

I. RECOMMENDATIONS FOR A FORMALDEHYDE STANDARD

The National Institute for Occupational Safety and Health recommends that employee exposure to formaldehyde in the occupational environment be controlled by compliance with the following sections. The standard is designed to protect the health and to provide for the safety of employees for up to a 10-hour workday for a 40-hour week over a working lifetime. Compliance with the standard should prevent adverse effects of exposure to formaldehyde. This recommended standard is not designed to protect an individual already sensitized to formaldehyde. Such individuals should not be exposed to formaldehyde. The standard is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The standard will be subject to review and revision as necessary.

Occupational exposure to formaldehyde is defined as exposure to formaldehyde in air at a concentration in excess of 0.6 mg/cu m (0.5 ppm), based on a 30-minute sampling period, or by contact with formaldehyde in liquid or solid form. Adherence to all provisions of Sections 3-6 is required in occupational environments where formaldehyde is used regardless of the concentration of airborne formaldehyde. Medical surveillance and environmental monitoring are required as specified in Sections 2 and 8, respectively.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Exposure to formaldehyde shall be controlled so that no employee is exposed to formaldehyde at a concentration greater than 1.2 milligrams per cubic meter of air (1 ppm) for any 30-minute sampling period.

(b) Sampling and Analysis

Methods for calibration of equipment, air sampling, and analysis for formaldehyde shall be as provided in Appendices I and II, or by any procedure shown to be equivalent in precision, accuracy, and sensitivity to the procedures specified.

Section 2 - Medical

Medical surveillance shall be made available as outlined below to all workers subject to occupational exposure to formaldehyde.

(a) Preplacement examinations shall include at least:

(1) Comprehensive medical and work histories with special emphasis on any evidence of chronic inflammatory reaction of the respiratory tract, of skin reaction or hypersensitivity, or of such other allergic conditions as asthma, hayfever, and rose fever.

(b) An evaluation of the employee's ability to use positive and negative pressure respirators.

(2) During examinations, applicants or employees having medical conditions which would be directly or indirectly aggravated by exposure to formaldehyde shall be counseled on the increased risk of impairment of their health from working with this substance.

(3) Initial medical examinations shall be made available to all workers within 6 months after the promulgation of a standard based on these

recommendations.

(4) In the event of an overexposure to formaldehyde, a physical examination as described in (1)(b) above shall be made available within a reasonable period of time.

(5) Pertinent medical records shall be maintained for all employees exposed to formaldehyde in the workplace. Such records shall be kept for at least 5 years after termination of employment. These records shall be made available to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

(a) All containers of formaldehyde solutions shall bear the following information in addition to, or in combination with, label information required by other statutes, regulations, and ordinances:

FORMALDEHYDE SOLUTION (Percent formaldehyde by weight)
(MAY CONTAIN METHANOL)

WARNING: HARMFUL IF INHALED OR SWALLOWED. CAUSES IRRITATION OF SKIN, EYES, NOSE, AND THROAT.

Avoid prolonged or repeated breathing of gas or mist. Avoid prolonged or repeated contact with skin. Keep container closed. Use with adequate ventilation. Do not get in eyes, on skin, on clothing. Wash thoroughly after handling. Wash contaminated clothing before reuse. Destroy and discard contaminated shoes.

FIRST AID: CALL A PHYSICIAN

On contact, immediately flush skin or eyes with large amounts

of water for at least 15 minutes; get medical attention. If inhaled, remove to fresh air, give artificial respiration if breathing has stopped.

IF SWALLOWED: Induce vomiting. If victim is unconscious, do not attempt to induce vomiting.

SPECIAL CONTAINER HANDLING AND STORAGE: Before moving a container, be sure closure is securely fastened. Loosen closure carefully. In case of spillage, flush with plenty of water.

(b) When environmental monitoring indicates that there is occupational exposure to formaldehyde, the following sign shall be posted in readily visible locations at or near entrances to the area and on or near process, storage, and other equipment utilizing or containing formaldehyde.

