R.W. LAPINE INC.
MECHANICAL CONTRACTORS

5140 East ML Avenue
Kalamazoo, MI. 49048

FORMALDEHYDE WRITEN PROGRAM

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Scope:

Any time R.W. LaPine, Inc. employees have an occupational exposure to any of the following:

a. Formaldehyde from any source
b. Formaldehyde gas
c. Formaldehyde solutions
d. Materials that release formaldehyde

This written program shall be implemented to reduce exposure to employees from formaldehyde in any of the forms listed above.

Definitions:

Action Level: Means a concentration of 0.5 part formaldehyde per million parts of air (0.5 ppm) calculated as any eight hour time weighted average (TWA) concentration.

Authorized Person: Means any person who is required by work duties to be present in regulated areas or who is authorized to be present in regulated areas by the employer.

Employee Exposure: Means the exposure to airborne formaldehyde that would occur without the use of a respirator.

Permissible Exposure Limits (PEL):

R.W. LaPine, Inc. shall ensure that an employee is not exposed to an airborne concentration of formaldehyde at a level of more than 0.75 parts of formaldehyde per million parts of air (0.75 ppm) as an 8 hour time-weighted average

This shall be accomplished by review of "Host Employers" site for potential formaldehyde risks, along with obtaining any air monitoring data for that particular area.

Short Term Exposure Level (STEL):

Exposure to formaldehyde at a level of more than 2 parts of formaldehyde per million parts of air (2 ppm) during any 15 minute period is determined as the short-term exposure limit (STEL).

Exposure Monitoring:

In the event R.W. LaPine, Inc. has employees working in an area that may expose them to Formaldehyde. Exposure monitoring shall be completed to determine the exposure level of employees in that work area.

Note: R.W. LaPine, Inc. is not required to monitor exposures if it can be documented, using objective data, that the presence of formaldehyde or formaldehyde releasing products in the workplace could not possibly expose an employee at or above the action level or STEL under foreseeable conditions of use.

Objective data can be obtained from the "Host Employer"

If R.W. LaPine, Inc. receives reports from the "Host Employer" or employee who has signs or symptoms of respiratory or skin conditions that are associated with formaldehyde exposure, R.W. LaPine, Inc. will promptly monitor and determine the affected employee's exposure status.

Periodic Exposure Monitoring:

Due to the limited time on most projects involving R.W. LaPine, Inc. employees:

1. If the last monitoring results indicate employee exposure at or above the action level, repeat monitoring of affected employees shall be done once every 6 months.

2. If the last monitoring results indicate employee exposure at or above the STEL, repeat monitoring of affected employees shall be done under "worst STEL conditions" at least once a year.

Notifications:

R.W. LaPine, Inc. within 15 days of receiving the results of exposure monitoring based on these programs requirements shall notify the affected employees of the results. Notification may be accomplished by distributing copies of the results to the employees or by posting the results.

If employee exposure is over either permissible exposure limit (TWA or STEL) a written plan shall be developed and implemented to reduce employee exposure to or below both PELs and give written notice to employees. The written notice shall contain a description of the corrective action being taken to decrease exposure.

Regulated Areas:

If R.W. LaPine, Inc. is working in an area that now becomes a regulated area where the concentration of airborne formaldehyde is more than either the TWA or the STEL the following notice shall be posted at all entrances and access ways with signs bearing the following information:

Danger
Formaldehyde
Irritant and Potential Cancer Hazard
Authorized Personnel Only

R.W. LaPine, Inc. shall limit access to regulated areas to authorized persons who have been trained to recognize the hazards of formaldehyde.

Engineering and Work Practice Controls:

In most cases the Host employer will implement engineering and work practice controls to reduce and maintain employee exposure to formaldehyde at or below the TWA and STEL. However, in the event of a spill or situation were engineering controls are not feasible respiratory protection shall be implemented under the R.W. LaPine, Inc. Respiratory Protection Program.

Protective Equipment and Clothing:

R.W. LaPine, Inc. shall select protective clothing and equipment based upon the form of formaldehyde to be encountered, the conditions of use, and the hazard to be prevented.

All chemical protective clothing shall be made of material impervious to formaldehyde along with other personal protective equipment such as goggles and face shields.

Maintenance of PPE:

R.W. LaPine, Inc. shall assure that protective equipment and clothing that has become contaminated with formaldehyde is disposed of in accordance with Federal EPA requirements or is cleaned and laundered before reuse.

Hygiene Facilities:

If the possibility of employee skin contact with solutions containing 1% or more of formaldehyde exists, due to equipment failure, or improper work practices, a quick drench shower shall be made available. Job site foreman shall assure the affected employees use these facilities immediately.

If there is possibility of employees eyes coming into contact with solutions containing 1% or more of formaldehyde, acceptable eye wash flushing stations shall be immediately available.

Housekeeping:

If R.W. LaPine, Inc. is involved with operations that is under their control were there is formaldehyde liquids or gas, a program shall be established to detect leaks and spills, including visual inspections. The program shall include all of the following that are applicable:

1. Preventive maintenance of equipment, including surveys for leaks, shall be undertaken at regular intervals.
2. In work areas where spillage may occur, containment for the spill and decontaminating the work area, along with waste disposal shall be put into place.
3. Assure that all leaks are repaired and spills are cleaned promptly by employees wearing appropriate PPE and that they have been trained in the proper methods of clean-up and disposal.
4. All formaldehyde contaminated waste and debris shall be placed for disposal in a sealed container bearing a label warning of formaldehyde presence and of the hazards associated with formaldehyde.

Medical Surveillance:

R.W. LaPine, Inc. will institute a medical surveillance program for all employees who are exposed to formaldehyde at concentrations at or exceeding the action level or exceeding the STEL.

The medical surveillance program shall be established following the guideline of MIOSHA Part 306, rules 17, 18, 19, and 20.

Hazard Communication:

R.W. LaPine, Inc. has an established "Hazard Communication Program" and will include this program into its policy.

Labeling: For materials which are capable of releasing formaldehyde at levels of 0.1 ppm to 0.5 ppm shall contain the following information.

a. A statement that the material contains formaldehyde.
b. The name and address of the manufacturer's or importers responsible person.
c. A statement that physical and health hazard information is readily available from the employer and from material safety date sheets (MSDS)

Employee Information and Training:

All employees who are assigned to workplaces where there is exposure to formaldehyde at or above 0.1 ppm will participate in R.W. LaPine, Inc.'s training program.

The training shall consist of the following:

1. A discussion of the contents of these rules and the contents of the material safety data sheet.
2. An explanation of the purpose of medical surveillance program.
3. Description of operations in the work area where formaldehyde is present and the safe work practices to limit exposure to formaldehyde.
4. The proper use and limitations of PPE.
5. An explanation of engineering controls and work practice controls.
6. Review of emergency procedures, including assignment of responsibilities.

Recordkeeping:

R.W. LaPine, Inc. office manager will keep all records of monitoring measurements to include the following:

1. The date of measurement
2. The operation being monitored
3. Methods of sampling and analysis and evidence of their accuracy and precision
4. The number, durations, time, and results of samples taken.
5. The types of protective devices worn
6. The name, job classification, social security numbers, and exposure estimates of the employees whose exposures are represented by the actual monitoring results.

Appendix A:

MIOSHA Part 306. FORMALDEHYDE

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

OCCUPATIONAL HEALTH STANDARDS

Filed with the Secretary of State on June 8, 1993 **(as amended October 1, 1999)**

These rules take effect 15 days after filing with the Secretary of State

(By authority conferred on the director of the department of consumer and industry services by section 24 of 1974 PA 154, MCL 408.1024, and Executive Reorganization Order Nos. 1996-1 and 1996-2, MCL 330.3101 and 445.2001)

R 325.51452, R 325.51460, R 325.51461, R 325.51462, R 325.51470, R 325.51476, and R 325.51477 of the Michigan Administrative Code are amended to read as follows:

PART 306. FORMALDEHYDE

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R 325.51451 Scope and application.

Rule 1. (1) These rules apply to all occupational exposures to any of the following:

(a) Formaldehyde from any source.

(b) Formaldehyde gas.

(c) Formaldehyde solutions.

(d) Materials that release formaldehyde

(2) These rules apply to all employment situations, including general industry and construction industry employment.

(3) These rules replace all references to formaldehyde contained in tables G-1 and G-2 in occupational health rules 2102 and 2103, table G-1-A and G-2 in R 325.51108, and table 3 of exhibit I of occupational health rule 6201(1).

R 325.51 452 Definitions.

Rule 2. As used in these rules:

(a) "Action level" means a concentration of 0.5 part formaldehyde per million parts of air (0.5 ppm) calculated as an eight (8)-hour time-weighted average (TWA) concentration.

(b) "Authorized Person" means any person who is required by work duties to be present in regulated areas or who is authorized to be present in regulated areas by the employer, by these rules, or by 1974 PA 154, MCL 408.1001 et seq.

(a) "Director" means the director of the Michigan department of consumer and industry services or his or her designee.

(c) "Emergency" means any occurrence, such as an equipment failure, the rupture of containers, or the failure to control equipment, that results in an uncontrolled release of a significant amount of formaldehyde.

(e) **"Employee exposure"** means the exposure to airborne formaldehyde that would occur without the use of a respirator.

(f) **"Formaldehyde"** means the chemical substance HCHO, chemical abstracts service registry no. 50-00-0.

R 325.51453 Permissible exposure limits (PEL).

Rule 3. (1) An employer shall ensure that an employee is not exposed to an airborne concentration of formaldehyde at a level of more than 0.75 parts of formaldehyde per million parts of air (0.75 ppm) as an 8- hour, time-weighted average (TWA).

(2) An employer shall ensure that an employee is not exposed to formaldehyde at a level of more than 2 parts of formaldehyde per million parts of air (2 ppm) during any 15-minute period. This is designated as a short-term exposure limit (STEL).

R 325.51454 Exposure monitoring generally.

Rule 4. (1) An employer shall monitor to determine employee exposure to formaldehyde.

(2) An employer is not required to monitor exposures if it can be documented, using objective data, that the presence of formaldehyde or formaldehyde-releasing products in the workplace could not possibly expose an employee at or above the action level or STEL under foreseeable conditions of use.

(2) Employee exposure to formaldehyde shall be determined by representative monitoring for each job classification, in each work area, for each shift, and during the full shift or for a short-term exposure, as appropriate. Other work shift monitoring need not be conducted if objective data can document equivalent exposures for different work shifts.

(4) Monitoring shall be accurate, at the 95% confidence level, to within plus or minus 25% for airborne concentrations of formaldehyde at the TWA and the STEL and to within plus or minus 35% for airborne concentrations of formaldehyde at the action level.

R 325.51 455 Initial exposure monitoring.

Rule 5. (1) An employer shall identify all employees who may be exposed at or above the action level or at or above the STEL and accurately determine the exposure of each employee so identified.

(2) Unless an employer chooses to measure the exposure of each employee who is potentially exposed to formaldehyde, an employer shall develop a representative sampling strategy and measure sufficient exposures within each job classification for each work shift to correctly characterize, and not underestimate, the exposure of any employee within each exposure group.

(2) The initial monitoring process shall be repeated each time there is a change in any of the following which may result in new or additional exposure to formaldehyde:

(a) Production.
(b) Equipment.
(c) Process.
(d) Personnel.
(e) Control measures.

