

A Guide to Formaldehyde

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Acknowledgments

This guide was prepared for the North Carolina Department of Labor by Health & Hygiene, Inc., 420 Gallimore Dairy Road, Greensboro, North Carolina, a firm that specializes in occupational health. Updated material was provided by North Carolina Department of Labor Health Standards Officer J. Edgar Geddie, Ph.D.

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 should be followed.

To obtain additional copies of this book, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

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

The projected cost of the OSHNC program for federal fiscal year 2002–2003 is \$13,130,589. Federal funding provides approximately 37 percent (\$4,920,000) of this total.



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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 this state, the North Carolina Department of Labor consultants and inspectors administer the federal OSHA laws through a plan approved by the U.S. Department of Labor. All current OSHA standards are enforced. Many educational programs, publications (including this guide), and other services are also offered to help inform people about their rights and responsibilities regarding OSHA.

As you look through this guide, please remember that OSHA's mission is greater than just enforcement. An equally important goal is to help citizens find ways to create safe and healthy workplaces. Reading and using the information in this booklet, like other educational materials produced by the North Carolina Department of Labor, can help.

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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 is a major user of formaldehyde. Over 60 percent of urea-formaldehyde resin is used as a binder in plywood and particleboard. The textile industry, however, is the major source of employee exposure to formaldehyde. While not a major user of formaldehyde on a volume basis, about 60 to 85 percent of all apparel fabric is finished with formaldehyde-containing resins.

Formaldehyde also finds its way into the workplace through 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.

Tobacco smoke contains formaldehyde. The smoker inhales the smoke directly into the lungs. Nonsmokers inhale sidestream smoke from cigarettes consumed by fellow workers.

Thus, 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

Occupational That May Involve Exposure to Formaldehyde

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

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 heal 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 overexposure 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. A concentration of 100 ppm is immediately dangerous to life and health. The response also depends on the length of exposure and individual sensitivity. One can also 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 spasm 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 phenol-formaldehyde 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 and/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. Physicians, nurses, and dentists routinely 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 and students	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	Fumigants, disinfectants
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, pipe fitters	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 persons 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, your employer must have developed an emergency procedure. If you are to play any part in the emergency procedure, you will have received training in your specific duty, including training for any equipment which you are expected to use. If you have not received such training and an emergency spill of formaldehyde occurs: LEAVE THE AREA as quickly as possible. Do not touch any spilled material.

Designated employees should stop the leak and shut off ignition sources. The hazard area should be isolated, and no one should be granted admittance unless they are wearing appropriate protective clothing and respirators.

Smoking and all flame or flares must be prohibited in the hazard area. Explosive concentrations may build up. Water spray may be used to reduce vapors. Fire fighting procedures should be well established and followed.

Small spills may be cleaned up with absorbent material. The waste should be placed in marked containers for later disposal. Large spills should be diked to facilitate salvage or disposal. Sodium hydroxide or sodium sulfate may be used to neutralize the spill.

EPA regulations must be followed for large spills and disposal of waste. If the spill exceeds 1,000 pounds per day, it is recordable under EPA's superfund legislation.

First Aid Treatment for Exposure to Formaldehyde

Treatment should be immediately available to employees exposed to formaldehyde.

If formaldehyde is ingested (swallowed):

- *If the victim is conscious*, administer milk, water, or activated charcoal to dilute, absorb, or inactivate the formaldehyde.
- Keep the exposed person warm and at rest.
- Get medical attention immediately.
- If vomiting occurs, keep the person's head lower than the hips, or turn the victim on his or her side and lower his or her head.

If formaldehyde is inhaled:

- Remove to fresh air immediately.
- **NOTE:** Where concentrations are high, the rescuer must wear a self-contained breathing apparatus.
- Check respiration. If breathing has stopped, initiate rescue breathing, giving two initial breaths followed by one breath every five seconds.
- If qualified, administer oxygen if it is available.
- Monitor vital signs and treat for shock.

- Get medical attention immediately.
- Where exposure results in coughing for more than 10 minutes and irritation of the upper respiratory tract, the individual should be hospitalized.