FORMALDEHYDE

WARNING: IRRITANT TO SKIN, EYES, NOSE, AND THROAT

Avoid prolonged breathing of formaldehyde.

Avoid prolonged or repeated contact.

(c) If formaldehyde concentrations in the air of a workroom or area exceed the recommended limit, the following statement shall be added in large letters to the signs as required in Section (b):

RESPIRATORY PROTECTION REQUIRED IN THIS AREA

(d) In any occupational environment or area where accidental or other release of formaldehyde vapor may cause an emergency requiring the use of respiratory protection, the signs required by Section (b) shall be supplemented by an additional sign giving: (1) the location of emergency

respiratory protective equipment, and (2) instructions for evacuation from the area and emergency procedures.

(e) Signs shall be printed in English and in the predominant language of non-English-reading employees, if any, unless employers use equally effective means to ensure that non-English-reading employees know the hazards associated with formaldehyde and with areas where formaldehyde is used, handled, or stored.

Section 4 - Personal Protective Equipment and Protective Clothing

Engineering controls shall be used to maintain the concentration of airborne formaldehyde at or below the ceiling concentration of 1.2 mg/cu m. In some situations, the added protection of personal protective equipment and clothing shall be provided to prevent excessive contact with solutions and solids containing formaldehyde or inhalation of formaldehyde gas. Such protective equipment and clothing shall be furnished to employees or shall be readily available at convenient and appropriate locations. Emergency equipment shall be located at well-marked and identified stations and shall be adequate to the needs of all employees, either to escape from the area or to safely cope with the emergency. Safe work practices including use of protective equipment and clothing, shall also be used to control exposure.

(a) Protective Clothing

(1) Employees shall wear gloves made of rubber or of other impervious material when working with formaldehyde and when contact with the hands is likely.

(2) Employees shall wear protective sleeves, aprons, jackets, trousers, and caps as needed to protect them from skin contact

with formaldehyde. Protective garments shall be made of a material impervious to formaldehyde. In emergencies or other circumstances involving exposure to formaldehyde at high concentrations of vapor, mists, or dusts in the air, full body protection shall be worn. Emergency garments shall be of an impervious material, and shall fit snugly about the wrists, neck, waist, and ankles.

(3) Employees handling drums, cans, or other containers of formaldehyde shall wear leather or rubber safety shoes. Rubbers may be worn over leather safety shoes as protection from splashes or spills of formaldehyde.

(4) Protective garments shall be cleaned inside and out and well ventilated after each use, and particularly after contamination has occurred.

(b) Eye and Face Protection

(1) Cup-type or rubber-framed chemical safety goggles shall be worn by employees when there is any possibility of eye or facial contact with formaldehyde solutions. Goggles also protect eyes from contact with gas. In cases of excessive vapor concentrations, a full face mask respiratory protective device shall be required; this device may be substituted for cup-type or rubber-framed chemical safety goggles.

(2) Full-length, plastic face shields shall be required in addition to safety goggles for face protection when the work process involves risks of exposure to splashes of formaldehyde. Chemical safety goggles are required in addition to the face shield when there is danger of formaldehyde entering underneath or around the sides of the shield.

(3) The safety goggles, full-face masks, and shields shall

be thoroughly decontaminated after each use.

(4) Eye-protective measures and equipment shall conform with the provisions under 29 CFR 1910.133.

(c) Respiratory Protection

Respirators may be used for nonroutine operations, evacuation, or emergencies which may involve occasional brief exposures to formaldehyde at concentrations in excess of 1.2 mg/cu m. Such exposures may occur during the period necessary to install or test required engineering controls, or to take protective actions.

Appropriate respirators as described in Table I-1 may only be used pursuant to the following requirements:

(1) For the purpose of determining the type of respirator to be used, the employer shall measure the airborne formaldehyde concentration in the workplace initially, and thereafter whenever process, operations, worksite, climate, control, or other changes may occur which are likely to increase the airborne concentration of formaldehyde. This requirement does not apply when only positive pressure supplied-air respirators are used.

