

NIOSH

CRITERIA FOR A
RECOMMENDED STANDARD.....

OCCUPATIONAL
EXPOSURE TO

FURFURYL ALCOHOL

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health



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March 1979

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DHEW (NIOSH) Publication No. 79-133

PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and provide for the safety of workers occupationally exposed to an ever-increasing number of potential hazards. The National Institute for Occupational Safety and Health (NIOSH) evaluates all available research data, establishes criteria, and recommends standards for occupational exposure. The Secretary of Labor will weigh these recommendations along with other considerations, such as feasibility and means of implementation, in promulgating regulatory standards.

After reviewing data and consulting with others, NIOSH formalized a system for the development of criteria on which standards can be established to protect the health and to provide for the safety of workers. The criteria and recommended standard should enable management and labor to develop better engineering controls and more healthful work environments, and simple compliance with the recommended standard should not be the final goal.

NIOSH will periodically review the recommended standards to ensure continuing protection of workers and will make successive reports as new information becomes available.

The contributions to this document on furfuryl alcohol by NIOSH staff, other Federal agencies or departments, the review consultants, the reviewers selected by the Society of Toxicology, and Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, are gratefully acknowledged.

The views expressed and conclusions reached in this document, together with the recommendations for a standard, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or Federal agencies. However, all comments, whether or not incorporated, have been sent with the criteria document to the Occupational Safety and Health Administration (OSHA) for its consideration in setting the standard. The review consultants and the Federal agencies that received the document for review appear on pages vi and vii.



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SYNOPSIS

This report reviews available scientific and technical information on furfuryl alcohol and recommends a standard for the control of furfuryl alcohol hazards in the workplace. The acute hazards include eye, skin, and upper respiratory irritation from direct contact and depression of the central nervous system from inhalation or percutaneous absorption. Evidence of a chronic effect is not available. Other hazards associated with the compound include combustibility and violent reactivity when mixed with acids.

About 9,000 workers are potentially exposed to furfuryl alcohol in the United States, and about 100 million pounds are produced and used each year. Its main use is in the synthesis of furan resins, which are used in such operations as the binding of foundry core sand.

In the absence of data indicating that the existing permissible limit is not protective, the standard proposed to the US Department of Labor contains recommendations for continuation of the present Federal limit of 200 mg/cu m as a time-weighted average concentration and also for a program of medical and environmental surveillance. Based in part on information gathered from plant site visits and reviewer comments, work practices are recommended to reduce fire and explosion hazards and to minimize skin contact. Requirements for posting and labeling, a respiratory protection program, an education program for employees, and the maintenance of relevant records are also included.

Suggested research to correct deficiencies in available information includes: (1) epidemiologic studies of employees exposed to furfuryl alcohol; (2) animal studies of any chronic effects of furfuryl alcohol, including experimental studies of its possible carcinogenicity; (3) possible effects on reproduction, including whether or not furfuryl alcohol can cause terata or induce mutations; and (4) biotransformation of furfuryl alcohol, its distribution, and elimination.

The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for the development of the criteria and recommended standard for furfuryl alcohol. Terence M. Grady of this Division served as criteria manager. Equitable Environmental Health, Inc. (EEH) developed the basic information for consideration by NIOSH staff and consultants under contract CDC 210-77-0148.

The Division review of this document was provided by Keith H. Jacobson, Ph.D. (Chairman), Douglas L. Smith, Ph.D., Frank L. Mitchell, D.O., Craig R. McCormack, Pharm. D. (Division of Biomedical and Behavioral Sciences), with Seymour D. Silver, Ph.D.

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I. RECOMMENDATIONS FOR A FURFURYL ALCOHOL STANDARD

NIOSH recommends that employee exposure to furfuryl alcohol in the workplace be controlled by adherence to the following sections. The recommended standard is designed to protect the health and provide for the safety of employees for up to a 10-hour workshift, 40-hour workweek, over a working lifetime. Compliance with all sections of the recommended standard should prevent adverse effects of exposure to furfuryl alcohol on the health of employees. Methods recommended in the standard are measurable by techniques that are reproducible and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. Although NIOSH considers the workplace environmental limit to be a safe level based on current information, the employer should regard it as the upper boundary of exposure, and every effort should be made to maintain the exposure at levels as low as is technically feasible. The criteria and recommended standard will be reviewed and revised as necessary.

