




Formaldehyde and Paraformaldehyde SOP

What is formaldehyde?

Formaldehyde is a strong-smelling, colorless, and flammable gas that is most commonly found dissolved in aqueous solutions at 37-40% in water or water/methanol (also known as formalin). The precursor to formaldehyde is paraformaldehyde, which is the crystallized polymer of formaldehyde. Paraformaldehyde is weighed out and dissolved in solution for use in cell and tissue fixation. Typically 3-10% formalin or paraformaldehyde solutions are used to perfuse or fix tissues. Both formalin and paraformaldehyde are able to release formaldehyde gas/vapor. Apart from its wide use in production of home building products and as an additive to hair straightening products, formaldehyde is also frequently used in research laboratories as a preservative, tissue fixative, and chemical reagent.

What are the hazards?

Formaldehyde is classified as a known human carcinogen and has been linked with cancers of the lung, nasopharyngeal and oropharynx, and nasal passages. It is also a reproductive toxin capable of exerting target organ damage upon prolonged and repeated exposure. Even at airborne levels as low as 0.1 parts per million (ppm), acute exposure health effects may be experienced including coughing, wheezing, watery eyes, skin irritation, and a burning sensation in the eyes, nose, and throat. Formaldehyde acts as a sensitizer and can cause an immune response upon initial exposure. Severe allergic reactions in the respiratory tract, skin, and eyes may occur upon ensuing exposures. Prolonged exposure to low levels of formaldehyde in air can cause asthma-like respiratory symptoms and various skin irritations such as dermatitis. Formaldehyde can be fatal if ingested. It may be inhaled as a gas or vapor or absorbed through the skin as a liquid. Specific hazards depend upon both the form and concentration of the formaldehyde. In research labs, it is typically used in solutions containing 37% formaldehyde (also called formalin), and its hazards are listed in the table below.

	Flammable liquids
	Germ cell mutagenicity; Carcinogenicity; Specific target organ toxicity (single exposure) - Respiratory system, Central nervous system (CNS), Optic nerve; Specific target organ toxicity - (repeated exposure) - Kidney, Liver, Heart, spleen, Blood
	Acute oral toxicity; Acute dermal toxicity; Acute Inhalation Toxicity - Vapors



Skin corrosion/irritation, Serious Eye Damage/Eye irritation, Skin sensitization

Occupational Exposure Limits

The OSHA and ACGIH Time Weighted Averages (TWAs) and Short Term Exposure Limits (STELs) for formaldehyde inhalation exposure are listed below. Concentrations are listed in parts per million (ppm). TWA limits should not be exceeded over the course of an 8-hour work day and workers should not be exposed to STEL concentrations for more than 15 minutes.

OSHA PELs		ACGIH TLVs	
TWA	STEL	TWA	STEL
0.75 ppm	2 ppm	0.1 ppm	0.3 ppm

For more information, please refer to OSHA PELs Table Z-1 (<https://www.osha.gov/dsg/annotated-pels/tablez-1.html>), NIOSH Pocket Guide to Chemical Hazards (<https://www.cdc.gov/niosh/npg/default.html>) and ACGIH® 2019 Threshold Limit Values.

What Activities Could Pose a Risk?

Exposure to formaldehyde occurs primarily through inhalation of gas or vapor from the air or by absorption through the skin. Paraformaldehyde and formaldehyde solutions may release formaldehyde gas into the air under normal conditions of use. Levels in air and around workers' breathing zones in laboratories can be high, especially if there is inadequate ventilation or poor handling practices. Manual handling processes in laboratories increase the risk of spills and splashing on to the skin or eyes.

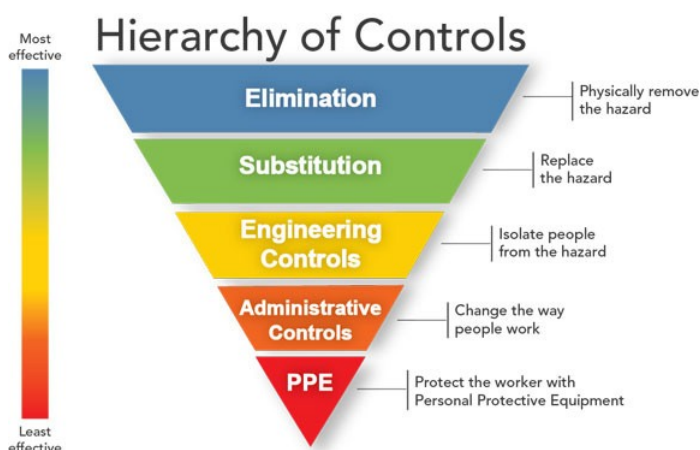
Laboratory workers are at risk for exposure when handling tissues perfused or preserved with formalin as specimens may release formaldehyde gas into the air during examination and dissection. Use of solid paraformaldehyde to prepare formalin solutions may also lead to exposure to formaldehyde vapors from the weighing and dissolving operations. Additionally, pouring formalin directly over a specimen could cause splashing. Off-gassing of formaldehyde can occur from materials that have come into contact with formalin, including gloves, dissection tools, absorbent wipes, and the specimen itself. Working with or storing such materials in an unenclosed area (including trash bins) poses an inhalation hazard due to the volatilization of formaldehyde into the surrounding air.

