



A Guide to Formaldehyde



NCDOL
N.C. Department of Labor

Occupational Safety and Health Division
N.C. Department of Labor
1101 Mail Service Center
Raleigh, NC 27699-1101

Cherie Berry
Commissioner of Labor

**N.C. Department of Labor
Occupational Safety and Health Program**

Cherie Berry
Commissioner of Labor
OSHA State Plan Designee

Allen McNeely
Deputy Commissioner for Safety and Health

Kevin Beauregard
Assistant Deputy Commissioner for Safety and Health

Susan Haritos
Reviewer

Acknowledgments

This guide was prepared by H. R. Imbus of Workplace Group, Greensboro, North Carolina, a firm that specializes in occupational health. Updated material was provided by N.C. Department of Labor employee J. Edgar Geddie. The information in this guide was updated in 2013.

This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard must be followed instead of this guide.

To obtain additional copies of this guide, or if you have questions about North Carolina occupational safety and health standards or rules, please contact:

**N.C. Department of Labor
Education, Training and Technical Assistance Bureau
1101 Mail Service Center
Raleigh, NC 27699-1101**

Phone: 919-807-2875 or 1-800-625-2267

Additional sources of information are listed on the inside back cover of this guide.

The projected cost of the NCDOL OSH program for federal fiscal year 2012–2013 is \$18,073,694. Federal funding provides approximately 30.5 percent (\$5,501,500) of this total.



Contents

Part		Page
	Foreword	iv
1	Formaldehyde in the Workplace	1
	What Is Formaldehyde?	1
	Sources of Formaldehyde	1
	How Can Formaldehyde Affect Our Health?	2
	How Formaldehyde Enters the Body	2
	Responding to Emergencies From Formaldehyde Releases	5
2	A Standard Regulating Formaldehyde in the Workplace	6
	Background Information	6
	Highlights of the Formaldehyde Standard	6
	Appendix—Safety Data Sheet	10
	Glossary	16
	References	17

Foreword

Formaldehyde in its simplest form is a colorless gas that is readily soluble in water. It has an acrid odor that can irritate the eyes and nose. Formaldehyde is commercially available as a solution called formalin, formed from various proportions of formaldehyde, water, and alcohol. Textile and wood product industries are large users of organic dyes and urea resins that contain formaldehyde. Formaldehyde is also used for disinfecting, embalming and producing some synthetic plastics.

Employers must be aware of workplace hazards facing their employees and take appropriate action to minimize or eliminate exposure to these hazards. *A Guide to Formaldehyde* describes how employers and employees can learn to protect their health in environments that contain formaldehyde.

In North Carolina, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe workplaces. Everyone profits when managers and employees work together for safety. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

Cherie Berry
Commissioner of Labor

Formaldehyde in the Workplace

What Is Formaldehyde?

Formaldehyde has the chemical elements carbon, hydrogen and oxygen in its structure. Hydrocarbons are among the most common of chemical compositions. The human body includes hydrocarbons among its elements and compounds, and it requires formaldehyde to metabolize biochemical substances.

Formaldehyde has a pungent odor and is very soluble in water. Formaldehyde is highly reactive and readily combines with many chemical compounds, and under normal conditions, it is a gas. In its simplest form, formaldehyde is a colorless gas. But the term formaldehyde is sometimes used to describe liquids composed of various mixtures of formaldehyde, water, and alcohol.

Formaldehyde is usually sold as an aqueous or watery solution called *formalin*, which contains 37 to 50 percent formaldehyde by weight. It is soluble in water, but not in most organic solvents, except alcohol and ether. It is principally used to produce resins, other industrial chemicals, and consumer items and as a bactericide or fungicide.

A mixture of polymers of formaldehyde (many molecules of formaldehyde linked together) is known as paraformaldehyde. Paraformaldehyde is a white powder containing 91 percent or more formaldehyde.

Sources of Formaldehyde

Formaldehyde is part of our general outdoor environment. It is released into the atmosphere through fumes from automobile and truck exhausts and by manufacturing facilities that burn fossil fuels. Uncontrolled forest fires and the open burning of waste give off formaldehyde. Because of formaldehyde's high water solubility, it is contained in rain water, oceans and surface waters.

Geographic location, wind conditions, cloud cover, rain or standing water, air temperature, and the season of the year are all important variants in the amount of formaldehyde in the ambient air.

Formaldehyde is also in our indoor work environment. A formaldehyde resin is used in the production of plywood and particle board. These wood products become part of the structure of various workplaces. For example, offices converted from mobile homes make use of large quantities of plywood. Paint used to cover walls contains formaldehyde. In the past, a foam made from a resin known as urea-formaldehyde was used as a thermal insulation in the outside walls of buildings. If the foam were formulated or mixed improperly, formaldehyde could be released into the building.

The paper products industry uses urea-formaldehyde resins. Paper products treated with formaldehyde include paper bags, waxed paper, paper towels and disposable sanitary products. All of these products are used in the work environment. The wood industry uses urea-formaldehyde resin as a binder in plywood and particleboard.

