



UK Health
Security
Agency

Formaldehyde

Incident management

Contents

| | |
|---|----|
| Main points..... | 3 |
| General..... | 3 |
| Health..... | 3 |
| Casualty decontamination at the scene..... | 3 |
| Environment..... | 3 |
| Hazard identification..... | 4 |
| Physicochemical properties..... | 8 |
| 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..... | 14 |
| Disrobe..... | 14 |
| Improvised decontamination..... | 15 |
| Improvised dry decontamination..... | 15 |
| Improvised wet decontamination..... | 15 |
| Additional notes..... | 16 |
| Interim wet decontamination..... | 16 |
| Decontamination at the scene references..... | 17 |
| Clinical decontamination and first aid..... | 18 |
| Important notes..... | 18 |
| Clinical decontamination following surface contamination..... | 18 |
| Dermal exposure..... | 19 |
| Ocular exposure..... | 19 |
| Ingestion..... | 20 |
| Inhalation..... | 20 |
| Clinical decontamination and first aid references..... | 20 |
| About the UK Health Security Agency..... | 21 |

Main points

General

Formaldehyde is a colourless gas with a pungent suffocating odour. It may also exist in solution as formalin, appearing as a colourless liquid.

Formaldehyde gas is flammable, and reacts violently with strong oxidants, strong acids, and strong bases which generates an explosion hazard.

Decomposition products include carbon dioxide and carbon monoxide.

Health

Inhalation of formaldehyde can cause sore throat, rhinitis, nasal irritation, bronchospasm and breathlessness; 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

Skin contact may cause irritation and dermatitis.

Formaldehyde is irritating to the eyes.

Casualty decontamination at the scene

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.



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 1a. Standard (UK) dangerous goods emergency action codes for formaldehyde solution

| | | | | |
|----------------|------------------|-------|--|---|
| 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 [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. | |
| APP | | A(fl) | Fire kit with gas tight chemical protective suit with breathing apparatus [note 2]. 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 | |

Abbreviations

UN = United Nations number.

EAC = emergency action code.

APP = additional personal protection.

HIN = hazard identification number.

Note to Table 1a


[note 1] 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 conforming to BS EN 137.

[note 2] Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

Reference

'[Dangerous Goods Emergency Action Code List](#)'. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023)

Table 1b. Standard (UK) dangerous goods emergency action codes for formaldehyde solution >25%

| | | | | |
|----------------|------------------|------|---|--|
| UN | | 2209 | Formaldehyde solution >25% | |
| 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 [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. | |
| APP | | - | | |
| Hazards | Class | 8 | Corrosive substance |  |
| | Sub-risks | - | - | |
| HIN | | 80 | Corrosive or slightly corrosive substance | |

Abbreviations

UN = United Nations number.

EAC = emergency action code.

APP = additional personal protection.

HIN = hazard identification number.

Note to Table 1b

[note 1] 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 conforming to BS EN 137.

Reference

'[Dangerous Goods Emergency Action Code List](#)'. National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. The Stationery Office (2023)

Table 2a. The GB classification, labelling and packaging (CLP) regulation formaldehyde ...%






| | | | |
|----------------------------------|---------------|---|---|
| Hazard class and category | Carc. 1B | Carcinogenicity, category 1B |  |
| | Muta. 2 | Germ cell mutagenicity, category 2 |  |
| | Acute tox. 3 | Acute toxicity, category 3 (oral, skin, inhalation) |  |
| | Skin Corr. 1B | Skin corrosion/irritation Category 1B |  |
| | Skin Sen. 1 | Skin sensitization, category 1 |  |
| Hazard statement | H350 | May cause cancer | |
| | H341 | Suspected of causing genetic defects | |
| | H301 | Toxic if swallowed | |
| | H311 | Toxic in contact with skin | |
| | H331 | Toxic if inhaled | |
| | H314 | Causes severe skin burns and eye damage | |
| | H317 | May cause an allergic skin reaction | |
| Signal words | DANGER | | |

Table 2b. The GB classification, labelling and packaging (CLP) regulation specific concentration limits