Individuals who work in shops with formaldehyde containing materials may also be at risk for formaldehyde exposure. Resins used in the manufacture of composite wood products (i.e., hardwood plywood, particleboard and medium-density fiberboard) contain formaldehyde. It's also found in glues, paints, lacquers, coatings, finishes, as well as many other building products. Cutting, grinding, sanding, welding, or otherwise manipulating such materials can increase risk of inhalation exposure as airborne particles containing formaldehyde are generated as a result of such processes. Other materials that commonly contain formaldehyde include textiles, fabrics, fabric softeners, pesticides, and disinfectants. Working with such materials may pose an exposure risk.

How Can Exposures Be Minimized?

When working with formaldehyde, or any other hazardous material, always conduct a thorough risk assessment and employ the hierarchy of controls to minimize risk. Some specific applications of the hierarchy of controls to the hazards of formaldehyde are listed below.

Always apply the controls in the order of most effective to least effective (see graphic), and apply as many controls as possible to reduce the risk to the lowest achievable level. Please contact EH&S if you need assistance with determining how to mitigate hazards or need an exposure assessment.



Elimination/Substitution

- Replace high concentration formaldehyde products with low concentrations or less hazardous substitutes, whenever possible. Use fixatives and specimens that do not contain formaldehyde when possible. Even fixatives with low concentrations of formaldehyde are capable of generating air concentrations that exceed permissible exposure limits.
- Use of pre-weighed paraformaldehyde packets or prepared formalin solutions should be considered if possible to minimize potential exposures.

Engineering Controls

- Avoid inhalation by using engineering controls where possible in storage and dispensing areas, such as local exhaust ventilation (e.g. chemical fume hood, snorkel ventilation, downdraft tables, etc.). Formaldehyde and paraformaldehyde should always be used with adequate ventilation, including weighing, dissolving, other handling steps and procedures, preferably in a fume hood, to minimize inhalation of formaldehyde vapor.
- Perfusions must be performed in a chemical fume hood or on a downdraft table.
- Routinely maintain local exhaust ventilation systems and check that chemical fume hoods are operating at the proper face velocity before each use.
- Ensure that laboratories are negatively pressurized with respect to the hallway.

Administrative Controls

- Before use:
 - Consult the manufacturer's Safety Data Sheet and additional chemical information at <https://cems.unh.edu/umass/CEMS/SearchSDS>.
 - Locate nearest eyewash and shower and confirm that they are accessible and within 50 ft. of the work area
- When not in use, ensure proper storage by:
 - Storing in a cool and well ventilated area;
 - Keeping away from heat, sunlight and moisture if possible;
 - Keeping all containers tightly closed and;
 - Storing separately from incompatible materials, including strong oxidizers, ammonia, strong alkalis, isocyanates, peracids, anhydrides and inorganic acids.

- Handle and store formaldehyde solutions as little as possible by purchasing the exact concentrations needed for the procedure rather than making dilutions from a more concentrated product.
- Waste that has come into contact with formalin (e.g. paper towels, gloves, leftover formalin-preserved specimens) should be sealed in a bag before disposal.
- Clean dissection and examination tools immediately after use with formalin preserved specimens.
- Keep containers closed as much as possible.
- Prevent exposure from evaporation of excess fluid in the specimen by rinsing or blotting the excess with paper towels.
- Use the smallest quantities needed for the experiment being performed. If weighing paraformaldehyde, use a balance inside of the fume hood if possible.
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- To minimize exposure from weighing and dissolving steps to prepare solutions, please consider purchasing “ready-to-use” buffered formalin solutions in concentrations ranging from 2% to 10%.
- Place as little volume of fixative solution into containers as possible, gently add specimens to limit splashing, and then gently pour fixative solution over the specimen, leaving some headspace at the top of the sample container.
- Purchase composite wood products that are certified as compliant for formaldehyde emission limits by the American National Standards Institute and the Hardwood Plywood and Veneer Association.
- For routine use outside of local exhaust ventilation systems, please contact EH&S for an assessment.
- Ensure laboratory personnel are thoroughly trained on the hazards of formaldehyde, including routes of exposure and hazard mitigation techniques.