The textile industry uses formaldehyde resins to finish apparel fabrics. Formaldehyde also finds its way into the workplace through other textile products. Floor covering and carpet backing may contain formaldehyde polymers. The textile industry uses formaldehyde for fire retardation, increased water repellency, stiffness and wrinkle-resistance in fabric. Draperies, wallpaper, carpet and upholstered furniture contain formaldehyde.

Formaldehyde surrounds us generally in the workplace, just as it does in the home and elsewhere. However, employees may be additionally exposed from formaldehyde used in their work products.

Formaldehyde can lead to widespread exposure in downstream industries. When formaldehyde is present in disinfectants, preservatives and embalming fluid, worker exposure can occur. Formaldehyde is found in release agents in foundries. Laboratories in schools, hospitals, dental facilities and veterinary settings may make use of formaldehyde. Hospitals use it as a disinfectant and deodorizer. See Table 1 for a partial list of occupations that may involve exposure to formaldehyde. Also see Table 2.

Table 1

Occupations That May Involve Exposure to Formaldehyde

Agriculture workers	Insulators
Botanists	Laboratory researchers/workers
Carpet manufacturers/installers	Lacquer producers and users
Disinfectant producers/users	Medical professionals
Dressmakers	Oil field workers
Drug makers	Paint and varnish manufacturers
Dye manufacturers	Paper manufacturers
Embalming fluid producers	Plastics manufacturers
Fabric store personnel	Plywood and particle board manufacturers
Fertilizer manufacturers and blenders	Poultry processors
Formaldehyde producers	Rubber workers
Formaldehyde resin producers	Sanitation workers
Foundry workers	Science instructors/teachers
Furniture makers and finishers	Taxidermists
Glue and adhesive makers	Textile workers: finishers, printers, cutters
Hazardous waste handlers	Veterinarians
Ink makers	Wood preservers

How Can Formaldehyde Affect Our Health?

Based on the best available evidence in OSHA's record on formaldehyde, OSHA determined that formaldehyde is genotoxic, showing properties of both a cancer initiator and promoter (early and late stage carcinogen). When inhaled, formaldehyde is a carcinogen in rats. In humans, formaldehyde exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages.

When humans are exposed to excess levels of formaldehyde, adverse health effects can result. Symptoms of excess exposure include respiratory irritation; watery, itchy eyes; itchy, runny, or stuffy nose; dry or sore throat; and headache. The EPA and OSHA recognize that contact with formaldehyde can cause skin irritation and dermatitis.

Normally, reactions to formaldehyde end within days or a few weeks of the cessation of exposure. Most people become acclimated to formaldehyde and come to experience its effects more mildly. But some people, especially those with allergic asthma, allergic hay fever, or infantile or childhood eczema, become sensitized and suffer a condition known as allergic contact dermatitis. Those with allergic contact dermatitis suffer itching, redness, swelling, multiple small blisters and scaling whenever subsequent exposure occurs. Sensitized individuals are usually unable to remain in formaldehyde-related jobs.

How Formaldehyde Enters the Body

There are four routes of exposure to a substance: ingestion, inhalation, skin absorption and eye contact. Since people may adapt to formaldehyde, dependency upon the perception of formaldehyde by odor and eye irritation can lead to over-exposure if the worker is relying on those cues as a warning against exposure.

Ingestion

Ingestion (eating or drinking) is not considered a common route of significant exposure to formaldehyde. Nevertheless, there have been reported cases of accidental formaldehyde ingestion. Swallowing liquids containing 10 to 40 percent formaldehyde results in severe irritation of the mouth, throat and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death.

Inhalation

Inhaling formaldehyde can cause symptoms ranging from mild irritation to severe difficulty in breathing. The response depends on the concentration of the formaldehyde. For example, concentrations of 10 to 20 parts per million (ppm) cause difficulty in breathing, burning of the nose and throat, cough, and heavy tearing. The response also depends on the length of exposure and individual sensitivity. Additionally, one can become exposed by inhalation through off-gassing from formaldehyde-containing materials (downstream exposure).

Because formaldehyde is so soluble, inhaling or breathing it causes irritation of the eyes and nose. The eyes will tear and the mucus in the nose will run. Other reactions include headache, sinus fullness, sore throat and hoarseness. Higher concentrations of formaldehyde or long-term exposure can cause severe coughing, chest tightness, and swelling or spasms in the throat (glottis).

Some studies have linked formaldehyde exposure to allergic asthma. Formaldehyde resins have been linked to respiratory disease in some workers, with symptoms including both an immediate and a delayed asthmatic reaction.

Hypersensitivity pneumonitis (a flulike illness with fever, chills, cough and shortness of breath) has occasionally been associated with worker exposure to phenoformaldehyde Bakelite resins. Exposure to formaldehyde in concentrations of 100 ppm is considered immediately dangerous to life and health.