If formaldehyde contacts the skin:

- Where there is potential for extensive exposure, protective clothing must be worn and emergency showers should be readily available.
- Remove contaminated clothing and shoes immediately.
- Wash affected area with soap and water till no evidence of the chemical remains (15 to 20 minutes).
- If chemical burns are noted, bandage with a dry, sterile dressing.
- If there is evidence of eye or respiratory distress, seek medical attention.

If formaldehyde contacts the eyes:

- Where there is potential for a splash to the eye, goggles or face shields must be used. Emergency eyewash stations should be readily available.
- Immediately wash eyes with copious amounts of water (15 to 20 minutes).
- If there is evidence of a burn or if there is extensive exposure, transport for medical care immediately, continuing irrigation while transporting.

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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 December 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. Since, the 1987 standard has been enforced by federal OSHA and by the Occupational Safety and Health Division of the North Carolina Department of Labor, except for its hazard communication provision. That provision was stayed until it could be clarified. In the interim, employers (including those in wood products industries) were required to comply with the generic hazard communication standard (29 CFR 1910.1200).

On May 27, 1992, federal 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 the stay from the hazard communication provisions, and required annual employee training. Compliance deadlines are included for the amended sections.

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 shall 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 shall 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 there is no formaldehyde hazard in the workplace and if employees have not complained of symptoms associated with formaldehyde exposure, there is no obligation to monitor.

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 or at or above the action level. *The action level is a concentration of 0.5 ppm calculated as an eight-hour TWA concentration.*

In documenting that employees are not exposed at or above the action level or STEL, the employer should consider all relevant information. Relevant information would include insurance company and trade association data, information from suppliers or exposure data collected from similar operations, and previous sampling results.

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

Assuming the employer determines that, for any operation, there is the possibility of employee exposure at or above the action level or the STEL, the employer is obligated to 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.

If there is an indication from materials handling records and material safety data sheets (MSDSs) (see the sample MSDS in the appendix) that formaldehyde is being used in the following types of processes, there may be the potential for formaldehyde exposure:

- ◆ Operations involving grinding, sanding, sawing, cutting, crushing, screening, sieving, and similar processes that may release formaldehyde-bearing dust
- ◆ Processes where employees have complained of symptoms indicative of formaldehyde exposure
- ◆ Any liquid or spray process involving formaldehyde
- ◆ Any process that uses formaldehyde in preserved tissue
- ◆ Any process that involves the heating of formaldehyde-bearing resin

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 shall be repeated every six months. If monitoring shows employee exposure at or

above the STEL, monitoring shall 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 be allowed to observe the monitoring process. 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:

<p style="text-align: center;">DANGER FORMALDEHYDE IRRITANT AND POTENTIAL CANCER HAZARD AUTHORIZED PERSONNEL ONLY</p>

Employees must be informed of these areas, and access must be limited to persons who have been trained to recognize the dangers of formaldehyde.

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.

Respirator Protection

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. With regard to respirators, the standard:

- ◆ Specifies circumstances in which respirators must be used
- ◆ Provides a table for guidance in the selection of respirators, depending upon the condition of use and concentration of formaldehyde

Appendix E *of the standard* outlines procedures for quantitative or qualitative face fit tests which the employer must perform initially and annually for employees required to wear negative pressure respirators. 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 negative pressure respirator is used, the test must not be conducted if there is any hair growth between the skin and the facepiece.

- ◆ 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.

The employer must institute a respiratory protection program that includes, among other things, the cleaning, storage, and location of respirators, in accordance with 29 CFR 1910.134.

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. 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 new MRP 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 the employee can or cannot return to work where there is exposure or for six months (whichever comes first). The employee must have the right to seek a second medical opinion and resolution of any disagreement through a review by a third physician. While removed, the employee's seniority, benefits, and earnings may not be reduced unless offset by other employment or public or employer-funded 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, material 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 MSDSs.

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. The standard specifies the content of the records and how long the records must be maintained. 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. The standard explains any conditions which the employer may require to be met prior to releasing the records.