This recommended standard for furfuryl alcohol is based on the limited information available on the effects from exposure to furfuryl alcohol. The standard is designed to safeguard workers occupationally exposed to furfuryl alcohol from absorption of the compound, possible subsequent irritation of the skin, eyes, and respiratory tract, from central nervous system (CNS) effects, and from the hazard arising from its violent, possibly explosive, reaction when in contact with acids.

These criteria and the recommended standard apply to occupational exposure of employees to hydroxymethyl furan, referred to as "furfuryl alcohol." Synonyms for furfuryl alcohol include 2-furylmethanol, 2-furylcarbinol, 2-furan methanol, furfural alcohol, and 2-(hydroxymethyl) furan. The major industrial use of furfuryl alcohol is in the production of furan resins, which are used as corrosion- and heat-resistant materials, particularly in the foundry industry.

An action level is defined as one-half the recommended time-weighted average (TWA) environmental limit. Occupational exposure to furfuryl alcohol is defined as exposure to airborne furfuryl alcohol above the action level. Exposures at lower concentrations will not require adherence to the following sections except for 2(a,e), 3(a), 4(a,c), 5, 6(a,d,e,f), 7, and 8(a).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to furfuryl alcohol shall be controlled so that employees are not exposed to furfuryl alcohol at a concentration greater than 200 milligrams per cubic meter (mg/cu m) of air, equivalent to 50 parts per million (ppm) parts of air by volume, determined as a TWA concentration for up to a 10-hour workshift and 40-hour workweek.

(b) Sampling and Analysis

Procedures for the collection and analysis of environmental samples shall be as provided in the appendix or by any other methods at least equivalent in precision, accuracy, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance as described below shall be made available to all employees occupationally exposed to furfuryl alcohol. The employer shall provide information to the physician performing or responsible for the medical surveillance program such as: the requirements of the applicable standard; an estimate of the employee's potential exposure to furfuryl alcohol, including any available workplace sampling results; and a description of any protective devices or equipment the employee may be required to use.

(a) Preplacement medical examinations shall include at least: comprehensive medical and work histories with special emphasis given to the upper respiratory tract and skin; a physical examination giving special attention to the skin, eyes, and respiratory system; and a judgment of the worker's ability to use a negative or positive pressure respirator.

(b) Periodic examinations shall be made available at a frequency to be determined by the responsible physician based on such factors as the severity and frequency of exposure. These examinations should include interim medical and work histories and a physical examination as outlined in paragraph (a) of this section.

(c) Following completion of the examination, the physician shall give to the employer a written statement specifying any condition or abnormality found which would increase the risk to the employee's health by exposure to furfuryl alcohol, and any limitations that should be placed on the employee's exposure. Employees and potential employees having medical conditions such as chronic respiratory or skin disorders that could be

aggravated directly or indirectly by exposure to furfuryl alcohol shall be counseled concerning the possibly increased risk of impairment of their health as a result of working with this substance.

(d) In cases involving massive exposure to furfuryl alcohol, prompt referral and medical attention shall be provided. In the event of skin or eye contact with liquid furfuryl alcohol, skin and eyes shall be thoroughly flushed with large amounts of water. In cases of splashes, spills, or leaks, individuals who have significant skin, eye, or respiratory contact with the material shall be referred to the responsible medical authority.

(e) Pertinent medical records shall be retained for at least 30 years after the individual's last occupational exposure to furfuryl alcohol. These records shall be made available to the designated medical representative of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

All warning signs shall be printed both in English and in the predominant language of non-English-reading workers. Workers unable to read labels and posted signs shall receive information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

(a) Labeling

The following label shall be affixed in a readily visible location on process equipment, storage tanks, containers, or other facilities used for furfuryl alcohol.