Skin Absorption

Skin absorption is one of the major routes of exposure to formaldehyde. Skin contact with formaldehyde can result in reactions ranging from mild irritation to severe allergic dermatitis. Concentrated solutions of formaldehyde will cause the skin to discolor, crack, dry and scale. Prolonged or repeated contact will cause numbness and hardening or tanning of the skin.

A number of factors affect skin absorption of formaldehyde. If there is an existing dermatitis or acne or if the skin is broken or irritated, absorption is increased. High humidity and the area of skin exposed also affect skin absorption of formaldehyde.

Formaldehyde is a chemical that causes a significant number of people to experience skin sensitization. Chemicals that cause sensitization are called allergens. Exposure to these chemicals causes the body to form antibodies. Future exposure to the substance, even in very small amounts, can cause symptoms.

Skin contact occurs in a variety of workplaces, such as veterinary clinics, schools, photography, plumbing, agricultural, pest control and medical settings (including pathology laboratories and morgues). In the fabric industry, material is treated with formaldehyde for use in making sheeting and garments. In garments, formaldehyde makes possible a durable press finish. Employees who work with such products are exposed to formaldehyde and subject to dermatitis. In recent times, technology has decreased the amount of free formaldehyde on fabrics, and the risk of dermatitis has been reduced.

Allergic contact dermatitis is seen among medical personnel who use formaldehyde. Pathologists use formaldehyde as a tissue fixative. Medical professionals may use it in disinfection procedures. Technicians and cleaning personnel in health care facilities are also routinely exposed to formaldehyde.

Other employees at similar risk include hairdressers; automotive industry workers who handle coolants and cutting oils; workers exposed to paint; and printing industry workers who are exposed to ink and who routinely handle journals and newspapers. (See Table 2 for a list of occupations where there exists the potential for dermatitis from formaldehyde exposure.)

Table 2***Jobs and Exposures with Potential for Formaldehyde Dermatitis***

Job	Exposure
Actors and theatrical artists	Makeup
Artists, printers, silk screeners	Inks, paper, preservatives
Bakers	Disinfectants
Beauticians, barbers	Disinfectants, germicides, cosmetics
Butchers and food preparation workers	Cleaners, disinfectants
Biology laboratory instructors	Preservatives
Carpenters, cabinet makers	Adhesives, solvents
Cleaning personnel	Detergents, preservatives
Clinical biologists, histologists	Formalin
Dentists, hygienists, assistants	Disinfectants, medications
Dry cleaners	Spot removers
Electricians and electronics workers	Resins, metal cleaners
Farming industry	Metal cleaners, resins
Foundry workers	Resin emissions from sand molds
Leather and fur workers	Tanning
Machinists	Metal cleaners, cutting fluids
Mechanics	Metal and tire cleaners, sealants
Medical personnel	Disinfectants, medicines
Morticians	Formalin
Painters	Resins
Paper workers	Resin emissions
Pathologists, histologists	Formalin
Pest control workers	Fumigants, cleaning agents
Pharmacists	Medicine, drug preservatives
Photographers	Developers, resin emissions
Plumbers, pipefitters	Metal cleaners, resins
Printers	Ink, paper
Stone workers	Cleaning solutions
Textile workers	Emissions from fabric finishes
Wallpaper hangers	Preservatives, adhesives
Welders	Metal cleaners, resins

Eye Contact

Eye contact results from spills or splashes of formaldehyde. Eye contact reactions range from mild irritation to permanent corneal cloudiness and loss of vision. The severity of injury is determined by the concentration of the solution and the length of contact. Eye irritation is a common complaint of people exposed to formaldehyde vapor. As the concentration of formaldehyde increases, the eyes become itchy and tear till they afford themselves some degree of natural protection by closing.

Responding to Emergencies From Formaldehyde Releases

If your work area has the potential for large formaldehyde releases, either from an accident or equipment failure, then your employer must develop an emergency procedure. Only employees trained per 29 CFR 1910.120, Hazardous Waste and Emergency Response (HAZWOPER), and equipped with appropriate personal protective equipment may attempt to stop formaldehyde leaks. Employees may dike large spills when they have been trained per HAZWOPER to take such actions.

Never attempt to rescue another employee from an area with high formaldehyde concentration unless you have received proper training and are equipped with appropriate personal protective equipment. If you are not trained per the HAZWOPER requirements, evacuate the area and call 911 for an outside hazardous material team.

Employees with hazard communication training can clean up small spills of formaldehyde. The employer must provide the employees with necessary personal protective equipment to minimize exposure.

A Standard Regulating Formaldehyde in the Workplace

Background Information

The federal Occupational Safety and Health Administration (OSHA) first regulated workers' exposure to formaldehyde in 1972, when it imposed a permissible exposure limit (PEL) of three parts of formaldehyde per million parts of air (3 ppm) as an eight-hour time weighted average (TWA). At that time, the standard was based on findings showing that formaldehyde was an eye, skin and respiratory irritant. Later research showed that formaldehyde might also cause cancer in humans. Based on this new research, OSHA issued a new standard (29 CFR 1910.1048) on Dec. 4, 1987.