(4) If an employer receives reports of an employee who has signs or symptoms of respiratory or skin conditions that are associated with formaldehyde exposure, the employer shall promptly monitor and determine the affected employee's exposure.

R 325.51456 Periodic exposure monitoring.

Rule 6. (1) An employer shall periodically measure and accurately determine exposure to formaldehyde for employees shown by the initial monitoring to be exposed at or above the action level or at or above the STEL.

(2) If the last monitoring results reveal employee exposure at or above the action level, an employer shall repeat monitoring of the employee at least once every 6 months.

(3) If the last monitoring results reveal employee exposure at or above the STEL, an employer shall repeat monitoring under the worst STEL conditions of the employees at least once a year.

(4) An employer may discontinue periodic monitoring for employees if results from 2 consecutive sampling periods taken not less than 7 days apart show that employee exposure is below the action level and the STEL. The results shall be statistically representative and consistent with the employer's knowledge of the job and work operation.

R 325.51457 Exposure monitoring; notification and observation.

Rule 7. (1) Within 15 days of receiving the results of exposure monitoring conducted pursuant to these rules, an employer shall notify the affected employees of the results. Notification shall be accomplished by distributing copies of the results to the employees or by posting the results. If employee exposure is over either permissible exposure limit (TWA or STEL), an employer shall develop and implement a written plan to reduce employee exposure to or below both PELs and give written notice to employees. The written notice shall contain a description of the corrective action being taken by the employer to decrease exposure.

(2) An employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to formaldehyde required by these rules. When observation of the monitoring of employee exposure to formaldehyde requires entry into an area where the use of protective clothing or equipment is required, an employer shall provide the clothing and equipment to the observer, require the observer to use such clothing and equipment, and assure that the observer complies with all other applicable safety and health procedures.

R 325.51 458 Regulated areas.

Rule 8. (1) An employer shall establish regulated areas where the concentration of airborne formaldehyde is more than either the TWA or the STEL and post all entrances and access ways with signs bearing the following information:

DANGER

FORMALDEHYDE

IRRITANT AND POTENTIAL CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

(2) An employer shall limit access to regulated areas to authorized persons who have been trained to recognize the hazards of formaldehyde.

(2) An employer at a multi-employer worksite who establishes a regulated area shall communicate the access restrictions and location of the area to other employers with

work operations at that worksite.

R 325.51459 Engineering and work practice controls.

Rule 9. (1) An employer shall institute engineering and work practice controls to reduce and maintain employee exposures to formaldehyde at or below the TWA and the STEL.

(2) If an employer has established that feasible engineering and work practice controls cannot reduce employee exposure to or below either of the PELs, the employer shall apply these controls to reduce employee exposures to the extent feasible and shall supplement them with respirator protection pursuant to the provisions of R 325.51460 and occupational health rule 3502.

R 325.51 460 Respiratory protection.

Rule 10. (1) For employees who use respirators required by these rules, the employer shall provide respirators that comply with the requirements of these rules. An employer shall ensure that an employee uses a respirator during all of the following:

(a) Periods necessary to install or implement feasible engineering and work practice controls.

(a) Work operations, such as maintenance and repair activities or vessel cleaning, for which the employer establishes that engineering and work practice controls are not feasible.

(b) Work operations for which feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the PELs.

(c) Emergencies.

(2) An employer shall select appropriate respirators from table 1 of this rule.

(3) An employer shall provide a powered air-purifying respirator that is adequate to protect against formaldehyde exposure to any employee who has difficulty using a negative-pressure respirator.

(4) Table 1 reads as follows:

Table 1

Minimum Requirements for Respirator Protection Against Formaldehyde

Condition of use of formaldehyde concentration (ppm)	Minimum respirator required[1]
Up to 7.5 ppm (10 x PEL)	Full facepiece with cartridges or canisters specifically approved for protection against formaldehyde[2].
Up to 75 ppm (100 x PEL)	Full–face mask with chin-style or chest or back-mounted type with industrial-size canister specifically approved for protection against formaldehyde. Type C supplied-air respirator, pressure demand or continuous – flow type, with full facepiece, hood or helmet.
Above 75 ppm or unknown (emergencies) (100 x PEL)	Self-contained breathing apparatus (SCBA) with positive-pressure full facepiece. Combination supplied-air, full facepiece, positive-pressure respirator with auxiliary self-contained air supply.
Firefighting	SCBA with positive pressure in full facepiece.
Escape	SCBA in demand or pressure demand mode. Full-face mask with chin-style or front or back-mounted type industrial-size canister specifically approved for protection against formaldehyde.

1 Respirators specified for use at higher concentrations may be used at lower concentrations.

2 A half-mask respirator with cartridges specifically approved for protection against formaldehyde can be substituted for the full facepiece respirator if effective gasproof goggles are provided and used in combination with the half-mask respirator.

R 325.51461 Respirator program.

Rule 11. (1) An employer shall implement a respiratory protection program in accordance with 29 C.F.R. §1910.134(b) to (d) and (f) to (m), except for (d)(1)(iii) and (d)(3)(iii)(b)(1) and (2), as adopted by reference in R 325.60051 et seq. of the Michigan Administrative Code.

(2) If air-purifying chemical-cartridge respirators are used, than the employer shall do both of the following:

(a) Replace the cartridge after 3 hours of use or at the end of the work shift, whichever occurs first, unless the cartridge contains a NIOSH-approved end-of-service-life indicator (ESLI) to show when breakthrough occurs.

(b) Unless the canister contains a NIOSH-approved ELSI to show when breakthrough occurs, replace canisters used in atmospheres up to 7.5 ppm (10 x PEL) every 4 hours and industrial-size canisters used in atmospheres up to 75 ppm (100 x PEL) every 2 hours, or at the end of the work shift, whichever occurs first.

R 325.51 462 Protective equipment and clothing.

Rule 12. (1) An employer shall comply with the provisions of general industry safety standards, Part 33. Personal Protective Equipment, being R 408.13301 et seq. and construction standard Part 6. Personal Protective Equipment, being R 408.40601 et seq. of the Michigan Administrative Code. If protective equipment or clothing is provided under Part 33 or Part 6, then an employer shall provide the protective devices at no cost to the employee and assure that the employee wears the devices.

(2) An employer shall select protective clothing and equipment based upon the form of formaldehyde to be encountered, the conditions of use, and the hazard to be prevented.

(3) An employer shall ensure that chemical-protective clothing made of material impervious to formaldehyde and other personal protective equipment, such as goggles and face shields, is used to prevent an employee's eyes and skin from coming into contact with liquids that contain 1% or more formaldehyde, as appropriate to the operation.

(4) An employer shall ensure that contact with irritating or sensitizing materials is prevented to the extent necessary to eliminate the hazard. If a face shield is worn, then an employer shall ensure that an employee wears chemical safety goggles if there is a danger of formaldehyde reaching the area of the eye. An employer shall ensure that an employee wears full body protection for entry into areas where concentrations of formaldehyde are more than 100 ppm and for emergency reentry into areas of unknown concentrations.

R 325.51463 Maintenance of protective equipment and clothing.

Rule 13. (1) An employer shall assure that protective equipment and clothing that has become contaminated with formaldehyde is cleaned or laundered before its reuse.

(2) When ventilating formaldehyde-contaminated clothing and equipment, an employer shall establish a storage area so that employee exposure is minimized. Labels for containers for contaminated clothing and equipment and signs for storage areas for contaminated clothing and equipment shall contain the following information:

DANGER

FORMALDEHYDE-CONTAMINATED CLOTHING/EQUIPMENT

AVOID INHALATION AND SKIN CONTACT

(3) An employer shall assure that only persons who are trained to recognize the hazards of formaldehyde remove the contaminated items from the storage areas or container for the purposes of cleaning, laundering, or disposal.

(4) An employer shall assure that an employee does not take his or her formaldehyde contaminated clothing or equipment home.

(3) An employer shall repair or replace all required protective clothing and equipment for each affected employee as necessary to assure its effectiveness.

(5) An employer shall inform any person who launders, cleans, or repairs contaminated clothing or equipment of formaldehyde's potentially harmful effects and of procedures to safely handle the clothing and equipment.

R 325.51 464 Hygiene facilities.

Rule 14. (1) An employer shall provide change rooms, as described in occupational health rule 4201(5), for employees who are required to change from work clothing into protective clothing to prevent skin contact with formaldehyde.

(2) If the possibility of employee skin contact with solutions containing 1% or more formaldehyde exists, for example because of equipment failure or improper work practices, an employer shall provide conveniently located quickdrench showers and assure that affected employees use these facilities immediately.

(2) If there is any possibility that an employee's eyes may be splashed with solutions containing 0.1% or more formaldehyde, an employer shall provide acceptable facilities for flushing eyes within the immediate work area for emergency use.

R 325.51465 Housekeeping.

Rule 15. For operations involving formaldehyde liquids or gas, an employer shall conduct a program to detect leaks and spills, including regular visual inspections. The program shall include all of the following that are applicable:

(a) Preventative maintenance of equipment, including surveys for leaks, shall be undertaken at regular intervals.

(b) In work areas where spillage may occur, an employer shall provide for containing the spill, decontaminating the work area, and disposing of the waste.

(a) An employer shall assure that all leaks are repaired and spills are cleaned promptly by employees wearing suitable protective equipment and trained in the proper methods for cleanup and decontamination.

(b) Formaldehyde-contaminated waste and debris resulting from leaks or spills shall be placed for disposal in sealed containers bearing a label warning of formaldehyde's presence and of the hazards associated with formaldehyde.

R 325.51 466 Emergencies.

Rule 16. For each workplace where there is the possibility of an emergency involving formaldehyde, an employer shall assure that appropriate procedures are adopted to minimize injury and loss of life. Appropriate procedures shall be implemented in the event of an emergency.

R 325.51467 Medical surveillance generally.

Rule 17. (1) An employer shall institute medical surveillance programs for all employees who are exposed to formaldehyde at concentrations at or exceeding the action level or exceeding the STEL.

(2) An employer shall make medical surveillance available for employees who develop signs and symptoms of overexposure to formaldehyde and for all employees who are exposed to formaldehyde in emergencies. When determining whether an employee may be experiencing signs and symptoms of possible overexposure to formaldehyde, an employer may rely on the evidence that signs and symptoms associated with formaldehyde exposure will occur only in exceptional circumstances when airborne exposure is less than 0.1 ppm and when formaldehyde is present in materials in concentrations less than 0.1%.

(2) All medical procedures, including the administration of medical disease questionnaires, shall be performed by or under the supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

(4) An employer shall make the following medical surveillance documents available to employees before assignment to a job where formaldehyde exposure is at or above the action level or above the STEL and annually thereafter. The employer shall also make the following medical surveillance documents available promptly upon determining that an employee is experiencing signs and symptoms indicative of possible overexposure to formaldehyde:

(a) An employer-administered medical disease questionnaire, such as in appendix D to these rules, which is designed to elicit information in the following areas:

(i) Work history.
(ii) Smoking history.
(iii) Any evidence of eye, nose, or throat irritation.
(iv) Chronic airway problems or hyperactive airway disease.
(i) Allergic skin conditions or dermatitis.
(v) Upper or lower respiratory problems.