(2) The respirator and cartridge or canister used shall be of the appropriate class, as determined on the basis of the airborne concentration of formaldehyde. The employer shall ensure that no employee is exposed to formaldehyde in excess of 1.2 mg/cu m for any 30-minute period because of improper respirator selection, fit, use, or maintenance.

(3) A respiratory protective program meeting the requirements of 29 CFR 1910.134 shall be established and enforced by the employer.

(4) The employer shall provide respirators in accordance

with Table I-1 and shall ensure that the employee uses the respirator properly.

(5) Respiratory protective devices described in Table I-1 shall be those approved under provisions of 30 CFR 11

(6) Respirators specified for use at greater airborne concentrations of formaldehyde may be used in lesser airborne concentrations of formaldehyde.

(7) Use of chemical cartridges and canisters more than once or for a period greater than that indicated in Table I-1 shall be prohibited.

(8) The employer shall ensure that respirators are adequately cleaned, maintained, and stored when not in use, and that employees are instructed on the use of respirators assigned to them and on how to test for leakage.

TABLE I-1

REQUIREMENTS FOR RESPIRATOR USAGE WHEN THE CEILING CONCENTRATION IS EXCEEDED

Formaldehyde Concentration	Respirator Type
Less than or equal to 2.4 mg/cu m	(1) Chemical cartridge respirator and organic vapor cartridge and full-face mask. Maximum service life of 3 hours (2) Type C supplied-air respirator, demand type (negative pressure), and full-face mask
Greater than 2.4 mg/cu m, up to 12 mg/cu m	(1) Chemical cartridge respirator and organic vapor cartridge and full facepiece. Maximum service life of 3 hours (2) Full-face mask, chin type, with organic vapor canister. Maximum life of 4 hours
Greater than 12 mg/cu m, up to 120 mg/cu m	(1) Full-face mask, chest- or back-mounted type, with industrial size organic vapor canister. Maximum service life of 2 hours (2) Type C supplied air-respirator, continuous-flow or pressure-demand type (positive pressure), with full facepiece, hood, or helmet
Greater than 120 mg/cu m	(1) Self-contained breathing apparatus with positive pressure in full facepiece. (2) Combination supplied-air respirator pressure-demand type with auxiliary self-contained air supply
Emergency or firefighting (no concentration limit)	(1) Self-contained breathing apparatus with positive pressure in facepiece (2) Combination supplied-air respirator, pressure-demand type, with auxiliary self-contained air supply
Evacuation or escape (no concentration limit)	(1) Self-contained breathing apparatus in demand or pressure-demand mode (negative or positive pressure) (2) Full-face mask, front- or back-mounted type with industrial size organic vapor canister.

Section 5 - Informing Employees of Hazards from Formaldehyde

(a) At the beginning of employment or assignment in areas that may involve exposure to formaldehyde and annually thereafter, each employee shall be informed of the hazards of his occupation and of possible injuries. He shall be instructed in the proper procedures for the safe handling and use of this compound, in the operation and use of protective systems and devices, and in appropriate emergency procedures.

(b) Instruction shall include the pertinent information in the Material Safety Data Sheet (Appendix III). In addition, employees shall be informed that repeated or prolonged contact with formaldehyde may result in sensitization and that excessive exposure may cause irritation of the skin, eyes, and respiratory tract. This information shall be posted in the work area and kept on file, readily accessible to employees at all worksites where exposure may occur. Employees shall be apprised of the location and availability of this information.

(c) A continuing education program, conducted by a person or persons qualified by experience or special training, shall be instituted to ensure that all employees have current knowledge of job hazards, proper maintenance procedures and cleanup methods, and that they know how to use respirators correctly. The instructional program shall include a description of the general nature of the medical surveillance procedures and why it is advantageous to employees to undergo these examinations.

