



Formaldehyde

Incident Management

Key Points

Fire

- flammable
- incompatible with acids, alkalis, amines, strong oxidisers, phenols and urea
- emits toxic fumes of carbon monoxide and carbon dioxide when heated to decomposition
- in the event of a fire involving formaldehyde, use alcohol resistant foam and chemical protective clothing with liquid-tight connections and breathing apparatus

Health

- inhalation exposure may occur to gas, or by ingestion, skin or eye contact to solution
- inhalation of formaldehyde can lead to irritation of the mucous membranes and respiratory tract; in severe cases laryngeal and pulmonary oedema, pneumonitis and acute respiratory distress syndrome may occur
- ingestion of concentrated formaldehyde solutions can cause burns and ulceration to the GI tract; common features are a burning sensation in the mouth and throat, chest or abdominal pain, nausea, vomiting, diarrhoea and GI haemorrhage
- dermal exposure to formaldehyde solutions may cause skin irritation and dermatitis
- formaldehyde is irritating to the eyes; solutions can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision



Environment

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


Hazard Identification

Standard (UK) dangerous goods emergency action codes






Formaldehyde solution, flammable

UN		1198	Formaldehyde solution, flammable	
EAC		•2W	Use alcohol-resistant foam but, if not available, fine water spray can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses.	
APP		A(fl)	Gas-tight chemical protective suit with breathing apparatus [†] Flammable liquid	
Hazards	Class	3	Flammable liquid	
	Sub-risks	8	Corrosive substance	
HIN		38	Flammable liquid (flash point between 23°C and 60°C inclusive), slightly corrosive or self-heating liquid, corrosive	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* 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 BS EN 137</p> <p>[†] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2, thermal-resistant gloves should be worn such as those conforming to BS EN 511:2006 or BS EN 407:2004</p> <p>Reference Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p>				

Formaldehyde solution with not less than 25%formaldehyde

UN		2209	Formaldehyde solution, with not less than 25 % formaldehyde	
EAC		•2X	Use alcohol resistant foam but, if not available, fine water spray can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses	
APP		-	-	
Hazards	Class	8	Corrosive substance	
	Sub-risks	-	-	
HIN		80	Corrosive or slightly corrosive substance	
<p>UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number</p> <p>* 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 BS EN 137</p> <p>Reference</p> <p>Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC) Part of Ricardo-AEA. The Stationery Office, 2017.</p>				

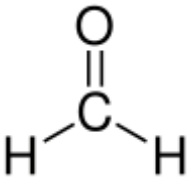
Classification, labelling and packaging (CLP)***Formaldehyde ...%**

Hazard class and category	Acute Tox. 3	Acute toxicity (inhalation, oral, dermal) category 3	
	Skin Corr. 1B	Skin corrosion, category 1B	
	Skin Sens. 1	Skin sensitisation, category 1	
	Muta. 2	Germ cell mutagenicity, category 2	
	Carc. 1B	Carcinogenicity, category 1B	
	Hazard statement	H301	Toxic if swallowed
	H311	Toxic in contact with skin	
	H314	Causes severe skin burns and eye damage	
	H317	May cause an allergic skin reaction	
	H331	Toxic if inhaled	
	H341	Suspected of causing genetic defects	
	H350	May cause cancer	
Signal words	DANGER		
* Implemented in the EU on 20 January 2009			
Reference			
European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 05/2017).			

Specific concentration limits

Concentration	Hazard class and category	Hazard statement	
C ≥ 0.2 %	Skin Sens. 1	H317	May cause an allergic skin reaction
C ≥ 5 %	STOT SE 3	H335	May cause respiratory irritation
5 % ≤ C < 25 %	Eye Irrit. 2	H319	Causes serious eye irritation
5 % ≤ C < 25 %	Skin Irrit. 2	H315	Causes skin irritation
C ≥ 25 %	Skin Corr. 1B	H314	Causes severe skin burns and eye damage
Reference European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 05/2017).			

Physicochemical Properties

CAS number	50-00-0
Molecular weight	30
Formula	CH ₂ O
Common synonyms	Methanal; Methylene oxide; Methyl aldehyde
State at room temperature	Gas
Volatility	Vapour pressure 3,890 mm Hg at 25°C
Vapour density	1.067 (air = 1)
Flammability	Flammable
Lower explosive limit	7.0%
Upper explosive limit	73.0%
Water solubility	Soluble in water
Reactivity	Polymerises when in contact with alkalis and if dissolved in water. Incompatible with acids, alkalis, amines, strong oxidisers, phenols and urea
Reaction or degradation products	Decomposition products include carbon dioxide and carbon monoxide
Odour	Pungent, suffocating
Structure	
References	
Formaldehyde (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. http://www.rightanswerknowledge.com (accessed 01/2017).	
Hazardous Substances Data Bank. Formaldehyde HSDB No. 164 (last revision date 19/10/2015). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 01/2017)	
International Programme on Chemical Safety. International Chemical Safety Card entry for Formaldehyde. ICSC 0275, 2012. World Health Organization: Geneva.	

Reported Effect Levels from Authoritative Sources

Exposure by inhalation

ppm	mg/m ³	Signs and symptoms	Reference
0.05	0.06	Slight eye irritation	a
0.08 - 2.5	0.1 - 3	Throat and upper respiratory tract irritation	a
0.4 to 3	0.49 to 3.69	Mild to moderate irritation of the eyes, nose, and throat	b
>5	>6	Lower airway and pulmonary irritation	a
50	>61	Severe lacrimation	c

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, Environmental Health Criteria 89: Formaldehyde, 1989.

b Agency for Toxic Substances and Disease Registry (ATSDR), Addendum To The Toxicological Profile For Formaldehyde. 2010.

c TOXBASE. Formaldehyde, 04/2015. <http://www.toxbase.org> (accessed 06/2017).