The 1987 standard set the PEL at 1 ppm. In June 1989, the U.S. Court of Appeals for the District of Columbia ordered OSHA to justify more fully its new PEL and the absence of a medical removal protection (MRP) provision in the new standard. On May 27, 1992, OSHA published amendments to its 1987 standard (57 *Federal Register* 22290) in response to the 1989 court order. The amendments lowered the PEL to 0.75 ppm, required MRP, lifted a stay from the hazard communication provisions, and required annual employee training.

Highlights of the Formaldehyde Standard

The information that follows is intended to offer the reader a quick grasp of the standard. It is general information. It is not a substitute for the standard itself.

The Hazard

The standard intends to protect employees from exposure to formaldehyde. Formaldehyde gas, all mixtures or solutions equal to or greater than 0.1 percent formaldehyde, and materials capable of releasing formaldehyde into the air are considered a health hazard.

The Extent of the Standard's Protection

The standard applies to all occupational exposures to formaldehyde, that is, from formaldehyde gas, its solutions and materials that release formaldehyde.

Limits Beyond Which Employees May Not Be Exposed to Formaldehyde

The employer must ensure that no employee is exposed to an airborne concentration of formaldehyde that exceeds 0.75 parts of formaldehyde per million parts of air (0.75 ppm) as an eight-hour time-weighted average (TWA). This limit is one of two permissible exposure limits (PEL). The standard also provides a short-term exposure limit (STEL). The employer must ensure that no employee is exposed to an airborne concentration of formaldehyde that exceeds two parts formaldehyde per million parts of air (2 ppm) as a 15-minute STEL.

Monitoring of Employee Exposure May Be Required

Ensuring that employees are not excessively exposed to formaldehyde may mean that the employer must monitor employees to measure levels of exposure. If formaldehyde or formaldehyde-releasing agents are in the workplace, the employer is not obligated to monitor if it is able to document through objective data that employees cannot be exposed at or above the STEL, at or above the action level, or under foreseeable conditions of use.

In documenting that employees are not exposed at or above the action level or STEL, the employer should consider all relevant information. Relevant information may include insurance company and trade association data, and information from suppliers. Additionally, exposure data collected from similar operations and previous sampling results from the same employer may be used. If the employer can demonstrate conclusively that no employee is exposed at or above the action level or the STEL through the use of objective data, the employer need not monitor until such time that conditions have changed and the determination is no longer valid.

Determining Which Employees Are Potentially Exposed

If the employer determines that employee exposure at or above the action level or the STEL is possible, the employer must measure employee exposure. The first step in making that determination is to determine all situations where formaldehyde is used in a manner such that it may be released into the workplace atmosphere or contaminate the skin. Tables 1 and 2 may be helpful in determining occupations where formaldehyde exposure occurs.

Monitoring

Initial Monitoring

The employer must monitor each potentially exposed employee or develop a representative sampling strategy for each exposure work group. Appendix B of the standard discusses the relative merits of various sampling strategies and monitoring methods. Initial monitoring must be repeated if there is a change in production, equipment, process, personnel or control measures that may result in new or additional exposure to formaldehyde.

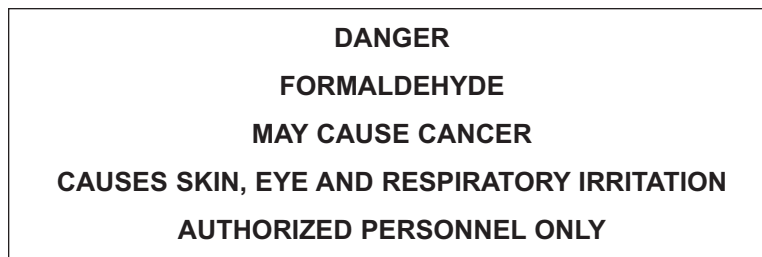
Periodic Monitoring

If monitoring shows employee exposure at or above the action level, monitoring must be repeated every six months. If monitoring shows employee exposure at or above the STEL, monitoring must be repeated every year under the worst conditions. The standard specifies the level of accuracy required of the monitoring process and describes conditions under which monitoring may be terminated. Employees must also be allowed to observe the monitoring process. Additionally, employees must be provided timely written notification of the results of monitoring and a description of the corrective action being taken.

Actions to Take When Monitoring Reveals Excess Exposure

Regulated Areas

If monitoring reveals concentrations of airborne formaldehyde at or in excess of the TWA or STEL, access ways to the area must be posted with signs saying:



Employees must be informed of these areas, and access must be limited to people who have been trained to recognize the dangers of formaldehyde. Additionally, the employer who established the regulated area must inform any other employers on the site of the restricted area locations and access requirements.