FURFURYL ALCOHOL

CAUTION!

May be absorbed through skin.
Reacts violently with strong acids.

Avoid contact with skin and eyes.
Avoid breathing vapor.
Use only with adequate ventilation.

In case of contact with skin and eyes: Immediately wash skin thoroughly or flush eyes with large amounts of water. Get medical attention.

(b) Posting

In areas where there is occupational exposure to furfuryl alcohol, signs containing health hazard warning statements appropriate for this substance shall be posted in readily visible locations. This information shall be arranged as in the example below.

FURFURYL ALCOHOL

IRRITATING TO EYES AND RESPIRATORY TRACT

Keep away from acids.
Avoid contact with skin and eyes.
Avoid breathing vapor.

Section 4 - Personal Protective Equipment and Clothing

Engineering controls and safe work practices shall be used when needed to keep concentrations of airborne furfuryl alcohol at or below the recommended exposure limit and to minimize skin and eye contact. Employers shall provide protective equipment and clothing to employees when necessary to prevent skin contact.

(a) Eye and Face Protection

Safety glasses with side shields, chemical safety goggles, or face shields with goggles, made completely of materials resistant to furfuryl alcohol, shall be provided by the employer and shall be worn during any operation in which furfuryl alcohol may enter the eyes (29 CFR 1910.133).

(b) Respiratory Protection

The use of respirators to achieve compliance with the recommended exposure limit is permitted only during the time necessary to install or test the required engineering controls, during emergencies when the concentration of airborne furfuryl alcohol may exceed the permissible environmental limit, and for nonroutine operations such as nonroutine maintenance or repair activities.

When the use of a respirator is permitted, it shall be selected and used pursuant to the following requirements: The employer shall establish and enforce a respiratory protective program meeting the requirements of 29 CFR 1910.134; the employer shall ensure that no employee is exposed to furfuryl alcohol because of improper respirator selection, fit, use, or maintenance; the employer shall provide respirators in accordance with Table I-1 and shall ensure that the employee uses the respirator when

necessary; the respirators shall be selected in accordance with Table I-1 and shall be those approved by NIOSH or the Mine Safety and Health Administration (MSHA) as specified in 30 CFR 11; the employer shall ensure that respirators are adequately cleaned and maintained and that employees are trained and drilled at least annually in the proper use and testing for leakage of respirators assigned to them; respirators shall be easily accessible, and employees shall be informed of their location in the workplace; and protective equipment for emergency entry shall be located at clearly identified places outside the work area. Respirators specified for use in higher concentrations of furfuryl alcohol may be used in atmospheres of lower concentrations.

TABLE I-1
RESPIRATOR SELECTION GUIDE FOR FURFURYL ALCOHOL

Concentration	Respirator Type Approved under Provisions of 30 CFR 11
1,000 mg/cu m or less	<ul style="list-style-type: none"> (1) A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) (2) A gas mask with a chin-style or a front- or back-mounted organic vapor canister (3) Any supplied-air respirator with a full facepiece, helmet, or hood (4) Any self-contained breathing apparatus with a full facepiece
Greater than 1,000 mg/cu m or entry and escape from area of unknown concentration	<ul style="list-style-type: none"> (1) Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode (2) A combination respirator that includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode
Firefighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode

(c) Protective Clothing

Protective clothing shall be resistant to the penetration and chemical action of furfuryl alcohol. Additional protection, including gloves, bib-type aprons, boots, and overshoes, shall be provided for, and worn by, each employee while in any operation that may cause direct contact with liquid furfuryl alcohol. Supplied-air hoods and suits resistant to penetration by furfuryl alcohol shall be worn when entering confined spaces, such as pits or storage tanks. In situations where heat stress is likely to occur, supplied-air suits, preferably cooled, are recommended. The employer shall ensure that all personal protective clothing is inspected regularly for defects and is maintained in a clean and satisfactory condition. Protective equipment suitable for emergency use shall be located at clearly identified stations outside the work area.

