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# Formaldehyde and Formalin

## Substance Technical Guidelines

### Chemical Information Overview

The precise hazards associated with exposure to formaldehyde depend both on the form (solid, liquid, or gas) of the material and the concentration of formaldehyde present. For example, 37-50% solutions of formaldehyde present a much greater hazard to the skin and eyes from spills or splashes than solutions containing less than 1 % formaldehyde. Technical guidelines used for training employees should be modified to provide accurate information on the material actually being used.

<b>Chemical Name:</b>	Formaldehyde	<b>Synonyms:</b>	Formalin; Formic Aldehyde; Paraform; Formol; Formalin (Methanol-free); Fyde; Formalith; Methanal; Methyl Aldehyde; Methylene Glycol; Methylene Oxide; Tetraoxymethalene; Oxomethane; Oxymethylene
<b>Chemical Family:</b>	Aldehyde		
<b>Chemical Formula:</b>	HCHO		
<b>Molecular Weight:</b>	30.03		
<b>CAS Number:</b>	50-00-0		

### Exposure Limits

OSHA TWA	0.75 ppm
OSHA STEL	2.0 ppm (15-minute)
ACGIH TLV	0.3 ppm (Ceiling)
NIOSH REL	0.016 ppm (TWA)
NIOSH REL	0.1 ppm Ceiling (15-minute)

### Components and Contaminants

Percent: 37.0 Formaldehyde  
Percent: 63.0 Water  
(NOTE: Inhibited solutions contain methanol.)  
Other Contaminants: Formic Acid (alcohol free)

### Physical Data

**Description:** Colorless liquid, pungent odor  
**Boiling Point:** 214° F (101° C)  
**Specific Gravity:** 1.08 (H<sub>2</sub>O = 1 @ 20° C)  
**pH:** 2.8-4.0  
**Ionization Potential:** 10.88 eV

**Solubility in Water:** Miscible  
**Solvent Solubility:** Soluble in alcohol and acetone  
**Vapor Density:** 1.04 (Air = 1 @ 20° C)  
**Odor Threshold:** 0.8 - 1 ppm

### Fire and Explosion Hazard

Moderate fire and explosion hazard when exposed to heat or flame. The flash point of 37% formaldehyde solutions is above normal room temperature, but the explosion range is very wide, from 7 to 73% by volume in air. Reaction of formaldehyde with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid yields explosive compounds.

**Flash Point:** 185°F (85°C) closed cup  
**Lower Explosion Limit:** 7%  
**Upper Explosion Limit:** 73%

**Autoignition Temperature:** 806°F (430°C)  
**Flammability Class (OSHA):** III A. -  
Flammable Gas or Combustible Liquid

**Extinguishing Media:** Use dry chemical, "alcohol foam," carbon dioxide, or water in flooding amounts as fog. Solid streams may not be effective. Cool fire-exposed containers with water from side until well after fire is out. Use of water spray to flush spills can also dilute the spill to produce nonflammable mixtures. Water runoff, however, should be contained for treatment.

### **National Fire Protection Association section 325M Designation:**

**Health: 2** (Blue) - Materials hazardous to health, but areas may be entered with full-faced mask self-contained breathing apparatus which provides eye protection.



**Flammability: 2 (Red)** - Materials which must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

**Reactivity: 0 (Yellow)** - Materials which (in themselves) are normally stable even under fire exposure conditions which are not reactive with water. Normal fire fighting procedures may be used.

### **Reactivity and Compatibility**

**Stability:** Formaldehyde solutions may self-polymerize to form paraformaldehyde which precipitates.

**Incompatibility (Materials to Avoid):** Strong oxidizing agents, caustics, strong alkalies, isocyanates, anhydrides, oxides, and inorganic acids. Formaldehyde reacts with hydrochloric acid to form the potent carcinogen, bischloromethyl ether. Formaldehyde reacts with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid to yield explosive compounds. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.