Engineering and Work Practice Controls

Engineering and work practice controls must be instituted to reduce exposure levels to or below the TWA or the STEL. If it is established that engineering controls are not feasible to comply, then the controls must be used to the extent feasible and supplemented with respirators.

Respiratory Protection

With regard to respirators, the formaldehyde standard specifies circumstances in which respirators must be used. A respiratory protection program which meets the requirements of 29 CFR 1910.134, Respiratory Protection, must be implemented.

Respirators must be provided at no cost to the employees who are required to wear them. The employer is responsible for ensuring that employees properly use the respirators. Respirators must be properly fit tested. Fit testing procedures can be found in paragraph (f) and in Appendix A of 29 CFR 1910.134. Quantitative or qualitative fit testing, which the employer must perform prior to initial use of the respirator and then annually, must be conducted for employees required to wear respirators with a tight-fitting face piece. Some principal considerations of fit test requirements, however, include the following:

- ◆ The most comfortable respirator must be used.
- ◆ The employee will be shown how to put on the respirator. He or she must have several choices and must wear the respirator for at least five minutes when selecting it.
- ◆ The assessment of comfort and fit must consider:
 - Position of the respirator on the nose and fit across the bridge of the nose
 - Room for eye protection
 - Room to allow talking
 - Proper placement of the chin
- ◆ When a tight-fitting positive or negative pressure respirator is used, the test must not be conducted if there is any hair growth between the skin and the face piece.
- ◆ The employer must certify that a successful fit test has been performed. The date completed; name of employee; and type, brand and size of the respirator will be part of the certification.
- ◆ During fit testing, specific exercises must be performed by the employee, including normal breathing, deep breathing, moving the head from side-to side and up and down, grimacing, and bending over.

Protective Equipment and Clothing

The standard requires compliance with other applicable standards regarding protective equipment and clothing. Such equipment and clothing must be provided at no cost to the employee. The employer is responsible for ensuring that the employees wear and use the clothing and equipment. Guidelines are provided for the selection and maintenance of protective equipment and clothing.

Hygiene Protection

The standard requires compliance with another applicable standard (29 CFR 1910.141) regarding the provision of quick change rooms for changing from work clothing into protective clothing. If there is the possibility that employees' skin and eyes may be splashed with formaldehyde, appropriate quick drench showers and eyewash facilities are required.

Housekeeping and Emergencies

For operations involving formaldehyde liquids or gas, there must be a program to detect leaks and spills. The program must encompass preventive and corrective maintenance and provisions to contain spills, decontaminate work areas and dispose of waste containing formaldehyde. However, employees must be properly trained per the HAZWOPER Standard to respond to spills that may be defined in that standard as an emergency response. The employer must develop appropriate procedures to be implemented in the event of an emergency.

Medical Surveillance

A medical surveillance program must be instituted for: (1) all employees exposed to formaldehyde at concentrations at or above the action level or STEL; (2) employees who develop signs and symptoms of overexposure to formaldehyde; and (3) all employees exposed to formaldehyde in an emergency. The program must be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

The program must make available a medical disease questionnaire. The questionnaire must be administered by a licensed physician or by someone under the physician's supervision. Appendix D of the standard includes an acceptable medical disease questionnaire.

A medical examination must be given to any employee designated by the physician on the basis of the questionnaire, to all employees who are required to wear a respirator—both at the time of initial assignment and annually, and to employees exposed in an emergency.

Under the medical removal provisions, an employee must be transferred to a job where formaldehyde does not exceed the action level if exposure causes significant eye, nose, throat or dermal sensitization. If job transfer is not possible, the employee must be removed from formaldehyde exposure until a physician determines whether the employee can return to work where there is exposure or for six months (whichever comes first). The employee has the right to seek a second medical opinion and resolution of any disagreement through a review by a third physician. During medical removal, the employee's seniority, benefits and earnings may not be reduced unless offset by other employment or public- or employer-funded compensation program.

Hazard Communication

The standard's hazard communication provisions cross-reference requirements in the generic standard at 29 CFR 1910.1200. A written hazard communication program must include labels and other forms of warning, safety data sheets, and employee information and training. Labels are required for all substances with 0.1 percent or more of formaldehyde and materials capable of releasing formaldehyde in excess of 0.1 ppm. If it is foreseeable that formaldehyde levels may exceed 0.5 ppm, labels must warn that formaldehyde is a Potential Cancer Hazard.

Training and Training Materials

Information and training must be provided in a manner in which the employee can understand, at the time of initial assignment, whenever a new exposure to formaldehyde is introduced into the work area, and at least annually. This guide might be used to inform employees of the contents of the standard. The appendix in this guide might be used to train about SDSs. Training should also include (among other things):

- ◆ Potential health hazards posed by formaldehyde (see Part 1 of this guide), including symptoms associated with formaldehyde exposure
- ◆ Work operation considerations, including:
 - Importance of engineering controls
 - Safe work practices
 - Use and limitations of personal protective equipment
 - Housekeeping procedures
 - Emergency procedures, including the specific duties or assignments of each employee in the event of an emergency

Employees should be informed of the location of written training materials on formaldehyde. The materials should be made available without cost.