(b) A written determination by the physician, based on evaluation of the medical disease questionnaire, of whether a medical examination is necessary for employees who are not required to wear respirators to reduce the exposure to formaldehyde.

R 325.51468 Medical examinations.

Rule 18. (1) Medical examinations shall be given to any employee who the physician feels, based on information in the medical disease questionnaire, may be at increased risk from exposure to formaldehyde and shall be given at the time of initial assignment and at least annually thereafter to all employees who are required to wear a respirator to reduce exposure to formaldehyde. The medical examination shall include all of the following:

(a) A physical examination, with an emphasis on evidence of irritation or sensitization of the skin and respiratory system, shortness of breath, or irritation of the eyes.

(a) Laboratory examinations for respirator wearers consisting of baseline and annual pulmonary function tests. At a minimum, these tests shall consist of forced vital capacity (FVC), forced expiratory volume in I second (FEVI), and forced expiratory flow (FEF).

(b) Any other test which the examining physician deems necessary to complete the written opinion.

(b) Counseling of employees who have medical conditions that would be directly or indirectly aggravated by exposure to formaldehyde on the increased risk of impairment of their health.

(2) An employer shall make medical examinations available as soon as possible to all employees who have been exposed to formaldehyde in an emergency. The examination shall include a medical and work history with an emphasis on any evidence of upper or lower respiratory problems, allergic conditions, skin reaction or hypersensitivity, and eye, nose, or throat irritation. Other examinations shall consist of those elements considered appropriate by the examining physician.

(3) An employer shall provide all of the following information to the examining physician:

(a) A copy of these rules and appendices A, C, D, and E.

(b) A description of the affected employee's job duties as they relate to the employee's exposure to formaldehyde.

(c) The representative exposure level for the employee's job assignment.

(d) Information concerning any personal protective equipment and respiratory protection used or to be used by the employee.

(e) Information from previous medical examinations of the affected employee within the control of the employer.

(f) For a non-routine examination because of an emergency, an employer shall provide, as soon as possible, a description of how the emergency occurred and the exposure-the victim may have received.

R 325.51 469 Physician's written opinion.

Rule 19. (1) For each examination pursuant to the provisions of R 325.51468, an employer shall obtain a written opinion from the examining physician. This written opinion shall contain the results of the medical examination, except that it shall not reveal specific findings or diagnoses unrelated to occupational exposure to formaldehyde. The written opinion shall include all of the following:

(a) The physician's opinion as to whether the employee has any medical condition that would place the employee at an increased risk of material impairment of health from exposure to formaldehyde.

(a) Any recommended limitations on the employee's exposure or changes in the use of personal protective equipment, including respirators.

(c) A statement that the employee has been informed by the physician of any medical conditions which would be aggravated by exposure to formaldehyde, whether these conditions may have resulted from past formaldehyde exposure or from exposure in an emergency, and whether there is a need for further examination or treatment.

(2) An employer shall provide for retention of the results of the medical examination and tests conducted by the physician.

(3) An employer shall provide a copy of the physician's written opinion to the affected employee within 15 days of its receipt.

R 325.51470 Employee medical removal procedures.

Rule 20. (1) This rule applies if an employee reports any of the following symptoms attributed to workplace formaldehyde exposure:

(a) Significant irritation of the mucosa of the eyes or of the upper airways.

(b) Respiratory sensitization.

(c) Dermal irritation.

(d) Dermal sensitization. This rule does not apply in the case of dermal irritation or sensitization if the product that is suspected of causing the dermal condition contains less than 0.05% formaldehyde.

(2) A physician shall evaluate an employee's report of signs or symptoms of possible overexposure to formaldehyde. An employer shall select the physician under R 325.51467. If the physician determines that a medical examination is not necessary, then there shall be a 2-week evaluation and remediation period to permit the employer to ascertain whether the signs or symptoms subside untreated or with the use of creams, gloves, first aid treatment, or personal protective equipment. An employer may also implement industrial hygiene measures that limit an employee's exposure to formaldehyde during the 2-week period. An employer shall immediately refer an employee to a physician before the end of the 2-week period if the signs or symptoms worsen. An employer shall not alter earnings, seniority, and benefits during the 2-week period because of an employee's medical report.

(3) If an employee's signs or symptoms of possible overexposure to formaldehyde have not subsided or been remedied by the end of the 2-week period, or earlier if the signs or symptoms warrant, then a physician who is selected by the employer shall examine the employee. The physician shall presume, absent contrary evidence, that observed dermal irritation or dermal sensitization is not attributable to formaldehyde when products to which the affected employee is exposed contain less than 0.1% formaldehyde.

(3) An employer shall ensure that a medical examination is conducted in compliance with R 325.51468(2). Additional guidelines for conducting medical exams are contained in appendix C to these rules.

(4) If the physician finds that significant irritation of the mucosa of the eyes or the upper airways, respiratory sensitization, dermal irritation, or dermal sensitization results from workplace formaldehyde exposure and recommends restrictions or removal of the employee from formaldehyde exposure, then the employer shall promptly comply with the restrictions or recommendation of removal. If there is a recommendation of removal, then the employer shall remove the affected employee from the current formaldehyde exposure and, if possible, transfer the employee to work that does not result in exposure to formaldehyde or that results in significantly less exposure to formaldehyde.

(5) If an employee is removed under subrule (5) of this rule, then an employer shall transfer the employee to comparable work for which the employee is qualified or can be trained in not more than a 6-month period and work where the formaldehyde exposures are as low as possible, but not higher than the action level. The employer shall maintain the employee's current earnings, seniority, and other benefits. If comparable work is not available, then the employer shall maintain the employee's current earnings, seniority, and other benefits until comparable work becomes available, until the employee is determined to be unable to return to workplace formaldehyde exposure, until the employee is determined to be able to return to the original job status, or for 6 months, whichever occurs first.

(6) An employer shall arrange for a follow-up medical examination to take place within 6 months after an employee is removed from formaldehyde exposure under this rule. The examination shall determine if the employee can return to the original job status or if the removal is to be permanent. A physician shall make a decision within 6 months of the date that an employee was removed as to whether the employee can be returned to the original job status or if the removal is to be permanent.

(3) An employer's obligation to provide earnings, seniority, and other benefits to an employee who is removed from formaldehyde exposure may be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program or from employment with another employer that is made possible by the employee's removal.

(9) In making determinations of the formaldehyde content of materials under this rule, an employer may rely on objective data.

R 325.51471 Multiple physician review.

Rule 21. (1) If an employer selects the initial physician to conduct a medical examination or consultation to determine if medical removal or restriction is appropriate, an employee may designate a second physician to do both of the following:

(a) Review the findings, determinations, or recommendations of the initial physician.

(b) Conduct examinations, consultations, and laboratory tests as the second physician deems necessary and appropriate to evaluate the effects of formaldehyde exposure and to facilitate his or her review of the findings, determinations, or recommendations of the initial physician.

(2) An employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that a physician who is selected by the employer conducts a medical examination or consultation for the purpose of medical removal or restriction.

(3) An employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing both of the following within 15 days after receipt of the employer's notification, as required in subrule (2) of this rule, or receipt of the initial physician's written opinion, whichever is later:

(a) Informing the employer that the employee intends to seek a second medical opinion.

(b) Initiating steps to make an appointment with a second physician.

(4) If the findings, determinations, or recommendations of a second physician differ from those of an initial physician, the employee and the employer shall ensure that efforts are made for the 2 physicians to resolve their disagreement. If the 2 physicians are unable to quickly resolve the disagreement, the employer and the employee, through their respective physicians, shall designate a third physician who shall be a specialist in the field at issue to do both of the following:

(a) Review the findings, determination, or recommendations of the prior physicians.

(a) Conduct examinations, consultations, laboratory test, and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement between the prior physicians. As an alternative, the employer and the employee or authorized employee representative may jointly designate a third physician.

(5) An employer shall act consistent with the findings, determinations, and recommendations of the third physician, unless the employer and the employee reach an agreement that is otherwise consistent with the recommendations of at least 1 of the 3 physicians.

R 325.51472 Hazard communication.

Rule 22. (1) Communication to employees of the hazards associated with formaldehyde in the workplace shall be governed by the provisions of this rule. The definitions set forth in the provisions of 29 C.F.R. §1910.1200 apply to these rules. The provisions of 29 C.F.R. §1910.1200 were incorporated by reference in Act No. 154 of the Public Acts of 1974, as amended, being §408.100 1 et seq. of the Michigan Compiled Laws, by Act No. 80 of the Public Acts of 1986, which added §408.1014a.

(2) The hazard communication requirements of this rule shall apply to formaldehyde gas, all mixtures or solutions composed of more than 0.1% formaldehyde, and materials that are capable of releasing formaldehyde into the air under any reasonably foreseeable condition of use at concentrations of, or more than, 0.1 ppm. At a minimum, an employer shall address all of the following specific health hazards:

(a) Cancer.

(b) Irritation and sensitization of the skin and respiratory system.

(c) Eye and throat irritation.

(d) Acute toxicity.

(3) Manufacturers and importers that produce or import formaldehyde or formaldehyde-containing products shall provide downstream employers who use or handle these products with an objective determination through the required labels and material safety data sheets (MSDS) if these items may constitute a health hazard within the meaning of the provisions of 29 C.F.R. §1910.1200(d) under normal conditions of use.

(3) With regard to labeling, all of the following provisions shall apply:

(a) An employer shall ensure that hazard warning labels that are in compliance with the requirements of 29 C.F.R. §1910.1200(f) are affixed to all containers of materials listed in subrule (2) of this rule, unless the provisions of 29 C.F.R. §1910.1200(f) are inconsistent with the provisions of this subdivision.

(b) Labels for all materials which are listed in subrule (2) of this rule and which are capable of releasing formaldehyde at levels of 0.1 ppm to 0.5 ppm shall contain all of the following information:

(i) A statement that the material contains formaldehyde.

(i) The name and address of the manufacturer's or importer's responsible person.

(iii) A statement that physical and health hazard information is readily available from the employer and from material safety data sheets (MSDS).

(c) Labels for all materials which are listed in subrule (2) of this rule and which are capable of releasing formaldehyde at levels of more than 0.5 ppm shall appropriately address all hazards that are defined in 29 C.F.R. §1910.1200(d) and appendices A and B of 29 C.F.R. §1910.1200. The label shall contain a statement that formaldehyde is a potential sensitizer of the respiratory system and shall contain the words 'POTENTIAL CANCER HAZARD."

(d) In determining an anticipated level of formaldehyde release, an employer may rely on objective data that indicates the extent of potential formaldehyde release under reasonably foreseeable conditions of use.

(e) An employer may use warning labels which are required by other statutes, regulations, or ordinances and which impart the same information as the warning statements required by this subrule.

(5) With regard to material safety data sheets, both of the following provisions apply:

(a) An employer who uses formaldehyde-containing materials listed in subrule (2) of this rule shall comply with the requirements of 29 C.F.R. §1910.1200(g) with regard to the development and updating of material safety data sheets.

(b) Manufacturers, importers, and distributors of formaldehyde-containing materials listed in subrule (2) of this rule shall ensure that material safety data sheets and updated information are provided to all employers who purchase such materials at the time of the initial shipment and at the time of the first shipment after a material safety data sheet is updated.