**Hazardous Combustion or Decomposition Products:** Oxygen from the air can oxidize formaldehyde to formic acid, especially when heated. Formic acid is corrosive.

### **Acute Effects of Exposure - (Health Hazard Data)**

**Ingestion (Swallowing):** Liquids containing 10 to 40% formaldehyde cause severe irritation and inflammation of the mouth, throat, and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death. Ingestion of dilute formaldehyde solutions (0.03-0.04%) may cause discomfort in the stomach and pharynx.

**Inhalation (Breathing):** Formaldehyde is highly irritating to the upper respiratory tract and eyes. Concentrations of 0.5 to 2.0 ppm may irritate the eyes, nose, and throat of some individuals. Concentrations of 3 to 5 ppm also cause tearing of the eyes and are intolerable to some persons. Concentrations of 10 to 20 ppm cause difficulty in breathing, burning of the nose and throat, cough, and heavy tearing of the eyes, and 25 to 30 ppm causes severe respiratory tract injury leading to pulmonary edema and pneumonitis. A concentration of 100 ppm is immediately dangerous to life and health. Deaths from accidental exposure to high concentrations of formaldehyde have been reported.

**Skin (Dermal):** Formalin is a severe skin irritant and a sensitizer. Contact with formalin causes white discoloration, smarting, drying, cracking, and scaling. Prolonged and repeated contact can cause numbness and a hardening or tanning of the skin. Previously exposed persons may react to future exposure with an allergic eczematous dermatitis or hives.

**Eye Contact:** Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision. The severity of the effect depends on the concentration of formaldehyde in the solution and whether or not the eyes are flushed with water immediately after the accident.

**NOTE:** The perception of formaldehyde by odor and eye irritation becomes less sensitive with time as one adapts to formaldehyde. This can lead to overexposure if a worker is relying on formaldehyde's warning properties to alert him or her to the potential for exposure.

#### **Acute Animal Toxicity:**

Oral, rats: LD50 = 800 mg/kg

Oral, mouse: LD50 = 42 mg/kg

Inhalation, rats: LCLo = 250 mg/kg

Inhalation, mouse: LCLo = 900 mg/kg

Inhalation, rats: LC50 = 590 mg/kg

## **Chronic Effects of Exposure - (Health Hazard Data)**

**Carcinogenicity:** Formaldehyde has the potential to cause cancer in humans. Repeated and prolonged exposure increases the risk. Various animal experiments have conclusively shown formaldehyde to be a carcinogen in rats. In humans, formaldehyde exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages.

**Mutagenicity:** Formaldehyde is genotoxic in several in vitro test systems showing properties of both an initiator and a promoter.

**Toxicity:** Prolonged or repeated exposure to formaldehyde may result in respiratory impairment. Rats exposed to formaldehyde at 2 ppm developed benign nasal tumors and changes of the cell structure in the nose as well as inflamed mucous membranes of the nose. Structural changes in the epithelial cells in the human nose have also been observed. Some persons have developed asthma or bronchitis following exposure to formaldehyde, most often as the result of an accidental spill involving a single exposure to a high concentration of formaldehyde.

## **Emergency and First Aid Procedures**

**Ingestion (Swallowing):** If the victim is conscious, dilute, inactivate, or absorb the ingested formaldehyde by giving milk, activated charcoal, or water. Any organic material will inactivate formaldehyde. Keep affected person warm and at rest. Get medical attention immediately. If vomiting occurs, keep head lower than hips.

**Inhalation (Breathing):** Remove the victim from the exposure area to fresh air immediately. Where the formaldehyde concentration may be very high, each rescuer must put on a self-contained breathing apparatus before attempting to remove the victim, and medical personnel should be informed of the formaldehyde exposure immediately. If breathing has stopped, give artificial respiration. Keep the affected person warm and at rest. Qualified first-aid or medical personnel should administer oxygen, if available, and maintain the patient's airway and blood pressure until the victim can be transported to a medical facility. If exposure results in a highly irritated upper respiratory tract and coughing continues for more than 10 minutes, the worker should be hospitalized for observation and treatment.