Recordkeeping

Exposure, medical and respirator fit testing records must be maintained. Exposure records must be maintained for 30 years and medical records must be maintained for life of employment plus 30 years. If the employer determines that exposure monitoring is not required, the objective data supporting that determination must be maintained. Exposure and medical records must be made available to the employee (or former employee) and his or her representative per certain requirements of 29 CFR 1910.1020, Access to Employee Exposure and Medical Records. The standard explains any conditions that the employer may require to be met prior to releasing the records.

Appendix

Safety Data Sheet

The following Substance Technical Guideline for Formalin provides information on uninhibited formalin solution (37 percent formaldehyde, no methanol stabilizer). It is designed to inform employees at the production level of their rights and duties under the formaldehyde standard whether their job title defines them as workers or supervisors. Much of the information provided is general; however, some information is specific for formalin. When employee exposure to formaldehyde is from resins capable of releasing formaldehyde, the resin itself and other impurities or decomposition products may also be toxic, and employers should include this information as well when informing employees of the hazards associated with the materials they handle. 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 percent solutions of formaldehyde present a much greater hazard to the skin and eyes from spills or splashes than solutions containing less than 1 percent formaldehyde. Individual Substance Technical Guidelines used by the employer for training employees should be modified to properly give information on the material actually being used.

Substance Identification

Chemical Name: Formaldehyde

Chemical Family: Aldehyde

Chemical Formula: HCHO

Molecular Weight: 30.03

Chemical Abstracts Service Number (CAS Number): 50-00-0

Synonyms: Formalin; Formic Aldehyde; Paraform; Formol; Formalin (Methanol-free); Fyde; Formalith; Methanal; Methyl Aldehyde; Methylene Glycol; Methylene Oxide; Tetraoxymethalene; Oxomethane; Oxymethylene

Components and Contaminants

Percent: 37.0 Formaldehyde

Percent: 63.0 Water

(Note.—Inhibited solutions contain methanol.)

Other Contaminants: Formic acid (alcohol free) Exposure Limits:

OSHA TWA-1 ppm

OSHA STEL-2 ppm

Physical Data

Description: Colorless liquid, pungent odor

Boiling point: 214 °F (101 °C)

Specific Gravity: 1.08 (H₂O=1 at 20 °C)

pH: 2.8-4.0

Solubility in Water: Miscible

Solvent Solubility: Soluble in alcohol and acetone

Vapor Density: 1.04 (Air=1 at 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 percent formaldehyde solutions is above normal room temperature, but the explosion range is very wide, from 7 to 73 percent 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 percent
Upper Explosion Limit: 73 percent
Autoignition Temperature: 806 °F (430 °C)
Flammability (OSHA): Category 4 flammable 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-Materials hazardous to health, but areas may be entered with full-faced mask self-contained breathing apparatus which provides eye protection.

Flammability: 2-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: D-Materials which (in themselves) are normally stable even under fire exposure conditions and which are not reactive with water. Normal fire fighting procedures may be used.

Reactivity

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, bis-chloromethyl 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.

Health Hazard Data

Acute Effects of Exposure

Ingestion (Swallowing): Liquids containing 10 to 40 percent 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 percent) 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: LC_{L0}=250 mg/kg

Inhalation, mouse: LC_{L0}=900 mg/kg

Inhalation, rats: LC₅₀=590 mg/kg

Chronic Effects of Exposure

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 airways 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 15 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 you work in an area where a large amount of formaldehyde could be released in an accident or from equipment failure, your employer must develop procedures to be followed in event of an emergency. You should be trained in your specific duties in the event of an emergency, and it is important that you clearly understand these duties. Emergency equipment must be accessible and you should be trained to use any equipment that you might need. Formaldehyde contaminated equipment must be cleaned before reuse.

If a spill of appreciable quantity occurs, leave the area quickly unless you have specific emergency duties. 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. Use water spray to reduce vapors. Do not smoke, and prohibit all flames or flares in the hazard area.

Special Firefighting Procedures: Learn procedures and responsibilities in the event of a fire in your workplace. Become familiar with the appropriate equipment and supplies and their location. In firefighting, withdraw immediately in case of rising sound from venting safety device or any discoloration of storage tank due to fire.

Spill, Leak, and Disposal Procedures

Occupational Spill: For small containers, place the leaking container in a well ventilated area. Take up small spills with absorbent material and place the waste into properly labeled containers for later disposal. For larger spills, dike the spill to minimize contamination and facilitate salvage or disposal. You may be able to neutralize the spill with sodium hydroxide or sodium sulfite. Your employer must comply with EPA rules regarding the clean-up of toxic waste and notify state and local authorities, if required. If the spill is greater than 1,000 lb/day, it is reportable under EPA's Superfund legislation.