(6) An employer shall develop, implement, and maintain, at the workplace, a written hazard communication program for formaldehyde exposures in the workplace. At a minimum, the program shall describe how the requirements of this rule and R 325.51473 will be met and how an employer in a multi-employer facility where other employers' workers may be exposed to formaldehyde will accomplish all of the following:

(a) Make copies of material safety data sheets for formaldehyde materials available to other employers and their employees.

(a) Inform other employers of precautionary measures that are needed to protect employees from formaldehyde exposure during normal operations and in foreseeable emergencies.

(c) Inform other employers of the labeling system that is used for formaldehyde materials.

R 325.51473 Employee information and training.

Rule 23. (1) An employer shall ensure that all employees who are assigned to workplaces where there is exposure to formaldehyde at or above 0.1 ppm participate in a training program.

(2) An employer shall provide employees with information and training on formaldehyde at the time of their initial assignment and when a new exposure to formaldehyde is introduced into their work areas. Employers shall provide such information and training at least annually.

(3) The training program shall be conducted in a manner that an employee is able to understand and shall include all of the following:

(a) A discussion of the contents of these rules and the contents of the material safety data sheet.

(b) An explanation of the purpose for, and a description of, the medical surveillance program required by these rules, including both of the following:

(i) A description of the potential health hazards associated with exposure to formaldehyde and a description of the signs and symptoms of exposure to formaldehyde.

(ii) Instructions to immediately report to the employer the development of any adverse signs or symptoms that the employee suspects is attributable to formaldehyde exposure.

(c) A description of operations in the work area where formaldehyde is present and an explanation of the safe work practices appropriate for limiting exposure to formaldehyde in each job.

(c) An explanation of the purpose for, and proper use and limitations of, personal protective clothing and equipment.

(d) Instructions for the handling of spills, emergencies, and clean-up procedures.

(d) An explanation of the importance of engineering and work practice controls for employee protection and any necessary instruction in the use of these controls.

(g) A review of emergency procedures, including the specific duties or assignments of each employee in an emergency.

(4) An employer shall inform all affected employees of the location of written training materials and shall make these materials readily available, without cost, to the affected employees. The employer shall provide, to the director, upon request, all training materials relating to the employee training program.

R 325.51 474 Recordkeeping.

Rule 24. (1) An employer shall establish and maintain an accurate record of all measurements taken to monitor employee exposure to formaldehyde. This record shall include all of the following information:

(a) The date of measurement.

(b) The operation being monitored.

(c) The methods of sampling and analysis and evidence of their accuracy and precision.

(d) The number, durations, time, and results of samples taken.

(e) The types of protective devices worn.

(e) The names, job classifications, social security numbers, and exposure estimates of the employees whose exposures are represented by the actual monitoring results.

(2) If an employer has determined that monitoring is not required pursuant to these rules, the employer shall maintain a record of the objective data relied upon to support the determination that employees are not exposed to formaldehyde at or above the action level.

(2) An employer shall establish and maintain an accurate record for each employee who is subject to medical surveillance pursuant to these rules. This record shall include all of the following information:

(a) The name and social security number of the employee.

(b) The physician's written opinion.

(c) A list of any employee health complaints that may be related to exposure to formaldehyde.

(a)A copy of the medical examination results, including medical disease questionnaires and results of any medical tests required by these rules or mandated by the examining physician.

(4) An employer shall establish and maintain accurate records for employees who are subject to negative-pressure respirator fit testing required by these rules. These records shall include all of the following information:

(a) A copy of the protocol selected for respirator fit testing.

(b) A copy of the results of any fit testing performed.

(a) The size and manufacturer of the types of respirators available for selection.

(b) The date of the most recent fit testing, the name and social security number of each tested employee, and the respirator type and facepiece selected.

(5) An employer shall retain records required by these rules for not less than the following periods:

(a) Exposure records and determinations shall be kept for not less than 30 years.

(b) Medical records shall be kept for the duration of employment, plus 30 years.

(c) Respirator fit testing records shall be kept until replaced by a more recent record.

(6) All of the following provisions apply with regard to the availability of records:

(a) Upon request, an employer shall make all records maintained as a requirement of these rules available for examination and copying to the director.

(a) An employer shall make employee exposure records, including estimates made from representative monitoring, available upon request for examination and copying to the subject employee or former employee and to employee representatives in accordance with the provisions of R 325.3451 et seq.

(c) Employee medical records required by these rules shall be provided upon request for examination and copying to the subject employee or former employee or to anyone who has the specific written consent of the subject employee or former employee in accordance with the provisions of R 325.3451 et seq.

R 325.51475 Compliance dates.

Rule 25. (1) Except as indicated in subrule (2) of this rule, compliance with the requirements of these rules is required on the effective date of these rules.

(2) Compliance with the rules specified in this subrule shall be as follows:

(a) R 325.51459, compliance with the 0.75 ppm exposure limit shall be completed as soon as possible, but not later than June 26, 1993.

(b) R 325.51470 and R 325.51471, compliance is required not later than December 31, 1992.

(c) R 325.51472(4), compliance is required not later than December 31, 1992.

R 325.51 476 Appendices.

Rule 26. Appendices A, B, C, and D to these rules are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

R 325.51477 Availability of rules; permission to reproduce.

Rule 27. (1) Single copies of these rules and appendices is available to affected employers and employees at no cost from the Michigan Department of Consumer and Industry Services, Standards Division, P.O. Box 30643 Lansing, Michigan 48909.

(2) Permission to reproduce these rules and their appendices, in full or in part, is granted by the director.

APPENDIX A - SUBSTANCE TECHNICAL GUIDELINES FOR FORMALIN

The following Substance Technical Guideline for Formalin provides information on uninhibited formalin solution (37% 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-0.75 ppm
OSHA STEL-2 ppm

Physical Data

Description: Colorless liquid, pungent odor
Boiling point: 214 deg. F (101 deg. C)
Specific Gravity: 1.08 (H2O=1 @ 20 deg. C)
pH: 2.8-4.0
Solubility in Water: Miscible
Solvent Solubility: Soluble in alcohol and acetone
Vapor Density: 1.04 (Air=1 @ 20 deg. C)
Odor Threshold: 0.8-1 ppm

Fire and Explosion Hazard

Moderate fire and explosion hazard when exposed to heat or flame.

The flash point of 37% formaldehyde solutions is above normal room temperature, but the explosion range is very wide, from 7 to 73% by volume in air.

Reaction of formaldehyde with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid yields explosive compounds.

Flash Point: 185 deg. F (85 deg. C) closed cup
Lower Explosion Limit: 7%
Upper Explosion Limit: 73%
Autoignition Temperature: 806 deg. F (430 deg. C)

Flammability Class (OSHA): III A

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, bischloromethyl ether. Formaldehyde reacts with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid to yield explosive compounds. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.

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

Health Hazard Data

Acute Effects of Exposure

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

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

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

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

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

Acute Animal Toxicity:
Oral, rats: LD50=800 mg/kg
Oral, mouse: LD50=42 mg/kg
Inhalation, rats: LCLo=250 mg/kg
Inhalation, mouse: LCLo=900 mg/kg
Inhalation, rats: LC50=590 mg/kg

Chronic Effects of Exposure

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 opthamologist 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% 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 work shift.) In all other situations, use positive pressure respirators such as the positive-pressure air purifying respirator or the self-contained breathing apparatus (SCBA).

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% 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.

APPENDIX B - SAMPLING STRATEGY AND ANALYTICAL METHODS FOR FORMALDEHYDE

To protect the health of employees, exposure measurements must be unbiased and representative of employee exposure. The proper measurement of employee exposure requires more than a token commitment on the part of the employer. OSHA's mandatory requirements establish a baseline; under the best of circumstances all questions regarding employee exposure will be answered. Many employers, however, will wish to conduct more extensive monitoring before undertaking expensive commitments, such as engineering controls, to assure that the modifications are truly necessary. The following sampling strategy, which was developed at NIOSH by Nelson A. Leidel, Kenneth A. Busch, and Jeremiah R. Lynch and described in NIOSH publication No. 77- 173 (Occupational Exposure Sampling Strategy Manual) will assist the employer in developing a strategy for determining the exposure of his or her employees.

There is no one correct way to determine employee exposure. Obviously, measuring the exposure of every employee exposed to formaldehyde will provide the most information on any given day. Where few employees are exposed, this may be a practical solution. For most employers, however, use of the following strategy will give just as much information at less cost.

Exposure data collected on a single day will not automatically guarantee the employer that his or her workplace is always in compliance with the formaldehyde standard. This does not imply, however, that it is impossible for an employer to be sure that his or her worksite is in compliance with the standard. Indeed, a properly designed sampling strategy showing that all employees are exposed below the PELs, at least with a 95 percent certainty, is compelling evidence that the exposure limits are being achieved provided that measurements are conducted using valid sampling strategy and approved analytical methods.

There are two PELs, the TWA concentration and the STEL. Most employers will find that one of these two limits is more critical in the control of their operations, and OSHA expects that the employer will concentrate monitoring efforts on the critical component. If the more difficult exposure is controlled, this information, along with calculations to support the assumptions, should be adequate to show that the other exposure limit is also being achieved.

Sampling Strategy

Determination of the Need for Exposure Measurements

The employer must determine whether employees may be exposed to concentrations in excess of the action level. This determination becomes the first step in an employee exposure monitoring program that minimizes employer sampling burdens while providing adequate employee protection. If employees may be exposed above the action level, the employer must measure exposure. Otherwise, an objective determination that employee exposure is low provides adequate evidence that exposure potential has been examined.

The employer should examine all available relevant information, eg. insurance company and trade association data and information from suppliers or exposure data collected from similar operations. The employer may also use previously-conducted sampling including area monitoring. The employer must make a determination relevant to each operation although this need not be on a separate piece of paper. If the employer can demonstrate conclusively that no employee is exposed above the action level or the STEL through the use of objective data, the employer need proceed no further on employee exposure monitoring until such time that conditions have changed and the determination is no longer valid.

If the employer cannot determine that employee exposure is less than the action level and the STEL, employee exposure monitoring will have to be conducted.

Workplace Material Survey

The primary purpose of a survey of raw material is to determine if formaldehyde is being used in the work environment and if so, the conditions under which formaldehyde is being used.

The first step is to tabulate all situations where formaldehyde is used in a manner such that it may be released into the workplace atmosphere or contaminate the skin. This information should be available through analysis of company records and information on the MSDSs available through provisions of this standard and the Hazard Communication standard.

If there is an indication from materials handling records and accompanying MSDSs that formaldehyde is being used in the following types of processes or work operations, there may be a potential for releasing formaldehyde into the workplace atmosphere:

(1) Any operation that involves grinding, sanding, sawing, cutting, crushing, screening, sieving, or any other manipulation of material that generates formaldehyde-bearing dust

(1) Any processes where there have been employee complaints or symptoms indicative of exposure to formaldehyde

(2) Any liquid or spray process involving formaldehyde

(2) Any process that uses formaldehyde in preserved tissue

(5) Any process that involves the heating of a formaldehyde-bearing resin. Processes and work operations that use formaldehyde in these manners will probably require further investigation at the worksite to determine the extent of employee monitoring that should be conducted.