Section 5 - Informing Employees of Hazards from Furfuryl Alcohol

(a) All employees working with furfuryl alcohol shall be informed of the hazards, relevant signs and symptoms of exposure, appropriate emergency procedures, and proper conditions and precautions concerning safe use and handling of furfuryl alcohol.

(b) A continuing education program, conducted at least annually by qualified health and safety personnel, shall be instituted to ensure that employees whose jobs may involve exposure to furfuryl alcohol, including those engaged in maintenance and repair, have current knowledge of job hazards, proper maintenance procedures, and cleanup methods. Employees shall be informed of the general nature of the medical and environmental surveillance procedures and why it is advantageous to the workers to participate in these procedures. Each employee shall be told about the availability of the required information, which shall include, as a minimum, that prescribed in paragraph (c) of this section. Records of such training should be maintained. Employees shall also be instructed on their responsibilities for following proper work practices and sanitation procedures to help protect the health and provide for the safety of themselves and of fellow employees.

(c) Appropriate written information describing the relevant toxic, physical, and chemical properties of furfuryl alcohol and of mixtures of furfuryl alcohol that are used or otherwise handled in the workplace shall be kept on file and shall be readily available to employees.

Section 6 - Work Practices

(a) Protective equipment and clothing, as set forth in Section 4, shall be worn by employees engaged in operations where there is a likelihood of skin or eye contact with furfuryl alcohol.

(b) Engineering controls, such as process enclosure or local exhaust ventilation, shall be used as needed to keep airborne furfuryl alcohol within the recommended environmental limit.

(c) Equipment and systems used for handling and transferring furfuryl alcohol shall be enclosed to the extent feasible to prevent skin and eye contact.

(d) Containers of furfuryl alcohol shall be kept tightly closed at all times when not in use. Storage shall be in well-ventilated areas away from heat, acids, and strong oxidizers. Containers shall be periodically inspected for leakage and deterioration.

Except for catalytic amounts, acids should be avoided in processes in which furfuryl alcohol is present; otherwise an exothermic explosive reaction may result.

A fail-safe system for filling tanks and transferring furfuryl alcohol shall be installed with unique hose fittings and tanks dedicated to furfuryl alcohol use only.

Equipment and systems used for handling and transferring furfuryl alcohol shall be inspected periodically for leaks. Valves, fittings, and connections shall be checked for tightness and good working order. Needed repairs and adjustments shall be made promptly.

Before maintenance work is started, sources of furfuryl alcohol shall be eliminated from the affected area to the extent feasible. If the concentration of airborne furfuryl alcohol exceeds the recommended environmental limit, use of respiratory protective equipment shall be required during such maintenance work.

Easily accessible, well-marked emergency showers and eyewash fountains shall be provided in work areas where eye or massive skin contact with furfuryl alcohol is likely.

Contaminated clothing shall be cleaned before reuse and shall be kept in properly labeled, closed containers until it is laundered or discarded. Anyone handling or responsible for cleaning contaminated clothing shall be informed about the hazards, relevant symptoms of overexposure, appropriate emergency procedures, and proper conditions and precautions for the safe handling of furfuryl alcohol. Materials that cannot be effectively decontaminated shall be discarded.

Transportation and use of furfuryl alcohol shall comply with Federal, state, and local regulations.

(e) Emergency plans and procedures shall be developed for furfuryl alcohol work areas. The measures shall include those specified below and

any others considered appropriate for a specific operation or process. Employees shall be trained to implement the plans and procedures effectively. Prearranged plans shall be instituted for obtaining emergency medical care and for the transportation of injured workers. A sufficient number of employees shall be trained in first aid so that assistance is available immediately when necessary.

Spills and leaks of furfuryl alcohol shall be cleaned up immediately. The area of the spill shall be posted and secured. Spills and leaks of furfuryl alcohol must be washed with water or alkali solution. Washing with any acids must be avoided so that a highly exothermic explosive reaction will not result. Only authorized personnel, adequately protected and properly trained, shall be permitted to enter the area to shut off sources of furfuryl alcohol. Spilled liquids can be sorbed with vermiculite, dry sand, earth, or other appropriate material. If sufficient drainage to suitable collection basins is available, spilled liquid can be hosed away with large quantities of water. Methods of waste disposal shall comply with Federal, state, and local regulations.