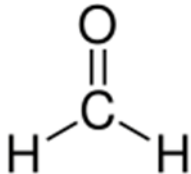
| Concentration | Hazard class and category | Hazard statement | |
|---------------------|---------------------------|------------------|---|
| $C \geq 0.2\%$ | Skin Sens. 1 | H317 | May cause an allergic skin reaction |
| $C \geq 5\%$ | STOT SE 3 | H335 | May cause respiratory irritation |
| $5\% \leq C < 25\%$ | Eye Irrit. 2 | H319 | Causes serious eye irritation |
| $5\% \leq C < 25\%$ | Skin Irrit. 2 | H315 | Causes skin irritation |
| $C \geq 25\%$ | Skin Corr. 1B | H314 | Causes severe skin burns and eye damage |

Reference

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

Physicochemical properties

Table 3. Physicochemical properties

| | |
|----------------------------------|---|
| CAS number | 50-00-0 |
| Molecular weight | 30.03 |
| Formula | CH ₂ O [HCHO] |
| Common synonyms | Formalin, methanal, paraformaldehyde, formic aldehyde, methyl aldehyde |
| State at room temperature | Colourless gas |
| Volatility | Gas vapour pressure 3890 mm Hg |
| Vapour density | 1.067 (air = 1) |
| Flammability | Flammable |
| Lower explosive limit | 7% |
| Upper explosive limit | 73% |
| Water solubility | Miscible in water at 25 ⁰ C |
| Reactivity | Formaldehyde is very reactive. e It polymerises when in contact with alkalis and if dissolved in water. Formaldehyde reacts violently with strong oxidants, strong acids and strong bases generating explosion hazard Decomposition products include carbon monoxide and carbon dioxide. |
| Odour | Pungent odour |
| Structure |  |

References

International Programme on Chemical Safety. [‘International Chemical Safety Card entry for formaldehyde](#). ICSC 0275, 2012. World Health Organization (WHO) Geneva (viewed February 2024)

PubChem [Internet]. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2004-. [PubChem Compound Summary for CID 712, Formaldehyde](#) (viewed February 2024)

Reported effect levels from authoritative sources

Table 4a. Exposure by inhalation

| ppm | mg/m ³ | Signs and symptoms | Reference |
|----------|-------------------|---|-----------|
| 0.05 | 0.06 | Slight eye irritation | c |
| 0.08-2.5 | 0.1-3 | Throat and upper respiratory tract irritation | c |
| 0.98 | 1.2 | Headaches, tiredness. (5.5 hour exposure) | a |

Table 4b. Exposure by ingestion

| g | Signs and symptoms | Reference |
|-----------------------|--|-----------|
| 113 | Unconsciousness, lethargy, significant acidosis, abdominal pain, breathing difficulties, bradypnea, hypotension, seizures, intravascular coagulopathy, cardiac arrest, death | a |
| mL | | |
| 120 (37% formalin) | Abdominal pain, unconsciousness, cyanosis, apnea, hypotension, significant acidosis, anuria, death | a |

Table 4c. Exposure to the eyes

| ppm | Signs and symptoms | Reference |
|-----|--------------------|-----------|
| >50 | Severe lacrimation | b |

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. Agency for Toxic Substances and Disease Registry (ATSDR). [Toxicological Profile for Formaldehyde](#). (May 2015) (viewed February 2024).
- b. TOXBASE. [Formaldehyde Gas](#) (June 2020) (viewed March 2024)
- c. International Programme on Chemical Safety, [Environmental Health Criteria 89: Formaldehyde](#), 1989.

Published emergency response guidelines

Table 5. Interim acute exposure guideline levels (AEGLs)

| | Concentration ppm | | | | |
|------------------------|-------------------|------------|------------|---------|---------|
| | 10 minutes | 30 minutes | 60 minutes | 4 hours | 8 hours |
| AEGL-1 [note 1] | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| AEGL-2 [note 2] | 14 | 14 | 14 | 14 | 14 |
| AEGL-3 [note 3] | 100 | 70 | 56 | 35 | 35 |

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 February 2024).

Exposure standards, guidelines or regulations

Table 6. Occupational standards

| | LTEL (8-hour reference period) | | STEL (15-min reference period) | |
|------------|--------------------------------|-------------------|--------------------------------|-------------------|
| | ppm | mg/m ³ | ppm | mg/m ³ |
| LEL | 2 | 2.5 | 2 | 2.5 |

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) (viewed February 2024)

Table 7. Public health standards and guidelines

| | |
|---|--|
| UK drinking water standard | No guideline value specified |
| WHO guideline for drinking water quality | Occurs in drinking water well below levels of concern |
| UK Indoor air quality guideline | 0.1 mg/m ³ (30-minute average concentration) 10 mg/m ³ (annual average) |
| WHO indoor air quality guideline | 0.1 mg/m ³ (30-minute average concentration) |

References

WHO. [Guidelines for Drinking-water Quality, 4th Edition Incorporating First and Second Addendum 2022](#) WHO: Geneva
 WHO [guidelines for indoor air quality: selected pollutants](#). World Health Organization Regional Office for Europe, Copenhagen WHO Regional Publications. 2010.
 PHE. [Indoor Air Quality Guidelines for selected Volatile Organic Compounds \(VOCs\) in the UK, 2019](#).