Workplace Observations

To this point, the only intention has been to provide an indication as to the existence of potentially exposed employees. With this information, a visit to the workplace is needed to observe work operations, to identify potential health hazards, and to determine whether any employees may be exposed to hazardous concentrations of formaldehyde.

In many circumstances, sources of formaldehyde can be identified through the sense of smell. However, this method of detection should be used with caution because of olfactory fatigue.

Employee location in relation to source of formaldehyde is important in determining if an employee may be significantly exposed to formaldehyde. In most instances, the closer a worker is to the source, the higher the probability that a significant exposure will occur.

Other characteristics should be considered. Certain high temperature operations give rise to higher evaporation rates. Locations of open doors and windows provide natural ventilation that tend to dilute formaldehyde emissions. General room ventilation also provides a measure of control.

Calculation of Potential Exposure Concentrations

By knowing the ventilation rate in a workplace and the quantity of formaldehyde generated, the employer may be able to determine by calculation if the PELs might be exceeded. To account for poor mixing of formaldehyde into the entire room, locations of fans and proximity of employees to the work operation, the employer must include a safety factor. If an employee is relatively close to a source, particularly if he or she is located downwind, a safety factor of 100 may be necessary. For other situations, a factor of 10 may be acceptable. If the employer can demonstrate through such calculations that employee exposure does not exceed the action level or the STEL, the employer may use this information as objective data to demonstrate compliance with the standard.

Sampling Strategy

Once the employer determines that there is a possibility of substantial employee exposure to formaldehyde, the employer is obligated to measure employee exposure.

The next step is selection of a maximum risk employee. When there are different processes where employees may be exposed to formaldehyde, a maximum risk employee should be selected for each work operation.

Selection of the maximum risk employee requires professional judgment. The best procedure for selecting the maximum risk employee is to observe employees and select the person closest to the source of formaldehyde. Employee mobility may affect this selection; eg. if the closest employee is mobile in his tasks, he may not be the maximum risk employee. Air movement patterns and differences in work habits will also affect selection of the maximum risk employee.

When many employees perform essentially the same task, a maximum risk employee cannot be selected. In this circumstance, it is necessary to resort to random sampling of the group of workers. The objective is to select a subgroup of adequate size so that there is a high probability that the random sample will contain at least one worker with high exposure if one exists. The number of persons in the group influences the number that need to be sampled to ensure that at least one individual from the highest 10 percent exposure group is contained in the sample. For example, to have 90 percent confidence in the results, if the group size is 10, nine should be sampled; for 50, only 18 need to be sampled.

If measurement shows exposure to formaldehyde at or above the action level or the STEL, the employer needs to identify all other employees who may be exposed at or above the action level or STEL and measure or otherwise accurately characterize the exposure of these employees.

Whether representative monitoring or random sampling are conducted, the purpose remains the same-to determine if the exposure of any employee is above the action level. If the exposure of the most exposed employee is less than the action level and the STEL, regardless of how the employee is identified, then it is reasonable to assume that measurements of exposure of the other employees in that operation would be below the action level and the STEL.

Exposure Measurements

There is no “best” measurement strategy for all situations. Some elements to consider in developing a strategy are:

(1) Availability and cost of sampling equipment
(2) Availability and cost of analytic facilities
(3) Availability and cost of personnel to take samples
(4) Location of employees and work operations
(5) Intraday and interday variations in the process
(1) Precision and accuracy of sampling and analytic methods, and
(7) Number of samples needed.

Samples taken for determining compliance with the STEL differ from those that measure the TWA concentration in important ways. STEL samples are best taken in a nonrandom fashion using all available knowledge relating to the area, the individual, and the process to obtain samples during periods of maximum expected concentrations. At least three measurements on a shift are generally needed to spot gross errors or mistakes; however, only the highest value represents the STEL.

If an operation remains constant throughout the workshift, a much greater number of samples would need to be taken over the 32 discrete nonoverlapping periods in an 8-hour workshift to verify compliance with a STEL. If employee exposure is truly uniform throughout the workshift, however, an employer in compliance with the 0.75 ppm TWA would be in compliance with the 2 ppm STEL, and this determination can probably be made using objective data.

Need to Repeat the Monitoring Strategy

Interday and intraday fluctuations in employee exposure are mostly influenced by the physical processes that generate formaldehyde and the work habits of the employee. Hence, in-plant process variations influence the employer’s determination of whether or not additional controls need to be imposed. Measurements that employee exposure is low on a day that is not representative of worst conditions may not provide sufficient information to determine whether or not additional engineering controls should be installed to achieve the PELs.

The person responsible for conducting sampling must be aware of systematic changes which will negate the validity of the sampling results. Systematic changes in formaldehyde exposure concentration for an employee can occur due to:

(1) The employee changing patterns of movement in the workplace
(1) Closing of plant doors and windows
(2) Changes in ventilation from season to season
(2) Decreases in ventilation efficiency or abrupt failure of engineering control equipment
(5) Changes in the production process or work habits of the employee. Any of these changes, if they may result in additional exposure that reaches the next level of action (i.e. 0.5 or 0.75 ppm as an 8-hr average or 2 ppm over 15 minutes) require the employer to perform additional monitoring to reassess employee exposure.

A number of methods are suitable for measuring employee exposure to formaldehyde or for characterizing emissions within the worksite. The Formaldehyde Institute reports more than 50 methods are known and some have been widely used or subjected to validation testing. Most have limitations or potential interferences. Two detailed analytical methods are presented below for informational purposes.

OSHA Method 52 for acrolein and formaldehyde is the first method. It has some inherent problems with the methodology. The sampling tube, XAD coated with 2- (hydroxymethyl) piperidine, or 2-(HMP), is contaminated with formaldehyde as provided from the supplier. This creates a high background level which has to be properly corrected for with blank subtraction and has a detrimental effect on the detection limit. Breakthrough can occur when other airborne contaminants deplete the 2-(HMP). Other derivatives may have the same retention time as the formaldehyde 2- (HMP).

The second method presented is used by the Michigan Department of Public Health's Occupational Health Laboratory. It utilizes a solid sorbent tube with silica gel impregnated with 20% sodium bisulfite by weight. Samples are desorbed with water and analyzed for formaldehyde colorimetrically using the chromotropic acid procedure developed by NIOSH.

Inclusion of the OSHA and MDPH methods in this appendix does not imply that they are the only acceptable ways to measure employee exposure to formaldehyde. Other methods that are free from significant interferences and that can determine formaldehyde at the permissible exposure limits within + or - 25 percent of the "true" value at the 95 percent confidence level are also acceptable. Where applicable, the method should also be capable of measuring formaldehyde at the action level to + or - 35 percent of the "true" value with a 95 percent confidence level. OSHA encourages employers to choose methods that will be best for their individual needs. The employer must exercise caution, however, in choosing an appropriate method since some techniques suffer from interferences that are likely to be present in workplaces of certain industry sectors where formaldehyde is used.

OSHA's Analytical Laboratory Method

Method No: 52
Matrix: Air
Target Concentration: 1 ppm (1.2 mg/m^3)

Procedures: Air samples are collected by drawing known volumes of air through sampling tubes containing XAD-2 adsorbent which have been coated with 2-(hydroxymethyl) piperidine. The samples are desorbed with toluene and then analyzed by gas chromatography using a nitrogen selective detector.

Recommended Sampling Rate and Air Volumes: 0.1 L/ min and 24 L

Reliable Quantitation Limit: 16 ppb (20 ug/m^3)

Standard Error of Estimate at the Target Concentration: 7.3%

Status of the Method: A sampling and analytical method that has been subjected to the established evaluation procedures of the Organic Methods Evaluation Branch.

Date: March 1985

1. General Discussion

1.1 Background: The current OSHA method for collecting acrolein vapor recommends the use of activated 13X molecular sieves. The samples must be stored in an ice bath during and after sampling and also they must be analyzed within 48 hours of collection. The current OSHA method for collecting formaldehyde vapor recommends the use of bubblers containing 10% methanol in water as the trapping solution.

This work was undertaken to resolve the sample stability problems associated with acrolein and also to eliminate the need to use bubblers to sample formaldehyde. A goal of this work was to develop and/or to evaluate a common sampling and analytical procedure for acrolein and formaldehyde.

NIOSH has developed independent methodologies for acrolein and formaldehyde which recommend the use of reagent-coated adsorbent tubes to collect the aldehydes as stable derivatives. The formaldehyde sampling tubes contain Chromosorb 102 adsorbent coated with N-benzylethanolamine (BEA) which reacts with formaldehyde vapor to form a stable oxazolidine compound. The acrolein sampling tubes contain XAD-2 adsorbent coated with 2-(hydroxymethyl) piperidine (2- HMP) which reacts with acrolein vapor to form a different, stable oxazolidine derivative. Acrolein does not appear to react with BEA to give a suitable reaction product. Therefore, the formaldehyde procedure cannot provide a common method for both aldehydes. However, formaldehyde does react with 2-HMP to form a very suitable reaction product. It is the quantitative reaction of acrolein and formaldehyde with 2- HMP that provides the basis for this evaluation.

This sampling and analytical procedure is very similar to the method recommended by NIOSH for acrolein. Some changes in the NIOSH methodology were necessary to permit the simultaneous determination of both aldehydes and also to accommodate OSHA laboratory equipment and analytical techniques.

1.2 Limit-defining parameters: The analyte air concentrations reported in this method are based on the recommended air volume for each analyte collected separately and a desorption volume of 1 mL. The amounts are presented as acrolein and/or formaldehyde, even though the derivatives are the actual species analyzed.

1.2.1 Detection limits of the analytical procedure: The detection limit of the analytical procedure was 386 pg per injection for formaldehyde. This was the amount of analyte which gave a peak whose height was about five times the height of the peak given by the residual formaldehyde derivative in a typical blank front section of the recommended sampling tube.

1.2.2 Detection limits of the overall procedure: The detection limits of the overall procedure were 482 ng per sample (16 ppb or 20 ug/m^3 for formaldehyde). This was the amount of analyte spiked on the sampling device which allowed recoveries approximately equal to the detection limit of the analytical procedure.

1.2.3 Reliable quantitation limits: The reliable quantitation limit was 482 ng per sample (16 ppb or 20 ug/ m^3) for formaldehyde. These were the smallest amounts of analyte which could be quantitated within the limits of a recovery of at least 75% and a precision ((+ or -)(1.96 SD) of + or - 25% or better.

The reliable quantitation limit and detection limits reported in the method are based upon optimization of the instrument for the smallest possible amount of analyte. When the target concentration of an exceptionally higher than these limits, they may not be attainable at the routine operating parameters.

1.2.4 Sensitivity: The sensitivity of the analytical procedure over concentration ranges representing 0.4 to 2 times the target concentration, based on the recommended air volumes, was 7,589 area units per ug/mL for formaldehyde. This value was determined from the slope of the calibration curve. The sensitivity may vary with the particular instrument used in the analysis.

1.2.5 Recovery: The recovery of formaldehyde from samples used in an 18-day storage test remained above 92% when the samples were stored at ambient temperature. These values were determined from regression lines which were calculated from the storage data. The recovery of the analyte from the collection device must be at least 75% following storage.