Appendix

Material Safety Data Sheet

Identification

NAME

Formaldehyde Solutions

CHEMICAL FAMILY

Aldehyde

SYNONYMS

Formalin; Methanal

FORMULA

CH₂O

CAS NAME

Formaldehyde Solutions

Physical Data

BOILING POINT

760 mmHg 94.3°–100°C (201°–212°F)

MELTING POINT

Polymerizes and separates below 0°–67°C (32°–153°F)

SPECIFIC GRAVITY

1.08–1.13

VAPOR PRESSURE

23–26 mmHg at 25°C (77°F); 39 mmHg at 37.8°C (100°F)

VAPOR DENSITY (Air = 1)

-1

SOLUBILITY IN WATER

100%

pH INFORMATION

2.8–4.0

EVAPORATION RATE (Butyl Acetate = 1)

Similar to water: >1

FORM

Liquid

APPEARANCE

Clear (turns milky on cooling)

COLOR

Colorless

ODOR

Pungent

Hazardous Components

<i>MATERIAL(S)</i>	<i>CAS NO.</i>	<i>APPROXIMATE PERCENT</i>
Formaldehyde	50-00-0	22-56
Methanol	67-56-1	1-15

Hazardous Reactivity

INSTABILITY

No known hazardous instability

INCOMPATIBILITY

Reacts with many compounds. Reaction with phenol, strong acids, or alkalis may be violent. Reaction with hydrochloric acid may form bis-chloromethyl ether, an OSHA-regulated carcinogen.

DECOMPOSITION

Occurs slowly at elevated temperatures, releasing formaldehyde gas.

POLYMERIZATION

Nonhazardous polymerization may occur at low temperatures, forming paraformaldehyde, a white solid.

Fire and Explosion Data

FLASH POINT

54°–88°C (129°–192°F) METHOD TCC

FLAMMABLE LIMITS IN AIR, PERCENT BY VOLUME

Lower 7

Upper 73

AUTOIGNITION TEMPERATURE

424°C (795°F)

FIRE AND EXPLOSION HAZARDS

OSHA Class II or IIIA Combustible Liquid. Follow appropriate National Fire Protection Association (NFPA) codes.

EXTINGUISHING MEDIA

Alcohol foam, dry chemical, carbon dioxide (CO₂), water spray.

SPECIAL FIREFIGHTING INSTRUCTIONS

Cool container with water spray or fog to help absorb escaping fumes. Evacuate affected area. Stay upwind and avoid contact with smoke and fumes. If contact cannot be avoided, wear personal protective equipment including chemical splash goggles and air mask with breathing air supply. Runoff from fire control may cause pollution.

Health Hazard Information

PRINCIPAL HEALTH HAZARDS

Causes eye burns. Harmful if inhaled or absorbed through the skin; causes general tissue damage. Causes skin, nose, throat, and lung irritation. May cause allergic skin reaction. May be fatal or cause blindness if swallowed. Cannot be made non-poisonous.

Formaldehyde:

Inhalation 4-hour LC₅₀: 250 ppm in rats

Skin absorption LD₅₀: 270 mg/kg in rabbits

Oral LD₅₀: 500 mg/kg in rats

Formaldehyde is a mild to moderate skin irritant, is an eye irritant, and can produce permanent eye damage and skin sensitization in animals. Toxic effects described in animals from exposure by inhalation to the vapor or mist include severe irritation to the upper respiratory tract and mucosal surfaces, eye irritation, and nonspecific effects such as weight loss and irritation. Toxic effects observed in animals from exposure by ingestion include severe irritation to mucosal surfaces and decreased body weight. Tests in some animals demonstrate carcinogenic activity. Formaldehyde shows mutagenic activity in bacterial and mammalian cell culture test systems but is generally negative in whole animal systems. Tests for teratogenic activity by several routes have been negative; however, one study indicated slightly decreased fetal weights, but only at high dose levels expected to also cause maternal toxicity. No malformations were observed. The available data are inadequate to assess reproductive effects, although limited studies do not suggest such effects.

Human health effects of overexposure by skin contact with formaldehyde solutions include irritation with discomfort or rash, or allergic skin rash. Eye contact with formaldehyde solutions may cause eye irritation with discomfort, tearing, and blurring of vision; or eye corrosion with corneal or conjunctival ulceration. Effects of overexposure to formaldehyde vapors may include discomfort, such as nausea, headache, or weakness; irritation of the upper respiratory passages; temporary lung irritation effects with cough, discomfort, difficulty breathing, or shortness of breath. On rare occasions, respiratory sensitization (asthma) has been reported in individuals. Gross overexposure by ingestion and, rarely, inhalation has been fatal. A Soviet study of questionable merit on women exposed to urea formaldehyde resin in textile processing noted effects on pregnant workers and

their offspring. However, these effects could be explained by other factors and have not been substantiated by other studies. Individuals with preexisting diseases of the lungs, eyes, or skin may have increased susceptibility to the toxicity of excessive exposures.