**Skin Contact.** Remove contaminated clothing (including shoes) immediately. Wash the affected area of your body with soap or mild detergent and large amounts of water until no evidence of the chemical remains (at least 10 to 20 minutes). If there are chemical burns, get first aid to cover the area with sterile, dry dressing, and bandages. Get medical attention if you experience appreciable eye or respiratory irritation.

**Eye Contact:** Wash the eyes immediately with large amounts of water occasionally lifting lower and upper lids, until no evidence of chemical remains (at least 15 to 20 minutes). In case of burns, apply sterile bandages loosely without medication. Get medical attention immediately. If you have experienced appreciable eye irritation from a splash or excessive exposure, you should be referred promptly to an ophthalmologist for evaluation.

## **Emergency Procedures**

**Emergencies:** If a spill of appreciable quantity occurs, leave the area quickly unless you are a designated person who has been given specific emergency response training and duty assignments. Do not touch spilled material. Designated persons may stop the leak and shut off ignition sources if these procedures can be done without risk. Designated persons should isolate the hazard area and deny entry except for necessary people protected by suitable protective clothing and respirators adequate for the exposure.

## **Spill, Leak, and Disposal Procedures**

**Occupational Spill:** For small containers, place the leaking container in your chemical fume hood or other well ventilated area. Clean-up small spills with absorbent material if this can be done safely. For larger spills, leave the area immediately and dial 911 or contact EH&S at 459-2553 directly.

**Waste Disposal:** Dispose of all hazardous chemical waste through the campus hazardous waste disposal program. Contact EH&S at 459-3086 if you need assistance.

### **Monitoring and Measurement Procedures**

**Monitoring Requirements:** If your exposure to formaldehyde exceeds the 0.5 ppm action level or the 2 ppm short term exposure limit (STEL), your employer must monitor your exposure. Your employer need not measure every exposure if a "high exposure" employee can be identified. This person usually spends the greatest amount of time nearest the process equipment. If you are a "representative employee," you will be asked to wear a sampling device to collect formaldehyde. This device may be a passive badge, adsorbent tube attached to a pump, or an impinger containing liquid. You should perform your work as usual, but inform the person who is conducting the monitoring of any difficulties you are having wearing the device.

**Evaluation of 8-hour Exposure:** Measurements taken for the purpose of determining time-weighted average (TWA) exposures are best taken with samples covering the full shift. Samples collected must be taken from the employee's breathing zone air.

**Short-term Exposure Evaluation:** If there are tasks that involve brief but intense exposure to formaldehyde, employee exposure must be measured to assure compliance with the STEL. Sample collections are for brief periods, only 15 minutes, but several samples may be needed to identify the peak exposure.

**Monitoring Techniques:** OSHA's only requirement for selecting a method for sampling and analysis is that the methods used accurately evaluate the concentration of formaldehyde in employees' breathing zones. Sampling and analysis may be performed by collection of formaldehyde on liquid or solid sorbents with subsequent chemical analysis. Sampling and analysis may also be performed by passive diffusion monitors and short-term exposure may be measured by instruments such as real-time continuous monitoring systems and portable direct reading instruments.

**Notification of Results:** You must be informed of the results of your exposure monitoring. You may be informed in writing, but posting the results where you have ready access to them constitutes compliance with the standard.

### **Protective Equipment and Clothing**

Material impervious to formaldehyde is needed if you handle formaldehyde solutions of 1% or more. Other employees may also require protective clothing or equipment to prevent dermatitis.

**Respiratory Protection:** You must participate in the UCSC respiratory protection program if you use a respirator. Contact EH&S at 459-4454 for more information.