1.2.6 Precision (analytical method only): The pooled coefficient of variation obtained from replicate determinations of analytical standards over the range of 0.4 to 2 times the target concentration was 0.0052 for formaldehyde (Section 4.3).

1.2.7 Precision (overall procedure): The precision at the 95% confidence level for the ambient temperature storage tests was (+ or -) 14.3% for formaldehyde. These values each include an additional (+ or -) 5% for sampling error. The overall procedure must provide results at the target concentrations that are (+ or -) 25% at the 95% confidence level.

1.2.8 Reproducibility: Samples collected from controlled test atmospheres and a draft copy of this procedure were given to a chemist unassociated with this evaluation. The formaldehyde samples were analyzed following 15 days storage. The average recovery was 96.3% and the standard deviation was 1.7%.

1.3 Advantages:

1.3.1 The sampling and analytical procedures permit the simultaneous determination of acrolein and formaldehyde.

1.3.2 Samples re stable following storage at ambient temperature for at least 18 days.

1.4 Disadvantages: None.

2. Sampling Procedure

2.1 Apparatus:

2.1.1 Samples are collected by use of a personal sampling pump that can be calibrated to within (+ or -) 5% of the recommended 0.1 L/min sampling rate with the sampling tube in line.

2.1.2 Samples are collected with laboratory prepared sampling tubes. The sampling tube is constructed of silane treated glass and is about 8-cm long. The ID is 4 mm and the OD is 6 mm. One end of the tube is tapered so that a glass wool end plug will hold the contents of the tube in place during sampling. The other end of the sampling tube is open to its full 4-mm ID to facilitate packing of the tube. Both ends of the tube are fire-polished for safety. The tube is packed with a 75- mg backup section, located nearest the tapered end and a 150-mg sampling section of pretreated XAD-2 adsorbent which has been coated with 2-HMP. The two sections of coated adsorbent are separated and retained with small plugs of silanized glass wool. Following packing, the sampling tubes are sealed with two 7/32 inch OD plastic end caps. Instructions for the pretreatment and the coating of XAD-2 adsorbent are presented in Section 4 of this method.

2.1.3 Sampling tubes, similar to those recommended in this method, are marketed by Supelco, Inc. These tubes were not available when this work was initiated; therefore, they were not evaluated.

2.2 Reagents: None required.

2.3 Technique:

2.3.1 Properly label the sampling tube before sampling and then remove the plastic end caps.

2.3.2 Attach the sampling tube to the pump using a section of flexible plastic tubing such that the large, front section of the sampling tube is exposed directly to the atmosphere. Do not place any tubing ahead of the sampling tube. The sampling tube should be attached in the worker's breathing zone in a vertical manner such that it does not impede work performance.

2.3.3 After sampling for the appropriate time, remove the sampling tube from the pump and then seal the tube with plastic end caps.

2.3.4 Include at least one blank for each sampling set. The blank should be handled in the same manner as the samples with the exception that air is not drawn through it.

2.3.5 List any potential interferences on the sample data sheet.

2.4 Breakthrough:

2.4.1 Breakthrough was defined as the relative amount of analyte found on a backup sample in relation to the total amount of analyte collected on the sampling train.

2.4.2 For formaldehyde collected from test atmospheres containing 6 times the PEL, the average 5% breakthrough air volume was 41 L. The sampling rate was 0.1 L/min and the average mass of formaldehyde collected was 250 µg.

2.5 Desorption Efficiency: No desorption efficiency corrections are necessary to compute air sample results because analytical standards are prepared using coated adsorbent. Desorption efficiencies were determined, however, to investigate the recoveries of the analytes from the sampling device. The average recovery over the range of 0.4 to 2 times the target concentration, based on the recommended air volumes, was 96.2% for formaldehyde. Desorption efficiencies were essentially constant over the ranges studied.

2.6 Recommended Air Volume and Sampling Rate:

2.6.1. The recommended air volume for formaldehyde is 24 L.

2.6.2. The recommended sampling rate is 0.1 L/min.

2.7 Interferences:

2.7.1 Any collected substance that is capable of reacting 2-HMP and thereby depleting the derivatizing agent is a potential interference. Chemicals which contain a carbonyl group, such as acetone, may be capable or reacting with 2-HMP.

2.7.2 There are no other known interferences to the sampling method.

2.8 Safety Precautions:

2.8.1 Attach the sampling equipment to the worker in such a manner that it well not interfere with work performance or safety.

2.8.2 Follow all safety practices that apply to the work area being sampled.

3. Analytical Procedure

3.1 Apparatus:

3.1.1 A gas chromatograph (GC), equipped with a nitrogen selective detector. A Hewlett-Packard Model 5840A GC fitted with a nitrogen-phosphorus flame ionization detector (NPD) was used for this evaluation. Injections were performed using a Hewlett- Packard Model 7671A automatic sampler.

3.1.2 A GC column capable of resolving the analytes from any interference. A 6 ft x 1/4 in OD (2mm ID) glass GC column containing 10% UCON 50-HB-5100 + 2% KOH on 80/1 00 mesh Chromosorb W-AW was used for the evaluation. Injections were performed on-column.

3.1.3 Vials, glass 2-mL with Teflon-lined caps.

3.1.4 Volumetric flasks, pipets, and syringes for preparing standards, making dilutions, and performing injections.

3.2 Reagents:

3.2.1 Toluene and dimethylformamide. Burdick and Jackson solvents were used in this evaluation.

3.2.2 Helium, hydrogen, and air, GC grade.

3.2.3 Formaldehyde, 37%, by weight, in water. Aldrich Chemical, ACS Reagent Grade formaldehyde was used in this evaluation.

3.2.4 Amberlite XAD-2 adsorbent coated with 2- (hydroxymethyl-piperidine (2-HMP), 10% by weight (Section 4).

3.2.5 Desorbing solution with internal standard. This solution was prepared by adding 20 uL of dimethylformamide to 100 mL of toluene.

3.3 Standard preparation:

3.3.1 Formaldehyde: Prepare stock standards by diluting known volumes of 37% formaldehyde solution with methanol. A procedure to determine the formaldehyde content of these standards is presented in Section 4. A standard containing 7.7 mg/mL formaldehyde was prepared by diluting 1 mL of the 37% reagent to 50 mL with methanol.

3.3.2 It is recommended that analytical standards be prepared about 16 hours before the air samples are to be analyzed in order to ensure the complete reaction of the analytes with 2-HMP. However, rate studies have shown the reaction to be greater than 95% complete after 4 hours. Therefore, one or two standards can be analyzed after this reduced time if sample results are outside the concentration range of the prepared standards.

3.3.3 Place 150-mg portions of coated XAD-2 adsorbent, from the same lot number as used to collect the air samples, into each of several glass 2-mL vials. Seal each vial with a Teflon-lined cap.

3.3.4 Prepare fresh analytical standards each day by injecting appropriate amounts of the diluted analyte directly onto 150-mg portions of coated adsorbent. It is permissible to inject both acrolein and formaldehyde on the same adsorbent portion. Allow the standards to stand at room temperature. A standard, approximately the target levels, was prepared by injecting 11 uL of the acrolein and 12 uL of the formaldehyde stock standards onto a single coated XAD-2 adsorbent portion.

3.3.5 Prepare a sufficient number of standards to generate the calibration curves. Analytical standard concentrations should bracket sample concentrations. Thus, if samples are not in the concentration range of the prepared standards, additional standards must be prepared to determine detector response.

3.3.7 Desorb the standards in the same manner as the samples following the 16-hour reaction time.

3.4 Sample preparation:

3.4.1 Transfer the 150-mg section of the sampling tube to a 2-mL vial. Place the 75-mg section in a separate vial. If the glass wool plugs contain a significant number of adsorbent beads, place them with the appropriate sampling tube section. Discard the glass wool plugs if they do not contain a significant number of adsorbent beads.

3.4.2 Add 1 mL of desorbing solution to each vial.

3.4.3 Seal the vials with Teflon-lined caps and then allow them to desorb for one hour. Shake the vials by hand with vigorous force several times during the desorption time.

3.4.4 Save the used sampling tubes to be cleaned and recycled.

3.5 Analysis:

3.5.1 GC Conditions

Column Temperature:

Bi-level temperature program - First level: 100 to 140 deg. C at 4 deg. C/min following completion of the first level.

Second level: 140 to 180 deg. C at 20 deg. C/min following completion of the first level.

Isothermal period: Hold column at 180 deg. C until the recorder pen returns to baseline (usually about 25 min after injection).

Injector temperature: 180 deg. C

Helium flow rate: 30 mL/min (detector response will be reduced if nitrogen is substituted for helium carrier gas).

Injection volume: 0.8 uL

GC column: Six-ft x 1/4 -in OD (2 mm ID) glass GC column containing 10% UCON 50-HB-5100+2% KOH on 80/1 00 Chromosorb W-AW.

NPD conditions:

Hydrogen flow rate: 3 mL/min

Air flow rate: 50 mL/min

Detector temperature: 275 deg. C

3.5.2 Chromatogram: For an example of a typical chromatogram, see Figure 4.11 in OSHA Method 52.

3.5.3 Use a suitable method, such as electronic integration, to measure detector response.

3.5.4 Use an internal standard method to prepare the calibration curve with several standard solutions of different concentrations. Prepare the calibration curve daily. Program the integrator to report results in ug/mL.

3.5.5 Bracket sample concentrations with standards.

3.6 Interferences (Analytical)

3.6.1 Any compound with the same general retention time as the analytes and which also gives a detector response is a potential interference. Possible interferences should be reported to the laboratory with submitted samples by the industrial hygienist.

3.6.2 GC parameters (temperature, column, etc.) may be changed to circumvent interferences.

3.6.3 A useful means of structure designation is GC/MS. It is recommended this procedure be used to confirm samples whenever possible.

3.6.4 The coated adsorbent usually contains a very small amount of residual formaldehyde derivative (Section 4.8).

3.7 Calculations:

3.7.1 Results are obtained by use of calibration curves. Calibration curves are prepared by plotting detector response against concentration for each standard. The best line through the data points is determined by curve fitting.

3.7.2 The concentration, in ug/mL, for a particular sample is determined by comparing its detector response to the calibration curve. If either of the analytes is found on the backup section, it is added to the amount found on the front section. Blank corrections should be performed before adding the results together.

3.7.3 The acrolein and/or formaldehyde air concentration can be expressed using the following equation:

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$$mg/m3=(A)(B)/C$$

where A=ug/mL from 3.7.2,
B=desorption volume,
and C=L of air sampled

No desorption efficiency corrections are required.

3.7.4 The following equation can be used to convert results in mg/m^3 to ppm.

$ppm=(m\ g/m^3)(24\ .45)/MW$ where mg/m^3=result from 3.7.3, 24.45=molar volume of an ideal gas at 760 mm Hg and 25 deg. C, MW=molecular weight (30.0).

4. Backup Data

4.1 Backup data on detection limits, reliable quantitation limits, sensitivity and precision of the analytical method, breakthrough, desorption efficiency, storage, reproducibility, and generation of test atmospheres are available in OSHA Method 52, developed by the Organics Methods Evaluation Branch, OSHA Analytical Laboratory, Salt Lake City, Utah.