CARCINOGENICITY

Formaldehyde is listed by the International Agency for Research on Cancer as probably carcinogenic to humans, on the basis of animal evidence and at least limited human data (IARC group 2A); listed by the National Toxicology Program as reasonably anticipated to be carcinogenic; listed by ACGIH as an A2 Industrial Substance Suspect of Carcinogenic Potential for Man; and OSHA, in its formaldehyde standard (29 CFR 1910.1048), considers formaldehyde a potential carcinogen. Formaldehyde (gas) is a chemical known to the state of California to cause cancer.

EXPOSURE LIMITS [PEL (OSHA), TLV (ACGIH)]

Formaldehyde: OSHA 8-hour time-weighted average (TWA) = 0.75 ppm; the OSHA short-term exposure limit (STEL) = 2 ppm, 3 mg/m³ (15-minute TWA, see 29 CFR 1910.1048). The ACGIH TLV-TWA = 1 ppm, 1.2 mg/m³; the ACGIH STEL = 2 ppm, 2.5 mg/m³; (in its 1989–1990 “Notice of Intended Changes,” ACGIH lists the TLV as 0.3 ppm, 0.45 mg/m³, ceiling, with the STEL deleted.

SAFETY PRECAUTIONS

Do not get in eyes.
Avoid contact with skin and clothing.
Avoid breathing mist or vapor.
Wash thoroughly after handling.

FIRST AID

In case of eye contact: immediately flush eyes with plenty of water for at least 15 minutes. Call a physician. In case of skin contact: immediately flush skin

with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse.

If inhaled: remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

If swallowed: induce vomiting immediately as directed by medical personnel. Following this, give activated charcoal slurry. Call a physician.

NOTE TO PHYSICIANS

To prepare activated charcoal slurry, suspend 50 gm of activated charcoal in 400 ml of water in a bottle and shake well. Give 5ml/kg of body weight, or 350 ml for an average adult.

Protection Information

GENERALLY APPLICABLE CONTROL MEASURES

Provide ventilation adequate to keep formaldehyde concentrations below indicated exposure limits.

PERSONAL PROTECTIVE EQUIPMENT

Have available and wear as appropriate: chemical splash goggles; full-length face shield/splash goggle combination; neoprene, nitrile, butyl, or polyvinyl gloves; coveralls with long sleeves. Selection and maintenance of personal protective equipment shall be in accordance with 29 CFR 1910.1048(h). If exposure limits may be exceeded, the appropriate respirator as specified in table 1, 29 CFR 1910.1048(g), should be used.

Wear self-contained breathing apparatus and full body protection for entry into areas where concentrations exceed 100 ppm and for emergency reentry into areas of unknown concentrations.

Disposal Information

AQUATIC TOXICITY

Formaldehyde: The 96-hour LC₅₀ in fathead minnows is 38–48 mg/l.

SPILL, LEAK, OR RELEASE

Wear self-contained breathing apparatus and full body protection. Soak up small spills with earth, sand, or other noncombustible absorbent material and remove in covered metal containers. Dike large spills and neutralize with diluted (5 percent) solutions of ammonia, sodium sulfite, or sodium bisulfite and remove. Flush area with plenty of water. Comply with federal, state, and local regulations on reporting releases.

WASTE DISPOSAL

Cleanup material is a RCRA hazardous waste. Comply with federal, state, and local regulations.

Additional Information

STORAGE CONDITIONS

Keep container closed. Keep away from heat and flame. Store in heated tank or warm room, above minimum storage temperature for grade handled.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

Product Hazard Categories:

Chronic Health:	Yes
Acute Health:	Yes
Fire Hazard:	Yes
Pressure Hazard:	No
Reactivity Hazard:	No

Lists:

Extremely Hazardous Substance:	Yes
CERCLA Hazardous Substance:	Yes
Toxic Chemical:	Yes

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.