Exposure by ingestion

mL	Signs and symptoms	Reference
60-90	Fatal dose	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 TOXBASE. Formaldehyde, 04/2015. <http://www.toxbase.org> (accessed 06/2017).

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg/m ³)
ERPG-1*	1 ¹	1.23
ERPG-2 [†]	10	12.3
ERPG-3 [‡]	40	49.2

* 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

[†] 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

[‡] 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

1 Odour should be detectable near ERPG-1

Reference
American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values. <https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf> (accessed 06/2017).

Acute exposure guideline levels (AEGLs) (Interim)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	0.9	0.9	0.9	0.9	0.9
AEGL-2 [†]	14	14	14	14	14
AEGL-3 [‡]	100	70	56	35	35

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

[†] 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

[‡] 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 06/2017).

Exposure Standards, Guidelines or Regulations

Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m ³	ppm	mg/m ³
WEL	2	2.5	2	2.5
<p>WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit</p> <p>Reference Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 2nd Edition, 2011.</p>				

Public health guidelines

WHO drinking-water guideline value	Formal guideline value not deemed necessary as it occurs in drinking-water at concentration's below those of health concern.
Air quality guideline	0.1 mg/m ³ (30-minute average concentration)
Soil guideline values and health criteria values	Guideline value not given
<p>Reference WHO. Guidelines for Drinking-Water Quality, 4th Edition, 2011. World Health Organization: Geneva. World health organisation (WHO) 2010. WHO guidelines for indoor air quality: selected pollutants. Air Quality Guidelines for Europe. World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications, European Series, No. 91, Second Edition, 2000.</p>	

Health Effects

Major route of exposure

- inhalation exposure may occur to gas or via ingestion, skin and eye contact to solution

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	<p>Inhalation of formaldehyde causes irritation of the mucous membranes and respiratory tract. Sore throat, rhinitis, nasal irritation, bronchospasm and breathlessness are common</p> <p>In severe cases, laryngeal and pulmonary oedema, pneumonitis and acute respiratory distress syndrome may occur</p>
Ingestion	<p>Ingestion of concentrated formaldehyde solutions can cause burns and ulceration to the GI tract. Common features are a burning sensation in the mouth and throat, chest or abdominal pain, nausea, vomiting, diarrhoea and GI haemorrhage. The most severe damage is found in the stomach; perforation has been reported. Rarely, free fluid has been demonstrated in the abdomen in the absence of obvious perforation</p> <p>Hypotension and shock are common and may be due in part to myocardial depression. Death from circulatory collapse may occur in severe cases</p> <p>Restlessness, drowsiness, coma and convulsions may also occur. Respiratory failure occasionally secondary to acute respiratory distress syndrome may also complicate severe poisoning</p> <p>Other clinical features include metabolic acidosis, disseminated intravascular coagulation, jaundice, proteinuria, albuminuria, haematuria, hyperglycaemia, minor increase in transaminase activity and methemoglobinemia</p>
Dermal	<p>Formaldehyde causes localised skin irritation and contact dermatitis. In addition, after large dermal exposures, there is the potential for significant systemic absorption and associated systemic toxicity</p> <p>Low concentrations of aqueous formaldehyde may cause skin irritation while higher concentrations may result in blisters, fissures and urticaria. Contact dermatitis has also been reported</p>
Ocular	<p>Formaldehyde is irritating to the eyes. Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision</p>
Reference	
TOXBASE. Formaldehyde, 04/2015. http://www.toxbase.org (accessed 06/2017).	
TOXBASE. Formalin and formaldehyde solutions, 01/2014. http://www.toxbase.org (accessed 06/2017).	

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.

Formaldehyde is an irritating and highly reactive gas. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details). Improvised wet decontamination should also be considered following exposure to formaldehyde solutions (including formalin) as they may be corrosive.

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 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

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 people individually.

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important note

- 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

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
- do **not** apply neutralising chemicals as 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 10–15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5–6, although it may be closer to 7 in children, or after irrigation). **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
- following decontamination recheck the pH of affected areas after a period of 15–20 minutes and repeat irrigation if abnormal; burns with strong solutions may require irrigation for several hours or more
- once the pH is normal and stabilised, treat as for a thermal injury
- 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 (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 or equivalent crystalloid (eg by an infusion bag with a giving set) for a minimum of 10-15 minutes irrespective of initial conjunctival pH. Amphoteric solutions are available and may be used. A Morgan Lens may be used if anaesthetic has been given. 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
- any particles lodged 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 referred urgently to an ophthalmologist**
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- give high-flow oxygen through a tight-fitting mask
- consider assisted ventilation with PEEP if acute respiratory distress syndrome develops
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- there is no role for either gastric lavage or activated charcoal
- look for evidence of burns to the mouth and throat and watch for features of GI haemorrhage
- monitor pulse, blood pressure, respiratory rate, cardiac rhythm and urine output
- perform 12-lead ECG in all patients who require assessment
- other supportive measures as indicated by the patients clinical condition

Health effects and decontamination references

- TOXBASE <http://www.toxbase.org> (accessed 06/2017)
- TOXBASE Formaldehyde, 04/2015
- TOXBASE Formalin and formaldehyde solutions, 01/2014

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.

First published: June 2017

For queries relating to this document, please contact generaltox@phe.gov.uk

© Crown copyright 2017, www.gov.uk/phe

Re-use of Crown copyright material (excluding logos) is allowed under the terms of the Open Government Licence, visit www.nationalarchives.gov.uk/doc/open-government-licence/version/3/ for terms and conditions.