NIOSH approved full facepiece negative pressure respirators equipped with approved cartridges or canisters may be used for protection from formaldehyde. (Present restrictions on cartridges and canisters do not permit them to be used for a full workshift.) In many situations air-line or self-contained breathing apparatus (SCBA) may be required.

**Protective Gloves:** Wear protective (impervious) gloves to prevent skin contact with formalin. Gloves based on neoprene/natural rubber blend or those which contain a layer of neoprene over a natural rubber substrate may provide good protection without significant decrements in tactility/dexterity. Nitrile and Butyl rubber gloves are also generally effective for protection from 37% formalin solutions.

**Eye Protection:** If you might be splashed in the eyes with formalin, it is essential that you wear splash goggles or some other type of complete protection for the eye. You may also need a face shield to supplement the protection provided by goggles, but you must never use just a face

shield without other eye protection. Eye protection is critical especially when working with formaldehyde solutions of 1% or more.

**Other Protective Equipment:** You must wear protective (impervious) clothing and equipment to prevent repeated or prolonged contact with formaldehyde liquids. If you are required to change into whole-body chemical protective clothing, you must be provided with a change room for your privacy and for storage of your normal clothing.

If you are splashed with formaldehyde, immediately use the *emergency showers and eyewash fountains* to prevent serious injury. Report the incident to your supervisor and obtain necessary medical support. According to the standard, Employers must provide conveniently located quick drench showers when employees work with formaldehyde solutions of 1% or more.

### **IDLH Atmosphere**

Areas where the formaldehyde concentration might be 100 ppm or more are considered "immediately dangerous to life and health" (IDLH). Work in an IDLH atmosphere must only be done with complete body protection including a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a supplied air respirator with full facepiece and operated in a positive pressure mode. This equipment is essential to protect life and health under such extreme conditions and should only be attempted by specially trained response personnel. (Note: NIOSH sets 20 ppm as an IDLH level because it considers Formaldehyde to be a Human Carcinogen)

### **Engineering Controls**

Ventilation is the most widely applied engineering control method for reducing the concentration of airborne substances in the breathing zones of workers. There are two distinct types of ventilation.

**Local Exhaust:** Local exhaust ventilation is designed to capture airborne contaminants as near to the point of generation as possible. To protect you, the direction of contaminant flow must always be toward the local exhaust system inlet and away from you. Laboratory chemical fume hoods are a good example of local exhaust ventilation.

**General Dilution:** General dilution ventilation involves continuous introduction of fresh air into the workroom to mix with the contaminated air and lower your breathing zone concentration of formaldehyde. Effectiveness depends on the number of air changes per hour and where devices emitting formaldehyde are located in the area. In some circumstances general dilution ventilation may be the only practical method of control but it is the least effective and should be used with extreme caution when working with a material as potentially hazardous as formaldehyde.

### **Work Practices**

Work practices and administrative procedures are an important part of a formaldehyde control system. If you are asked to perform a task in a certain manner to limit your exposure to formaldehyde, it is extremely important that you follow these procedures. If you are unsure what work practices to follow it is extremely important that you find out before you begin your work. If you would like assistance in reviewing your procedures contact EH&S at 459-4454.

### **Medical Surveillance**

UCSC must make a medical surveillance program available at no expense to employees who are exposed to formaldehyde concentrations above 0.5 ppm as an 8-hour average or 2 ppm over any 15-minute period. Required medical surveillance should be provided at the time of initial assignment and once a year afterward for as long as the exposure continues. Employees are strongly encouraged to participate in the medical surveillance program when personal exposures are over these limits.

If personal exposure is below this range and an employee feels that, (based on their training about the signs and symptoms of exposure to formaldehyde), they are experiencing symptoms, they should report such concerns to their supervisor. Medical surveillance is the best way to determine if health is being impaired by formaldehyde exposure.