(d) Information shall be recorded on a "Material Safety Data Sheet" described in Appendix III or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices and Engineering Controls

(a) Appropriate protective clothing and equipment (goggles, face shields, gloves, etc), as described in Section 4, shall be worn by each employee engaged in the transfer of formaldehyde solution or in any other task in which splashes, spills, or other circumstances likely to involve contact with the solution may occur. When working with formaldehyde-generating solids, protective garments shall be worn to prevent contact of the solids or dust with the eyes or skin.

(b) Appropriate respiratory protective devices, as described in Section 4, shall be worn by all exposed employees in any operation or area for which the airborne concentrations of formaldehyde vapor or formaldehyde-generating substances are determined to be likely to cause exposure in excess of the recommended limit. Suitable respiratory protection shall be worn by all employees in emergency exposure situations.

(c) Systems or processes using or handling formaldehyde shall be enclosed to the extent that is feasible for the necessary operations.

(1) Total enclosure is most desirable, with provision for venting of excess gas without allowing it to enter the air of the workplace.

(2) When total enclosure is not possible, processes shall be designed and operated to limit occupational exposure of employees by contact with, or inhalation of, any gas, liquid, splash, or mist. Such installations shall be adequately ventilated to ensure that formaldehyde concentrations in the workroom air will not exceed the recommended limit.

(3) Enclosed process equipment which must be opened periodically to charge or discharge materials shall be provided with a

system of venting or ventilation such that employees are protected from exposures to formaldehyde concentrations in excess of the recommended limit.

(d) Formaldehyde solutions and formaldehyde-generating substances shall be stored in securely closed containers in a storage area which is adequately ventilated to ensure that airborne concentrations of formaldehyde will not exceed the limit specified in Section 1(a).

(1) Bulk storage tanks for formaldehyde solution:

(A) Shall have vents of such size and design as to permit the safe venting of tanks for the purpose of pressure and vacuum relief. The vents must be easily cleared and shall be regularly inspected and cleaned. Formaldehyde gas shall be vented in such a manner that excessive exposure of employees or other individuals cannot occur.

(B) Each storage tank shall have one or more manholes to allow for inspection and cleaning of the tank.

(C) Each tank shall be equipped with positive sealing connections for filling and draining the tank.

(D) All such tanks shall be adequately grounded to discharge static electricity.

(2) Drums and barrels of formaldehyde solution shall be stored with the bungs up and tightly placed.

(3) When drums, barrels, carboys, or other such containers of formaldehyde solutions are placed in a storage room, trapped floor drains shall be provided, and the floor shall be pitched toward the drains.

(e) When handling containers of formaldehyde solutions (carboys, drums, barrels, etc), suitable methods and procedures shall be used to prevent contact with formaldehyde or inhalation of formaldehyde at airborne

concentrations in excess of the recommended limit.

(1) Carboys shall be handled with special care to prevent breakage.

(2) All such containers shall be securely closed or sealed when being moved or handled, except for the transfer of the solution.

(3) When transferring solution from such containers, pumps should be used when practical. If the solution is removed by tilting, a supporting device (inclinator) shall be used for all containers of more than 2-gallon capacity. Transfer operations shall be accomplished in a manner and by methods which will not result in contact or inhalation exposures in excess of the recommended limit. Transfer shall be made only with adequate ventilation for control of the gas concentrations.

(4) Carboys, drums, and barrels shall be completely drained before being returned for reuse. These containers may not be used for any other material until cleaned.

(f) When solutions of formaldehyde or formaldehyde-yielding substances are used in open or unsealed containers, the containers shall be kept covered as much as possible and provided with general or local exhaust ventilation adequate to control emission of gas or dust.

(g) The transfer of formaldehyde solution to or from tank trucks or tank cars may be done only in areas and at facilities designed and specified for these operations. The area should be level and the wheels of the vehicle shall be blocked. Connections must be compatible and specifically identified. Only trained persons may carry out the procedures.