4.2 Procedure to Coat XAD-2 Adsorbent with 2-HMP:

4.2.1 Apparatus: Soxhlet extraction apparatus, rotary evaporation apparatus, vacuum dessicator, 1-L vacuum flask, 1-L round- bottomed evaporative flask, 1-L Erlenmeyer flask, 250-mL Buchner funnel with a coarse fritted disc, etc.

4.2.2 Reagents:

4.2.2.1 Methanol, isooctane, and toluene.

4.2.2.2 2-(Hydroxymethyl) piperidine.

4.2.2.3 Amberlite XAD-2 non-ionic polymeric adsorbent, 20 to 60 mesh, Aldrich Chemical XAD-2 was used in this evaluation.

4.2.3 Procedure: Weigh 125 g of crude XAD-2 adsorbent into a 1-L Erlenmeyer flask. Add about 200 mL of water to the flask and then swirl the mixture to wash the adsorbent. Discard any adsorbent that floats to the top of the water and then filter the mixture using a fritted Buchner funnel. Air dry the adsorbent for 2 minutes. Transfer the adsorbent back to the Erlenmeyer flask and then add about 200 mL of methanol to the flask. Swirl and then filter the mixture as before. Transfer the washed adsorbent back to the Erlenmeyer flask and then add about 200 mL of methanol to the flask. Swirl and then filter the mixture as before. Transfer the washed adsorbent to a 1-L round-bottomed evaporative flask, add 13 g of 2-HMP and then 200 mL of methanol, swirl the mixture and then allow it to stand for one hour. Remove the methanol at about 40 deg. C and reduced pressure using a rotary evaporation apparatus. Transfer the coated adsorbent to a suitable container and store it in a vacuum desiccator at room temperature overnight. Transfer the coated adsorbent to a Soxhlet extractor and then extract the material with toluene for about 24 hours. Discard the contaminated toluene, add methanol in its place and then continue the Soxhlet extraction for an additional 4 hours. Transfer the adsorbent to a weighted 1- L round-bottom evaporative flask and remove the methanol using the rotary evaporation apparatus. Determine the weight of the adsorbent and then add an amount of 2-HMP, which is 10% by weight of the adsorbent. Add 200 mL of methanol and then swirl the mixture. Allow the mixture to stand for one hour. Remove the methanol by rotary evaporation. Transfer the coated adsorbent to a suitable container and store it in a vacuum desiccator until all traces of solvents are gone. Typically, this will take 2-3 days. The coated adsorbent should be protected from contamination. XAD- 2 adsorbent treated in this manner will probably not contain residual acrolein derivative. However, this adsorbent will often contain residual formaldehyde derivative levels of about 0.1 µg per 150 mg of adsorbent. If the blank values for a batch of coated adsorbent are too high, then the batch should be returned to the Soxhlet extractor, extracted with toluene again and then recoated. This process can be repeated until the desired blank levels are attained.

The coated adsorbent is now ready to be packed into sampling tubes. The sampling tubes should be stored in a sealed container to prevent contamination. Sampling tubes should be stored in the dark at room temperature. The sampling tubes should be segregated by coated adsorbent lot number. A sufficient amount of each lot number of coated adsorbent should be retained to prepare analytical standards for use with air samples from that lot number.

4.3 A Procedure to Determine Formaldehyde by Acid Titration: Standardize the 0.1 N HCl solution using sodium carbonate and methyl orange indicator.

Place 50 mL of 0.1 M sodium sulfite and three drops of thymophthalein indicator into a 250-mL Erlenmeyer flask. Titrate the contents of the flask to a colorless endpoint with 0.1 N HCl (usually one or two drops is sufficient). Transfer 10 mL of the formaldehyde/methanol solution (prepared in 3.3.1) into the same flask and titrate the mixture with 0.1 N HCl, again, to a colorless endpoint. The formaldehyde concentration of the standard may be calculated by the following equation:

$$\text{Formaldehyde, mg/mL} = \frac{\text{acid titer X acid normality X 30.0}}{\text{mL of sample}}$$

This method is based on the quantitative liberation of sodium hydroxide when formaldehyde reacts with sodium sulfite to form the formaldehyde-bisulfite addition product. The volume of sample may be varied depending on the formaldehyde content but the solution to be titrated must contain excess sodium sulfite. Formaldehyde solutions containing substantial amounts of acid or base must be neutralized before analysis.

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1. Scope and Application

1.1 This method is suitable for the analysis of air samples for formaldehyde. The normal operating range is from 0.07 to 0.68 ppm for a 30 liter air sample.

Compound	CAS No.	IMIS HSC No.
Formaldehyde	50-00-0	1290

2. Summary of Method

2.1 Collect an air sample using a silica gel tube coated with 20% sodium bisulfite (see Reference 12.1). Desorb the formaldehyde with R.O. water. Formaldehyde reacts with chromotropic acid-sulfuric acid solution to form a purple color. Quantitate samples against standards at 580 nm, on an UV-visible spectrophotometer.

3. Sample Collection, Handling and Preservation

3.1 Collect the sample using a silica gel tube coated with 20% sodium bisulfite (SKC-ORBO-53 or equivalent). Attach the tube to a personal air sampling pump which has been calibrated with a representative sampler in line. Collect the sample at an accurately known flow rate of 0.2 L/min for 150 minutes. Record the volume of air sampled.

3.2 Submit the sample to the Technical Supporting Services (TSS) as soon as possible by conventional means of transmittal.

3.3 Analyze samples within two weeks.

4. Interferences or Biases

4.1 Phenols, in eight-fold excess over formaldehyde, produce a 10 to 20% negative bias.

4.2 Ethanol and higher molecular weight alcohols, olefins, and aromatic hydrocarbons in mixtures with formaldehyde produce negative interferences. Cyclohexanone causes bleaching of the final color.

4.3 Other aldehydes produce little interference.

5. Laboratory Equipment and Supplies

5.1 Mixing graduated cylinder, 25 ml.

5.2 Round cuvettes optically matched, 12x75 mm (Coleman C006308A or disposable equivalent).

5.3 UV-visible spectrophotometer (Coleman 295 or equivalent).

5.4 Programmable calculator (Hewlett – Packard 1 1C or IBM PC)

5.5 Thermolyne 16700 Mixer.

6. Reagents

6.1 Water, reverse osmosis (RO) or equivalent.

6.2 Chromotropic acid, 1%: Dissolve 0.1g of 4,5-dihydroxy- 2,7-napthalenedisulfonic acid disodium salt in 10 mL RO water.Filter if necessary and store in a brown bottle. Make up fresh weekly.

6.3 Concentrated sulfuric acid.

6.4 Formaldehyde stock solution "A" (1mg/mL):

Dissolve 0.4470g of sodium formaldehyde bisulfite in RO water and dilute to 100 mL.

6.5 Formaldehyde working standard "B" (10tg/mL): Dilute 1 mL of stock solution "A" to 100 mL with RO water. Make up fresh daily.

7. Analytical Procedure

7.1 Transfer the front section of the silica gel tube to a 25 mL mixing graduated cylinder labeled with DOH sample number. Transfer the back section of the silica gel tube to separate 25 mL mixing graduated cylinder also labeled with DOH sample number.

7.2 Add 10 mL RO water to each graduated cylinder, mix, and allow to desorb for approximately ten minutes.

7.3 Pipette 4 mL aliquots from the graduated cylinder representing the front section of the silica gel tube to a separate 25 mL graduated cylinder. Repeat this process for the graduated cylinder representing the back section of the silica gel tube.

7.4 Add 100 tL of the 1% chromotropic acid to each of the graduated cylinders and mix.

7.5 To the solution SLOWLY add 6 mL of concentrated sulfuric acid. The solution becomes extremely hot during the addition of the sulfuric acid.

7.6 Stopper the graduated cylinder. Using the Thermolyne mixer, mix the sulfuric acid thoroughly until there is a homogenous solution.

7.7 Allow the solution to cool and read within ten minutes at 580 nm on an UV-visible spectrophotometer.

8. Calibration

8.1 Prepare a set of standards by diluting 0, 0.1, 0.3, 0.5, 0.7, and 1.0 mL of working standard "B" to 4 mL with RO water in labeled 25 mL graduated cylinders. Concentrations will be 0, 1.0, 3.0, 5.0, 7.0 and 10.0 tg formaldehyde per graduate.

8.2 Prepare two independent calibration checks by pipetting 1.0 mL of the working standard into a 25 mL graduate and diluting to 4 mL with RO water. The concentration will be 10.0 tg per graduate.

8.3 Add 100 tL of 1% chromotropic acid to each of the standards and mix.

8.4 To the solution SLOWLY add 6 mL of concentrated sulfuric acid. The solution becomes extremely hot during the addition of the sulfuric acid.

8.5 Stopper the graduated cylinder. Using the Thermolyne mixer, mix the sulfuric acid thoroughly until there is a homogenous solution.

8.6 Allow the solution to cool and read at 580 nm on an UV-visible spectrophotometer.

8.7 Determine the best fit for the calibration points using a programmable calculator. Use either a linear regression fit ($y=a+bx$) or power curve fit $y=ax^b$ ($a>0$) depending on the better fit based upon the coefficient of determination(r^2=1 .0000).

9. Quality Control

9.1 Check system audits with each analytical batch. QC audits which should be checked and in-control include:

9.1.1 the absorbance of the 0 tg/mL standard

9.1.2 the "a" and "b" values of the calibration curve,

9.1.3 and the coefficient of determination of the calibration curve.

9.2 Check calibration and precision with each analytical batch by analyzing a non-calibration standard in duplicate.

9.2.1 Use the average percent recovery as an audit for accuracy.

9.2.2 Use the range (difference) of the results as an audit for precision.

9.3 Establish statistical control limits when ten or more sets of data are available. Use appropriate arbitrary control limits prior to an adequate data base of actual results.

9.4 Use Lotus 1-2-3 or similar software program to compile QC data and develop QC charts.

5. Calculations

10.1 Enter the tg of formaldehyde present determined from the calibration curve into the following equation:

mg HCHO/m^3 = (S-B) tg/V x 1000 Liters/m^3 x mg/
1000tg = (S-B) / V

where: S = tg HCHO in sample
B = tg HCHO in the blank submitted from the field
V = volume of air sampled in liters

10.1.1 To convert mg/m^3 to ppm use the following equation:

ppm = mg/m^3 x 24.45/30.03 x 760/P x (T+ 273)/298
= mg/m^3 x 0.8142 (@ NTP)
where: P = pressure in (mm Hg) of air sampled
T = temperature (°C) of air sampled
24.45 = molar volume (liters/mole) at 25 C and 760 mm Hg
30.03 = molecular weight of HCHO
760 = normal pressure (mm Hg)
298 = normal temperature (°K)

10.2 To calculate the detection limit for a sample, enter the lowest standard value that has a significant absorbance, probably 1.0 tg, in the above equation (10.1). Round and report as one significant digit.

10.3 If the blank field sample is acceptably low, report as ND<0.001mg. Subtract a significant blank from the positive results and/or inform the field industrial hygienist of possible contamination.

11. Validation Data

11.1 Detection: Seven separate standards containing 0.1 mL of 10 tg/mL HCHO working standard (1.0 tg HCHO) had an average concentration of 1.0803 tg with a standard deviation of 0.05 tg. This equates to a theoretical detection limit of 0.16 tg at 99% confidence level. Use 1.0 tg as the reported detection limit.