Waste Disposal: Your employer must dispose of waste containing formaldehyde in accordance with applicable local, state, and Federal law and in a manner that minimizes exposure of employees at the site and of the clean-up crew.

Monitoring and Measurement Procedures

Monitoring Requirements: If your exposure to formaldehyde exceeds the 0.5 ppm action level or the 2 ppm 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, a sorbent 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: Your employer must inform you of the results of exposure monitoring representative of your job. 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 the employee handles formaldehyde solutions of 1 percent or more. Other employees may also require protective clothing or equipment to prevent dermatitis.]

Respiratory Protection: Use NIOSH-approved full facepiece negative pressure respirators equipped with approved cartridges or canisters within the use limitations of these devices. (Present restrictions on cartridges and canisters do not permit them to be used for a full workshift.) In all other situations, use positive pressure respirators such as the positive-pressure air purifying respirator or the self-contained breathing apparatus (SCBA). If you use a negative pressure respirator, your employer must provide you with fit testing of the respirator at least once a year.

Protective Gloves: Wear protective (impervious) gloves provided by your employer, at no cost, to prevent contact with formalin. Your employer should select these gloves based on the results of permeation testing and in accordance with the ACGIH Guidelines for Selection of Chemical Protective Clothing.

Eye Protection: If you might be splashed in the eyes with formalin, it is essential that you wear goggles or some other type of complete protection for the eye. You may also need a face shield if your face is likely to be splashed with formalin, but you must not substitute face shields for eye protection. (This section pertains to formaldehyde solutions of 1 percent or more.)

Other Protective Equipment: You must wear protective (impervious) clothing and equipment provided by your employer at no cost to prevent repeated or prolonged contact with formaldehyde liquids. If you are required to change into whole-body chemical protective clothing, your employer must provide a change room for your privacy and for storage of your normal clothing.

If you are splashed with formaldehyde, use the emergency showers and eyewash fountains provided by your employer immediately to prevent serious injury. Report the incident to your supervisor and obtain necessary medical support.

Entry Into an IDLH Atmosphere

Enter areas where the formaldehyde concentration might be 100 ppm or more only 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 your life and health under such extreme conditions.

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.

General (Mechanical): 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. Where devices emitting formaldehyde are spread out over a large area, general dilution ventilation may be the only practical method of control.

Work Practices: Work practices and administrative procedures are an important part of a 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.

Medical Surveillance

Medical surveillance helps to protect employees' health. You are encouraged strongly to participate in the medical surveillance program.

Your employer must make a medical surveillance program available at no expense to you and at a reasonable time and place if you are exposed to formaldehyde at concentrations above 0.5 ppm as an 8-hour average or 2 ppm over any 15-minute period. You will be offered medical surveillance at the time of your initial assignment and once a year afterward as long as your exposure is at least 0.5 ppm (TWA) or 2 ppm (STEL). Even if your exposure is below these levels, you should inform your employer if you have signs and symptoms that you suspect, through your training, are related to your formaldehyde exposure because you may need medical surveillance to determine if your health is being impaired by your exposure.

The surveillance plan includes:

- (a) A medical disease questionnaire.
- (b) A physical examination if the physician determines this is necessary.

If you are required to wear a respirator, your employer must offer you a physical examination and a pulmonary function test every year.

The physician must collect all information needed to determine if you are at increased risk from your exposure to formaldehyde. At the physician's discretion, the medical examination may include other tests, such as a chest x-ray, to make this determination.

After a medical examination the physician will provide your employer with a written opinion which includes any special protective measures recommended and any restrictions on your exposure. The physician must inform you of any medical conditions you have which would be aggravated by exposure to formaldehyde.

All records from your medical examinations, including disease surveys, must be retained at your employer's expense.

Emergencies

If you are exposed to formaldehyde in an emergency and develop signs or symptoms associated with acute toxicity from formaldehyde exposure, your employer must provide you 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.

Glossary

Action Level. Concentration of a specific substance, calculated on an eight-hour time-weighted average (TWA), which initiates certain required activities such as exposure monitoring and medical surveillance.

Aqueous Solution. A watery or water-based solution.

Carcinogen. A substance that produces cancer.

Dermatitis. A disorder or irritation of the skin. Signs may include itching, redness, rashes and various skin lesions.

Hazard. The risk presented by a particular exposure to do harm by virtue of its explosiveness, flammability, corrosiveness, toxicity, etc., and the ease with which contact can be established with the substance.

Metabolize. The changes that occur in substances entering the body till they are used or excreted from the body.

PEL. Permissible exposure level. A term used to indicate the permissible amount of exposure to a specific substance, based on an eight-hour time-weighted average (TWA).

Protective Equipment and Clothing. Equipment or clothing provided to the worker to prevent contact with a specific substance. Should be chosen based on the concentration, method of exposure and conditions of use. Can include respirators, gloves, clothing, goggles and face shields.