FEF. Forced expiratory flow. The flow of air midpoint in a forced expiratory maneuver.

FEV₁. Forced expiratory volume in one second. The amount of air one can forcefully exhale in the first second of a forced expiration.

FVC. Forced vital capacity. The maximum amount of air one can forcefully exhale after maximum inspiration.

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 and/or excreted from the body.

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

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 and/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 Mine Safety and Health Administration (MSHA) and by the National Institute of Occupational Safety and Health (NIOSH).

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 15 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.

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- 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, United States 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.

The following industry guides are available from the N.C. Department of Labor's Division of Occupational Safety and Health:

- #1. A Guide to Safety in Confined Spaces*
- #2. A Guide to Procedures of the Safety and Health Review Board of North Carolina*
- #3. A Guide to Machine Safeguarding*
- #4. A Guide to OSHA in North Carolina*
- #5. A Guide for Persons Employed in Cotton Dust Environments*
- #6. A Guide to Lead Exposure in the Construction Industry*
- #7. A Guide to Bloodborne Pathogens in the Workplace*
- #8. A Guide to Voluntary Training and Training Requirements in OSHA Standards*
- #9. A Guide to Ergonomics*
- #10. A Guide to Farm Safety and Health*
- #11. A Guide to Radio Frequency Hazards With Electric Detonators*
- #12. A Guide to Forklift Operator Training*
- #13. A Guide to the Safe Storage of Explosive Materials*
- #14. A Guide to the OSHA Excavations Standard*
- #15. A Guide to Developing and Maintaining an Effective Hearing Conservation Program*
- #17. A Guide to Asbestos for Industry*
- #18. A Guide to Electrical Safety*
- #19. A Guide to Occupational Exposure to Wood, Wood Dust and Combustible Dust Hazards*
- #20. A Guide to Crane Safety*
- #21. A Guide to School Safety and Health*
- #23. A Guide to Working With Electricity*
- #25. A Guide to Personal Protective Equipment*
- #26. A Guide to Manual Materials Handling and Back Safety*
- #27. A Guide to the Control of Hazardous Energy (Lockout/Tagout)*
- #28. A Guide to Eye Wash and Safety Shower Facilities*
- #29. A Guide to Safety and Health in Feed and Grain Mills*
- #30. A Guide to Working With Corrosive Substances*
- #31. A Guide to Formaldehyde*
- #32. A Guide to Fall Prevention in Industry*
- #33. A Guide to Office Safety and Health*
- #34. A Guide to Safety and Health in the Poultry Industry*
- #35. A Guide to Preventing Heat Stress*
- #36. A Guide to the Safe Use of Escalators and Elevators*
- #37. A Guide to Boilers and Pressure Vessels*
- #38. A Guide to Safe Scaffolding*
- #39. A Guide to Safety in the Textile Industry*
- #40. A Guide to Emergency Action Planning*
- #41. A Guide to OSHA for Small Businesses in North Carolina*

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, Internet Web site address: <http://www.nclabor.com>.

N.C. Division of Occupational Safety and Health

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 3rd Floor)
Local Telephone: (919) 807-2900	Fax: (919) 807-2856

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

Bureau of Education, Training and Technical Assistance

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 4th Floor)
Telephone: (919) 807-2875	Fax: (919) 807-2876

For information concerning occupational safety and health consultative services and safety awards programs contact:

Bureau of Consultative Services

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 3rd Floor)
Telephone: (919) 807-2899	Fax: (919) 807-2902

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

Agricultural Safety and Health Bureau

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2923	Fax: (919) 807-2924

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office (313 Chapanoke Road, Raleigh, NC 27603)
Telephone: (919) 779-8570 Fax: (919) 662-4709

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) 776-4422

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

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

For statistical information concerning program activities contact:

Planning, Statistics and Information Management

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2950	Fax: (919) 807-2951

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

N.C. Department of Labor Library

Mailing Address:	Physical Location:
1101 Mail Service Center	111 Hillsborough St.
Raleigh, NC 27699-1101	(Old Revenue Building, 5th Floor)
Telephone: (919) 807-2848	Fax: (919) 807-2849

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

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