis, bronchospasm, pneumonitis, asphyxia and pulmonary oedema. Systemic features may occur.
Ingestion	Ingestion may result in abdominal pain, oropharyngeal and gastric irritation with vomiting. There is one report of corrosive oesophageal injury. Systemic features may occur.
Dermal	Skin contact may cause irritation, dryness, transient erythema, defatting, blistering and necrotic skin burns if contact is extensive and/or prolonged. Systemic features may occur.
Systemic features	Systemic features include initial euphoria and hallucinations then drowsiness, confusion, ataxia, tremor, headache, slurred speech, coma, respiratory failure, convulsions and sometimes death. Cardiovascular features include hypertension or hypotension, tachycardia or bradycardia. Ventricular fibrillation, cardiac arrest and myocardial infarction may also occur, although are more common after chronic exposure. Rhabdomyolysis, hepatic and renal damage can occur. The latter is characterised by distal renal tubular injury causing hyperchloraemic metabolic acidosis with associated hypokalaemia and hypophosphataemia. These features are more common after chronic exposure. Other features of exposure include nausea, vomiting, paraesthesiae and peripheral neuropathy.
Ocular	Eye contact can cause burning, irritation, conjunctivitis and reversible corneal injury.

Reference

TOXBASE Toluene December 2022 (viewed April 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, 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 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 in a well-ventilated area, preferably with its own ventilation system.

The patient should remove soiled clothing and wash themself if possible.

Contaminated clothing should be removed, double-bagged, sealed and stored safely to prevent escape of volatile substances.*

Decontaminate open wounds first and avoid contamination of unexposed skin. Wash hair and all contaminated skin with liberal amounts of water (preferably warm) and soap.

Pay special attention to skin folds, fingernails and ears.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Manage systemic toxicity as per inhalation or ingestion

Chemical burns totalling more than 15% of body surface area in adults (or more than 10% in children) will require standard fluid resuscitation as for thermal burns.

Cover affected area with a clean non-adherent dressing

Chemical burns should be reviewed by a burns specialist. 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 final conjunctival pH of 7.0 to 8.0. The conjunctivae may be tested with indicator paper. Retest 20 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.

Ingestion or inhalation

Maintain a clear airway and ensure adequate ventilation.

Administer oxygen to achieve adequate oxygenation.

Following ingestion: Gut decontamination is contraindicated.

Monitor vital signs and check the cardiac rhythm; check capillary blood glucose.
Check and record pupil size.

Perform a 12-lead ECG in all patients who require assessment. This agent is cardiotoxic and careful assessment of the ECG is required.

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

Clinical decontamination and first aid references

- TOXBASE (viewed in April 2024)
- TOXBASE 'Toluene – features and management' (December 2022)
- TOXBASE 'Chemicals splashed or sprayed into eyes – features and management' (2020)
- TOXBASE 'Skin decontamination – solvents' (2019)

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.

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