(1) No such transfers may be made unless authorized by the

responsible supervisor.

(2) The area shall be posted and unauthorized persons shall be excluded from the area during such transfers.

(h) Cleaning, maintenance, and repair of tanks and process equipment or lines may be done only by properly instructed and trained personnel under responsible supervision. When possible, such work shall be accomplished from the outside. Entry into confined spaces such as tanks, pits, tank cars, barges, process vessels, and tunnels shall be controlled by a permit system. Permits shall be signed by an authorized representative of the employer certifying that preparation of the confined space, precautionary measures, and personal protective equipment are adequate, and that precautions have been taken to ensure that prescribed procedures will be followed.

(1) Tanks, equipment, lines, pumps, and valves shall be drained, then thoroughly flushed with water and drained again before any work is done on them. All spillage shall be flushed to the drain with large amounts of water. Contact with drainage liquid shall be avoided.

(2) Prior to entry, the atmosphere in any tank or equipment to be entered for such work shall be tested and found to have adequate oxygen and to be free of excessive formaldehyde concentrations for work contemplated and equipment worn.

(3) No employee shall enter any tank or equipment which does not have a manhole or entry large enough to admit an employee equipped with safety harness, lifeline, and emergency respiratory equipment. The employee shall be able to leave the tank or vessel by the same opening.

(4) A person shall be stationed at the entry to keep employees under constant observation and one or more other persons shall be

readily available in case of an emergency requiring rescue of the employee(s). A supplied-air or self-contained breathing apparatus with safety harness and lifeline shall be located outside the tank or vessel for emergency use.

(5) Prior to entry, provision shall be made for adequate ventilation of the tank or vessel to provide sufficient oxygen for the employees inside and to remove or flush any airborne formaldehyde in excess of the recommended limit.

(6) Before work in or on any tank, line, or equipment is started, provision shall be made to prevent inadvertent entry of formaldehyde solution or vapor into the work area.

(7) Exterior work involving cutting, chipping, riveting, and welding on a tank, vent, or equipment may not be started until the item has been cleaned and purged of formaldehyde gas, solutions, or formaldehyde-yielding solids, and until a test has been made to ensure that formaldehyde concentrations are below the lower flammable limit.

(j) Employers shall ensure that waste of formaldehyde solutions or formaldehyde-yielding substances is disposed of by methods and procedures which will prevent exposure of employees and other persons.

(k) Eye-flushing stations and showers shall be provided in any area where contact of the eyes or the skin with formaldehyde or formaldehyde-yielding substances is likely to occur.

(l) All leaks and spills of formaldehyde solution and/or formaldehyde-generating substances shall be cleaned up immediately. When the quantities involved are likely to produce exposures exceeding the recommended limit, the employees at such cleanup operations shall wear

suitable respiratory protection and protective clothing.

(m) Plans and procedures to meet emergency situations shall be formulated and all personnel shall be trained in their effective use.

(1) All employees shall be thoroughly instructed in emergency procedures and in the proper use of emergency equipment.

(2) Appropriate emergency equipment including protective clothing, emergency and rescue breathing apparatus, and first-aid supplies shall be located in each area where an emergency could occur. Locations of such emergency stations shall be prominently and clearly posted in the work areas.

(3) During emergency situations, all personnel shall be evacuated from the area except the trained and equipped emergency teams.

(n) Protective clothing, respirators, goggles, and other personal protective gear which have been contaminated by contact with formaldehyde or formaldehyde-yielding substances shall be thoroughly washed or cleaned before reuse by the employee.

Section 7 - Sanitation

(a) Eating and food preparation or dispensing (including vending machines) shall be prohibited in formaldehyde work areas.

(b) Smoking shall not be permitted in areas where formaldehyde is used, transferred, stored, or manufactured.

(c) Employees who handle formaldehyde or equipment contaminated with formaldehyde shall be instructed to wash their hands thoroughly with soap or mild detergent and water before eating, smoking, and using toilet facilities.