11.2 Precision: Four standards containing 0.4 mL and four standards containing 1.5 mL of 10 tg/mL HCHO working standard (4.0 tg and 15.0 tg HCHO, respectively) had average concentrations of 4.23 and 14.74 tg with standard deviations of 0.08 (RSD = 1.9%) and 0.02 tg (RSD = 0.14%), respectively.

11.3 Accuracy: Four standards containing 0.4 mL and four standards containing 1.5 mL of 10 tg/mL HCHO (4.0 tg and 15.0 tg HCHO respectively) had average concentrations of 4.23 and 14.74 tg for recoveries of 106% and 98.3% respectively.

12. References

12.1 Gaertner, Reimar R.W., "Solid Sorbent Media for Collection of Formaldehyde in Air," Applied Industrial Hygiene, Vol. 3, No. 9, September 1988, pp 258-262.

12.2 "Formaldehyde," Manual of Analytical Methods, National Institute for Occupational Safety and Health, Third Edition, Method 3500, issued 5/15/89.

12.3 "Formaldehyde," Chemical Information Manual, Occupational Safety and Health Administration, OSHA Instructor CPL2-2.43 Oct.20,1987 Chapter II, pp. 158- 159.

12.4 "Determination of Formaldehyde Content of the Atmosphere," Methods of Air Sampling and Analysis, Third Edition, 1989, pp. 274-278.

13. Approval

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13.4 Date as revised	May 1993

APPENDIX C - MEDICAL SURVEILLANCE – FORMALDEHYDE

I. Health Hazards

The occupational health hazards of formaldehyde are primarily due to its toxic effects after inhalation, after direct contact with the skin or eyes by formaldehyde in liquid or vapor form, and after ingestion.

II. Toxicology

A. Acute Effects of Exposure

1. Inhalation (breathing): Formaldehyde is highly irritating to the upper airways. The concentration of formaldehyde that is immediately dangerous to life and health is 100 ppm. Concentrations above 50 ppm can cause severe pulmonary reactions within minutes. These include pulmonary edema, pneumonia, and bronchial irritation which can result in death. Concentrations above 5 ppm readily cause lower airway irritation characterized by cough, chest tightness and wheezing. There is some controversy regarding whether formaldehyde gas is a pulmonary sensitizer which can cause occupational asthma in a previously normal individual. Formaldehyde can produce symptoms of bronchial asthma in humans. The mechanism may be either sensitization of the individual by exposure to formaldehyde or direct irritation by formaldehyde in persons with pre-existing asthma. Upper airway irritation is the most common respiratory effect reported by workers and can occur over a wide range of concentrations, most frequently above 1 ppm. However, airway irritation has occurred in some workers with exposures to formaldehyde as low as 0.1 ppm. Symptoms of upper airway irritation include dry or sore throat, itching and burning sensations of the nose, and nasal congestion. Tolerance to this level of exposure may develop within 1-2 hours. This tolerance can permit workers remaining in an environment of gradually increasing formaldehyde concentrations to be unaware of their increasingly hazardous exposure.

1. Eye contact: Concentrations of formaldehyde between 0.05 ppm and 0.5 ppm produce a sensation of irritation in the eyes with burning, itching, redness, and tearing. Increased rate of blinking and eye closure generally protects the eye from damage at these low levels, but these protective mechanisms may interfere with some workers' work abilities. Tolerance can occur in workers continuously exposed to concentrations of formaldehyde in this range. Accidental splash injuries of human eyes to aqueous solutions of formaldehyde (formalin) have resulted in a wide range of ocular injuries including corneal opacities and blindness. The severity of the reactions have been directly dependent on the concentration of formaldehyde in solution and the amount of time lapsed before emergency and medical intervention.

2. Skin contact: Exposure to formaldehyde solutions can cause irritation of the skin and allergic contact dermatitis. These skin diseases and disorders can occur at levels well below those encountered by many formaldehyde workers. Symptoms include erythema, edema, and vesiculation or hives. Exposure to liquid formalin or formaldehyde vapor can provoke skin reactions in sensitized individuals even when airborne concentrations of formaldehyde are well below 1 ppm.

1. Ingestion: Ingestion of as little as 30 ml of a 37 percent solution of formaldehyde (formalin) can result in death. Gastrointestinal toxicity after ingestion is most severe in the stomach and results in symptoms which can include nausea, vomiting, and severe abdominal pain. Diverse damage to other organ systems including the liver, kidney, spleen, pancreas, brain, and central nervous systems can occur from the acute response to ingestion of formaldehyde.

B. Chronic Effects of Exposure

Long-term exposure to formaldehyde has been shown to be associated with an increased risk of cancer of the nose and accessory sinuses, nasopharyngeal and oropharyngeal cancer, and lung cancer in humans. Animal experiments provide conclusive evidence of a causal relationship between nasal cancer in rats and formaldehyde exposure. Concordant evidence of carcinogenicity includes DNA binding, genotoxicity in short-term tests, and cytotoxic changes in the cells of the target organ suggesting both preneoplastic changes and a dose-rate effect. Formaldehyde is a complete carcinogen and appears to exert an effect on at least two stages of the carcinogenic process.

III. Surveillance considerations

A. History

1. Medical and occupational history: Along with its acute irritative effects, formaldehyde can cause allergic sensitization and cancer. One of the goals of the work history should be to elicit information on any prior or additional exposure to formaldehyde in either the occupational or the non-occupational setting.

2. Respiratory history: As noted above, formaldehyde has recognized properties as an airway irritant and has been reported by some authors as a cause of occupational asthma. In addition, formaldehyde has been associated with cancer of the entire respiratory system of humans. For these reasons, it is appropriate to include a comprehensive review of the respiratory system in the medical history. Components of this history might include questions regarding dyspnea on exertion, shortness of breath, chronic airway complaints,

hyperreactive airway disease, rhinitis, bronchitis, bronchiolitis, asthma, emphysema, respiratory allergic reaction, or other preexisting pulmonary disease.

In addition, generalized airway hypersensitivity can result from exposures to a single sensitizing agent. The examiner should, therefore, elicit any prior history of exposure to pulmonary irritants, and any short- or long-term effects of that exposure.

Smoking is known to decrease mucociliary clearance of materials deposited during respiration in the nose and upper airways. This may increase a worker's exposure to inhaled materials such as formaldehyde vapor. In addition, smoking is a potential confounding factor in the investigation of any chronic respiratory disease, including cancer. For these reasons, a complete smoking history should be obtained.

3. Skin Disorders: Because of the dermal irritant and sensitizing effects of formaldehyde, a history of skin disorders should be obtained. Such a history might include the existence of skin irritation, previously documented skin sensitivity, and other dermatologic disorders. Previous exposure to formaldehyde and other dermal sensitizers should be recorded.

3. History of atopic or allergic diseases: Since formaldehyde can cause allergic sensitization of the skin and airways, it might be useful to identify individuals with prior allergen sensitization. A history of atopic disease and allergies to formaldehyde or any other substances should also be obtained. It is not definitely known at this time whether atopic diseases and allergies to formaldehyde or any other substances should also be obtained. Also it is not definitely known at this time whether atopic individuals have a greater propensity to develop formaldehyde sensitivity than the general population, but identification of these individuals may be useful for ongoing surveillance.

5. Use of disease questionnaires: Comparison of the results from previous years with present results provides the best method for detecting a general deterioration in health when toxic signs and symptoms are measured subjectively. In this way recall bias does not affect the results of the analysis. Consequently, OSHA has determined that the findings of the medical and work histories should be kept in a standardized form for comparison of the year-to-year results.

B. Physical Examination

1. Mucosa of eyes and airways: Because of the irritant effects of formaldehyde, the examining physician should be alert to evidence of this irritation. A speculum examination of the nasal mucosa may be helpful in assessing possible irritation and cytotoxic changes, as may be indirect inspection of the posterior pharynx by mirror.

1. Pulmonary system: A conventional respiratory examination, including inspection of the thorax and auscultation and percussion of the lung fields should be performed as part of the periodic medical examination. Although routine pulmonary function testing is only required by the standard once every year for persons who are exposed over the TWA concentration limit, these tests have an obvious value in investigating possible respiratory dysfunction and should be used wherever deemed appropriate by the physician. In cases of alleged formaldehyde-induced airway disease, other possible causes of pulmonary disfunction (including exposures to other substances) should be ruled out. A chest radiograph may be useful in these circumstances. In cases of suspected airway hypersensitivity or allergy, it may be appropriate to use bronchial challenge testing with formaldehyde or methacholine to determine the nature of the disorder. Such testing should be performed by or under the supervision of a physician experienced in the procedures involved.

3. Skin: The physician should be alert to evidence of dermal irritation of sensitization, including reddening and inflammation, urticaria, blistering, scaling, formation of skin fissures, or other symptoms. Since the integrity of the skin barrier is compromised by other dermal diseases, the presence of such disease should be noted. Skin sensitivity testing carries with it some risk of inducing sensitivity, and therefore, skin testing for formaldehyde sensitivity should not be used as a routine screening test. Sensitivity testing may be indicated in the investigation of a suspected existing sensitivity. Guidelines for such testing have been prepared by the North American Contact Dermatitis Group.

C. Additional Examinations or Tests

The physician may deem it necessary to perform other medical examinations or tests as indicated. The standard provides a mechanism whereby these additional investigations are covered under the standard for occupational exposure to formaldehyde.

D. Emergencies

The examination of workers exposed in an emergency should be directed at the organ systems most likely to be affected. Much of he content of the examination will be similar to the periodic examination unless the patient has received a severe acute exposure requiring immediate attention to prevent serious consequences. If a severe overexposure requiring medical intervention or hospitalization has occurred, the physician must be alert to the possibility of delayed symptoms. Follow-up nonroutine examinations may be necessary to assure the patient's well-being.

E. Employer Obligations

The employer is required to provide the physician with the following information: A copy of this standard and appendices A, C, D, and E; a description of the affected employee's duties as they relate to his or her exposure concentration; an estimate of the employee's exposure including duration (e.g. 15 hr/wk, three 8-hour shifts, fulltime); a description of any personal protective equipment, including respirators, used by the employee; and the results of any previous medical determinations for the affected employee related to formaldehyde exposure to the extent that this information is within the employer's control.

F. Physician's Obligations

The standard requires the employer to obtain a written statement from the physician. This statement must contain the physician's opinion as to whether the employee has any medical condition which would place him or her at increased risk of impaired health from exposure to formaldehyde or use of respirators, as appropriate. The physician must also state his opinion regarding any restrictions that should be placed on the employee's exposure to formaldehyde or upon the use of protective clothing or equipment such as respirators. If the employee wears a respirator as a result of his or her exposure to formaldehyde, the physician's opinion must also contain a statement regarding the suitability of the employee to wear the type of respirator assigned. Finally, the physician must inform the employer that the employee has been told the results of the medical examination and of any medical conditions which require further explanation or treatment. This written opinion is not to contain any information on specific findings or diagnoses unrelated to occupational exposure to formaldehyde.

The purpose in requiring the examining physician to supply the employer with a written opinion is to provide the employer with a medical basis to assist the employer in placing employees initially, in assuring that their health is not being impaired by formaldehyde, and to assess the employee's ability to use any required protective equipment