Personal Protective Equipment

- Always wear appropriate PPE including:
 - Safety glasses or chemical splash goggles
 - Lab coat and closed toed shoes
 - One pair butyl gloves or two pairs disposable exam-grade nitrile gloves when working with concentrated formaldehyde solutions ($\geq 37\%$) or one pair disposable exam-grade nitrile glove when working with diluted solutions ($<37\%$).
- In cases where engineering controls do not provide sufficient protection for inhalation exposure, please contact EH&S. We will work with you to determine the appropriate respirator based on a risk assessment for work conducted using formaldehyde. Respirator users must enroll in the University’s Respiratory Protection Program (<https://ehs.umass.edu/respiratory-protection-program>). Please note that particulate filtering respirators (dust masks) do not provide any protection against formaldehyde vapors.

Waste Handling

All concentrated formaldehyde and paraformaldehyde wastes must be placed in an appropriate containers (usually 4L or 20L containers) and labeled. If paraformaldehyde waste is not able to be safely collected in appropriate containers, please make sure the waste is 1% paraformaldehyde or less and flushed with water

for drain disposal. The label should indicate all constituents in the waste using a percent format. If disposing biowaste, such as specimens, please refer to Biological waste program. To have the waste picked up by EH&S staff, complete a Hazardous Materials Pickup Request Form in CEMS.

Exposure and Spill Procedure

In the event of a spill involving formaldehyde that does not involve the contamination of a person, the material may be cleaned up if it is safe to do so following the general procedure for small spills detailed in the University's Chemical Hygiene Plan.

- Ensure that cleaning up the material will not generate airborne dust or aerosols.
 - Spills of formaldehyde outside of enclosures (fume hoods or other enclosure devices) should be immediately referred to EH&S (413-54-2682) and the area should be evacuated. Do not permit entry to the area until EH&S arrives.
- Place all items used for cleanup in a labeled hazardous waste container and request a pickup through CEMS.
- If at any point you are uncomfortable cleaning up the spill or require assistance, stop and call EH&S (413-545-2682).

Exposures to formaldehyde should follow the general procedures for exposures to hazardous materials outlined in the University's Chemical Hygiene Plan.

For a major exposure requiring the use of a drench shower or eyewash:

- Have someone call 911 (report the building name, room number, and street address) or 413-545-3111 (or simply 5-3111 from a campus line) to report the incident and request medical help. Have someone obtain the SDS for the material (if there is one) and provide it to the first responders when they arrive, if possible.
- Help the affected individual to position their head over the eyewash and activate it, or position them under the drench shower and activate it as appropriate.
 - Always ensure your own safety before helping others. Only help if it is safe for you to do so.
 - Wear gloves, safety glasses, and a lab coat.
- If using an eyewash: Instruct the affected individual to open their eyes and roll them around while the water is flowing. Help them to hold their eyes open if necessary and safe to do so.
- If using a drench shower: Remove all clothing from the affected area while under the shower.
- Flush the affected area for 15 minutes with water.

For minor exposures such as a spill to readily accessible extremities (e.g., hand):

- Flush the affected area in a sink equipped with potable water for at least 15 minutes.
- Go to University Health Services (UHS) for medical evaluation, and tell them you have had a lab exposure.
- Provide the SDS for the material if possible.
- Notify EH&S (413-545-2682) as soon as possible and complete the lab incident form (<https://ehs.umass.edu/lab-incidents-and-lab-incident-report-form>).

References and Additional Resources

1. OSHA Formaldehyde Fact Sheet. https://www.osha.gov/OshDoc/data_General_Facts/formaldehyde-factsheet.pdf
2. National Cancer Institute. <https://www.cancer.gov/about-cancer/causes->

[prevention/risk/substances/formaldehyde/formaldehyde-fact-sheet](#)

3. National Institute of Environmental Health.
<https://www.niehs.nih.gov/health/topics/agents/formaldehyde/index.cfm>
4. OSHA Regulations. 29 CFR, 1910-1048. Occupational Safety and Health Standards, subpart Z. Toxic and Hazardous Substances: Formaldehyde.
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10075
5. ThermoFisher Scientific SDS for 37% formaldehyde solution.
<https://www.fishersci.com/store/msds%3FpartNumber%3DF75P20%26productDescription%3DFORMALDEHYDE%2B37%2525%2B20L%26vendorId%3DVN00033897%26countryCode%3DUS%26language%3Den>