(d) Waste material contaminated with formaldehyde shall be disposed of in a manner not hazardous to employees and in compliance with local regulations.

Section 8 - Monitoring and Recordkeeping Requirements

(a) Workroom areas shall not be considered to have formaldehyde exposure if airborne concentrations of formaldehyde, as determined on the basis of annual industrial hygiene surveys, do not exceed a ceiling concentration of 1.2 mg/cu m (1 ppm) and if there is no occupational exposure to formaldehyde solutions. Records of these surveys, including the basis for concluding that the airborne concentration of formaldehyde does not exceed either half of the ceiling concentration limit, or the ceiling concentration limit, shall be maintained.

(b) Employers shall maintain records of exposures to airborne formaldehyde based upon the following sampling and recording schedules:

(1) The first workplace environmental survey shall be completed within 6 months of the promulgation of a standard incorporating these recommendations.

(2) Workplace environmental surveys shall be conducted within 30 days after installation of a new process or any process changes.

(c) Should environmental sampling indicate airborne formaldehyde concentrations between half of the ceiling concentration limit and the ceiling concentration limit, the following requirements shall apply: Samples shall be collected at least semiannually in accordance with Section 1(b) for the evaluation of the workplace environment with respect to the recommended standard. Each employee or employee location shall be

evaluated at least once every year. Samples shall be collected in accordance with Appendix I and analyzed in accordance with Section 1(b) for the determination of the airborne 30-minute ceiling concentrations of formaldehyde.

(d) When employee exposure exceeds the 30-minute ceiling limit, environmental controls shall be applied. Monitoring and recordkeeping shall be repeated on a weekly basis until two consecutive sampling periods have demonstrated that corrective measures have decreased airborne formaldehyde concentrations at or below the limit.

(e) Records of all sampling and analysis of airborne concentrations of formaldehyde shall be retained for at least 5 years. Records shall indicate the type of personal protective devices, if any, in use at the time of sampling. Records shall be maintained and classified so that an employee shall be able to obtain information about his or her own present and past workplace exposures to formaldehyde.

(f) Access to records

(1) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and to the Director of the National Institute for Occupational Safety and Health.

(2) Employee exposure determination and exposure measurement records required to be maintained by this section shall be made available to employees and their designated representatives.

(3) Without interfering with the measurement, observers shall be entitled to receive an explanation of the measurement procedure, visually observe all steps related to the measurements that are being performed at the place of exposure, and record the results obtained.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational diseases and injuries arising from exposure to formaldehyde. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health and provide for the safety of employees by limiting their exposure to hazardous chemical and physical agents. Criteria for a standard should enable management and labor to develop better engineering or administrative controls, resulting in more healthful work practices and mere compliance with the recommended standard should not be regarded as a final goal.

The criteria and recommended standard for formaldehyde are a part of a continuing series of documents published by NIOSH. The proposed standard applies only to the processing, manufacture, and use of formaldehyde as applicable under the Occupational Safety and Health Act of 1970.

The standard was not designed for the population-at-large, and any

extrapolation beyond the occupational environment is not warranted. It is intended to (1) protect against injury from formaldehyde, (2) allow measurement by valid, reproducible procedures available to industry and official agencies, and (3) be attainable by using existing technology.

For the purpose of this standard, formaldehyde is defined as monomeric formaldehyde, HCHO. Sources of formaldehyde include aqueous solutions, such as formalin (37 to 42% formaldehyde), and formaldehyde-yielding substances, such as trioxane, paraformaldehyde, polyoxymethylene, and hexamethylenetetramine.

There is a need to obtain more information on possible chronic effects produced by prolonged exposures to formaldehyde at low concentrations. Information on the solution chemistry of formaldehyde and its reactive derivatives would be useful in developing sampling and analytical procedures. The formation of bis-chloromethyl ether, a potent carcinogen, from the reaction of formaldehyde with chlorides appears unlikely at low concentrations of formaldehyde in air, but additional research on this topic is desirable.