Respirator. A device worn over the nose and mouth to protect one from inhaling harmful substances. The respirator must be selected to protect against the specific substance and must be approved by the National Institute of Occupational Safety and Health (NIOSH).

SDS. Safety data sheet. Substances that are considered potentially dangerous are required by OSHA to have an SDS. Information required to be on the SDS includes product identifier, ingredients, the manufacturer, possible safety and health hazards, and health precautions to follow.

Solubility. The ability of a substance to be dissolved into solution.

STEL. Short-term exposure limit. A term used to indicate the maximum amount of time (usually minutes) that it is safe for one to be exposed to a substance in high concentrations

Toxic. The ability of a substance to cause harm to the body. Toxicity is influenced by how much and how often one is exposed to a particular substance.

TWA. Time-weighted average. A term used to determine and set exposure limits for a particular substance.

References

- AIHA. June 1987. Occupational Exposure and Work Practices Guidelines for Formaldehyde, Final Draft.
- American Industrial Hygiene Association, Akron, Ohio. Feinman, S. E., ed. 1988. *Formaldehyde Sensitivity and Toxicity*. CRC Press, Inc.
- Gibson, J. E., ed. 1983. *Formaldehyde Toxicity, The Chemical Industry Institute of Toxicology Series*. Hemisphere Publishing Corporation.
- Horvath, E. P., and H. Anderson, et al. February 5, 1988. Effects of Formaldehyde on the Mucous Membranes and Lungs: A Study of an Industrial Population. *Journal of American Medical Association* 259, No. 5:701–707.
- NIOSH. *NIOSH Pocket Guide to Chemical Hazards*. National Institute of Occupational Safety and Health Publication. U.S. Department of Health and Human Services, Washington, D.C.: Government Printing Office. (Can be obtained from NIOSH Web site: <http://www.cdc.gov/niosh/npg/default.html>)
- NRC. 1981. *Formaldehyde and Other Aldehydes*. National Research Council. Committee on Aldehydes, Board of Toxicology and Environmental Health Hazards, National Research Council. National Academy Press.
- OSHA. May 27, 1992. Occupational Exposure to Formaldehyde: Final Rule. Occupational Safety and Health Administration, 29 CFR 1910.1048 Federal Register 57:22290.
- Ottoboni, M.A. 1984. *The Dose Makes the Poison*. Vincente Books.
- International Union, United Automobile, Aerospace and Agricultural Implement Workers of America, UAW, *et al.* v. Pendergrass; Amalgamated Clothing and Textile Workers Union, *et al.* v. Whitfield, Deputy Secretary of Labor; Formaldehyde Institute, Inc., *et al.* v. Whitfield; International Molders and Allied Workers Union, AFL-CIO-CLC, *et al.* v. Dole, U.S. Court of Appeals for the District of Columbia Circuit, Docket Nos. 87-1743, 87-1744, 88-1021, and 88-1063 (June 9, 1989), 1989 OSHD (CCH) ¶28,564.

OSH Publications

We provide a variety of OSH publications. These include general industry and construction regulations, industry guides that cover different OSH topics, quick cards, fact sheets and brochures that cover a wide variety of serious safety and health workplace hazards. Workplace labor law posters are available free of charge. To obtain publications, call toll free at 1-800-NC-LABOR (1-800-625-2267) or direct at 919-807-2875. You may view the list of publications and also download many of them at **www.nclabor.com/pubs.htm**.

Occupational Safety and Health (OSH) Sources of Information

You may call 1-800-NC-LABOR (1-800-625-2267) to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web: <http://www.nclabor.com>.

Occupational Safety and Health Division

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Local Telephone: 919-807-2900 Fax: 919-807-2856

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning education, training, interpretations of occupational safety and health standards, and OSH recognition programs contact:

Education, Training and Technical Assistance Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2875 Fax: 919-807-2876

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 4th Floor)

For information concerning occupational safety and health consultative services contact:

Consultative Services Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2899 Fax: 919-807-2902

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2923 Fax: 919-807-2924

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office (3801 Lake Boone Trail, Suite 300, Raleigh, NC 27607)
Telephone: 919-779-8570 Fax: 919-420-7966

Asheville District Office (204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: 828-299-8232 Fax: 828-299-8266

Charlotte District Office (901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: 704-665-4341 Fax: 704-665-4342

Winston-Salem District Office (4964 University Parkway, Suite 202, Winston-Salem, NC 27106-2800)
Telephone: 336-776-4420 Fax: 336-767-3989

Wilmington District Office (1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: 910-251-2678 Fax: 910-251-2654

To make an OSH Complaint, **OSH Complaint Desk:** 919-807-2796

For statistical information concerning program activities contact:

Planning, Statistics and Information Management Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2950 Fax: 919-807-2951

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2850 Fax: 919-807-2849

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 5th Floor)

N.C. Department of Labor (Other than OSH)

1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-733-7166 Fax: 919-733-6197