Health effects

Inhalation is the main route of exposure to formaldehyde gas, with dermal and eye exposure also being of concern. Ingestion and inhalation are the main routes of exposure to formalin solution.

Table 8. Signs or symptoms of acute exposure (formaldehyde gas)

| Route | Signs and symptoms |
|-------------------|--|
| Inhalation | Inhalation of formaldehyde causes irritation of the mucous membranes and respiratory tract; sore throat, rhinitis, nasal irritation, bronchospasm and breathlessness are common. In severe cases, laryngeal and pulmonary oedema, pneumonitis and acute respiratory distress syndrome may occur. |
| Dermal | 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, although this has not been reported. |
| Ocular | Formaldehyde is irritating to the eyes even at low concentrations. When the exposure is greater than 50 ppm, severe lacrimation can occur. |

Table 9. signs or symptoms of acute exposure (formalin solution)

| Route | Signs and symptoms |
|------------------|---|
| Ingestion | <p>Concentrated formaldehyde solutions are corrosive to the GI tract causing burns and ulceration. 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. Also rarely, free fluid has been demonstrated in the abdomen in the absence of obvious perforation. Oesophageal or gastric outlet obstruction may develop some weeks later.</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. Metabolic acidosis is observed commonly. Respiratory failure, occasionally secondary to acute respiratory distress syndrome, may also complicate severe poisoning.</p> <p>Pleural effusion and acute renal failure have been reported in severe cases. Rhabdomyolysis, disseminated intravascular coagulation and intravascular haemolysis have been observed.</p> |

| Route | Signs and symptoms |
|-------------------|---|
| | <p>Other clinical features (some of which may be related to the effects described above) include jaundice, proteinuria, albuminuria, haematuria, hyperglycaemia, minor increase in transaminase activity and methaemoglobinaemia. Restlessness, drowsiness, coma and convulsions may occur.</p> <p>Later features: Strictures of the GI tract occur in up to 20% of patients within 2-8 weeks of ingestion. In some cases the stomach is reduced along its length to a narrow tube, while in others the stricture is in the mid-gastric region.</p> |
| Inhalation | <p>Evaporated vapours may cause the same inhalation symptoms listed above for formaldehyde gas. In severe cases, laryngeal and pulmonary oedema, pneumonitis and acute respiratory distress syndrome may occur.</p> |
| Dermal | <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>Depending on concentration, formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort and redness to severe, permanent corneal clouding, abrasions and loss of vision.</p> |

Reference

[TOXBASE](#). Formalin and formaldehyde solutions, June 2020 (viewed February 2024)
[TOXBASE](#). Formaldehyde gas, June 2020 (viewed February 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.

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 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

Carry out decontamination after resuscitation.

This should be performed in a well-ventilated area, preferably with its own ventilation system.

Avoid contaminating yourself with this product and wash any exposed area.

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 copious amounts of 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.

Following decontamination, recheck 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 a thermal injury.

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

Patients should be advised on discharge to seek medical attention if symptoms subsequently develop.

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 crystalloid (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 7.5 to 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 discussed urgently with an ophthalmologist.

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

Ingestion

Maintain airway and establish haemodynamic stability.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway

Children are at increased risk of airway obstruction and treating clinicians should have a low threshold for establishing a protected airway.

Do NOT attempt gastric lavage.

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.

Check cardiac rhythm, QT interval and QRS duration.

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

Inhalation

Administer oxygen to achieve adequate oxygenation.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway

Children are at increased risk of airway obstruction and treating clinicians should have a low threshold for establishing a protected airway.

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

Clinical decontamination and first aid references

[TOXBASE](#) (viewed February 2023).

[TOXBASE](#). Formalin and formaldehyde solutions. (2020) (viewed February 2024)

[TOXBASE](#). Formaldehyde gas. (2020) (viewed February 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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