(f) Cleaning, maintenance, and repair of tanks, process equipment, and lines shall be performed only by properly trained, adequately protected, and supervised personnel. Entry into confined spaces, such as tanks, pits, tank cars, barges, and process vessels, shall be controlled by a permit system. Permits shall be signed by an authorized representative of the employer and shall certify that preparation of the confined space, precautionary measures, and personal protective equipment are adequate, and that precautions have been taken to ensure that prescribed procedures will be followed.

Before entry, confined spaces shall be inspected and tested for oxygen deficiency and for the presence of furfuryl alcohol and other known or suspected contaminants such as formaldehyde or phenol.

No employee shall enter any confined space that does not have an entry large enough to admit an employee wearing safety harness, lifeline, and appropriate respiratory equipment as specified in Section 4(b).

Confined spaces shall be ventilated while work is in progress to keep the concentration of airborne furfuryl alcohol at or below the recommended environmental limit, to keep the concentration of other contaminants below dangerous levels, and to prevent oxygen deficiency.

Anyone entering a confined space shall be observed from the outside by another properly trained and protected worker. An additional supplied-air or self-contained breathing apparatus with safety harness and lifeline shall be located outside the confined space for emergency use. The person entering the confined space shall maintain continuous communication with the standby worker.

Section 7 - Sanitation Practices

(a) Preparing, dispensing (including the use of vending machines), and eating food shall be prohibited in areas where furfuryl alcohol is produced, stored, processed, or otherwise used.

(b) Smoking shall be prohibited in areas where furfuryl alcohol is produced, processed, stored, or otherwise used.

(c) Employees who handle furfuryl alcohol shall be instructed to wash their hands thoroughly before eating, smoking, or using toilet facilities.

(d) Facilities such as double lockers should be provided for employees so soiled clothing can be stored separately from clean clothing.

Section 8 - Monitoring and Recordkeeping Requirements

(a) Employers shall determine by an industrial hygiene survey whether there is occupational exposure to furfuryl alcohol. Records of these surveys shall be kept; if an employer concludes that there is no occupational exposure, the records must show the basis for this conclusion. Surveys shall be repeated at least annually and within 30 days of any process change likely to result in an increased concentration of airborne furfuryl alcohol.

(b) If there is occupational exposure to furfuryl alcohol, a program of personal monitoring shall be instituted to identify and measure, or to permit calculation of, the exposure of each employee occupationally exposed to airborne furfuryl alcohol. Source and area monitoring may be a useful supplement to personal monitoring. In all personal monitoring, samples representative of the exposure to airborne furfuryl alcohol in the breathing zone of the employee shall be collected.

For each TWA concentration determination, a sufficient number of samples shall be taken to characterize employee exposures during each workshift. Variations in work and production schedules, as well as employee locations and job functions, shall be considered in decisions on sampling locations, times, and frequencies.

Each operation shall be evaluated at least once every 6 months or as otherwise indicated by a professional industrial hygienist. If an employee is found to be exposed in excess of the TWA concentration limit, controls shall be initiated, the exposure of that employee shall be evaluated at least once a week, and the employee shall be notified of the exposure and of the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that employee exposure no longer exceeds the environmental limit. Semiannual monitoring may then be resumed.

(c) Environmental records shall be kept for at least 30 years after the last occupational exposure. These records shall include the dates and times of measurements; duties and location of the employees within the worksite; sampling and analytical methods used; number, duration, and results of the samples taken; TWA concentrations estimated from these samples; type of personal protective equipment used, if any; and employees' names. Each employee shall be able to obtain information on his or her exposures. Environmental records shall be available to the designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare.

Pertinent medical records shall be retained for 30 years after the last occupational exposure. Copies of exposure data applicable to an employee shall be included in that employee's medical records. These medical records shall be made available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.