The medical surveillance plan includes: (a) a medical disease questionnaire, and (b) a physical examination if the physician determines this is necessary. The physician must collect all information needed to determine if an employee is at increased risk from exposure to formaldehyde. At the physician's discretion, the medical examination may include tests, such as a chest X-ray, to make this determination. After a medical examination, the physician will provide the employer with a written opinion which includes any special protective measures recommended and any restrictions on the employee's exposure. The physician must inform the employee of any medical conditions which would be aggravated by exposure to formaldehyde. All records from medical examinations, including disease surveys, must be retained at no expense to you.

If you are exposed to formaldehyde in an emergency and develop signs or symptoms associated with acute toxicity from formaldehyde exposure, you must be provided with a medical examination as soon as possible. This medical examination will include all steps necessary to stabilize your health. You may be kept in the hospital for observation if your symptoms are severe to ensure that any delayed effects are recognized and treated.

### **Training Requirements Under the Formaldehyde Standard**

- (1) **Participation** - UCSC is obligated to assure that all employees who work with or around formaldehyde participate in a training program if exposures are at or above 0.1 ppm.
- (2) **Frequency** - Training should be done at the time of initial assignment and whenever a new exposure to formaldehyde is introduced into the work area. The training shall be repeated at least annually.
- (3) **Training program** - The training program shall be conducted in a manner which the employee is able to understand and shall include:
  - (A) A discussion of the contents of the formaldehyde regulation (California Code of Regulations Title 8 §5217. Formaldehyde) and the contents of the Material Safety Data Sheet;
  - (B) The purpose for and a description of the medical surveillance program required by the standard, including:
    1. A description of the potential health hazards associated with exposure to formaldehyde and a description of the signs and symptoms of exposure to formaldehyde.
    2. Instructions to immediately report the development of any adverse signs or symptoms that the employee suspects is attributable to formaldehyde exposure.
  - (C) Description of operations in the work area where formaldehyde is present and an explanation of the safe work practices appropriate for limiting exposure to formaldehyde to each job;
  - (D) The purpose for, proper use of, and limitations of personal protective clothing and equipment;
  - (E) Instructions for the handling of spills, emergencies, and clean-up procedures;
  - (F) An explanation of the importance of engineering and work practice controls for employee protection and any necessary instruction in the use of these controls; and
  - (G) A review of emergency procedures including the specific duties or assignments of each employee in the event of an emergency.

**(4) Access to training materials.**

- (A) The University is obligated to inform all affected employees of the location of written training materials and shall make these materials readily available, without cost, to the affected employees.
- (B) The employer shall provide, upon request, all training materials relating to the employee training program to the Cal-OSHA Compliance Officers.

**Regulated Areas and Signage**

The following is subject to the hazard communication requirements of the formaldehyde standard:

Formaldehyde gas, all mixtures or solutions composed of greater than 0.1 percent formaldehyde, and materials capable of releasing formaldehyde into the air, under reasonably foreseeable conditions of use, at concentrations reaching or exceeding 0.1 ppm.

As a minimum, specific health hazards that the employer shall address are: cancer, irritation and sensitization of the skin and respiratory system, eye and throat irritation, and acute toxicity.

**Labels:**

For materials capable of releasing formaldehyde at levels above 0.5 ppm, labels shall appropriately address the hazard, including respiratory sensitization, and shall contain the words

**"Potential Cancer Hazard."**

**Regulated areas:**

The employer shall establish regulated areas where the concentration of airborne formaldehyde exceeds either the TWA or the STEL, and post all entrances and accessways with signs bearing the following information:

**DANGER  
FORMALDEHYDE  
IRRITANT AND POTENTIAL CANCER HAZARD  
AUTHORIZED PERSONNEL ONLY**

The employer shall limit access to regulated areas to authorized persons who have been trained to recognize the hazards of formaldehyde.

*The Information contained in this document is adapted from the Federal OSHA Standard 1910.1048 Formaldehyde, Appendix A - Substance Technical Guidelines for Formalin.*