

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** FURFURYL ALCOHOL ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for FURFURYL ALCOHOL

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance FURFURYL ALCOHOL.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of furfuryl alcohol not in excess of 50 parts per million (ppm) (200 milligrams per cubic meter (mg/M3)) averaged over an eight-hour work shift (time weighted average), as stated in § 1910.1000, Table Z-1.

(2) "Action level" means one-half of the permissible exposure for furfuryl alcohol averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which furfuryl alcohol is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of furfuryl alcohol above the permissible level. The initial determination shall be made each time there is a change in production, process, or control measures which may result in an increase in airborne concentrations of furfuryl alcohol.

(2) A written record of the initial determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to furfuryl alcohol;

(ii) Any measurements of furfuryl alcohol taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to furfuryl alcohol; and

(iv) Date of initial determination, work being performed at the time, location within work site, and employees considered.

(3) If the employer determines that any employee may be exposed to furfuryl alcohol above the permissible exposure, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to furfuryl alcohol above the action level, the employer shall:

(i) Identify all employees who may be exposed above the permissible level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to furfuryl alcohol above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every three months.

(6) If an employee exposure measurement reveals that an employee is exposed to furfuryl alcohol above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to furfuryl alcohol above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

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(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to furfuryl alcohol below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy (Percent of True Value)
Above permissible exposure	± 25
At or below permissible exposure and above the action level	± 35
At or below the action level	± 50

(d) Compliance. (1) No employee shall be exposed to furfuryl alcohol above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of furfuryl alcohol shall be controlled to at or below the permissible exposure by engineering and work practice controls.

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (i) When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of furfuryl alcohol.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving furfuryl alcohol shall be classified as B-4 at 21 degrees C (70 degrees F.)

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

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- (i) During the time period necessary to install or implement engineering or work practice controls; or
 - (ii) In work situations in which engineering and work practice controls are not feasible; or
 - (iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of furfuryl alcohol to at or below the permissible exposure; or
 - (iv) For operations which require entry into tanks or closed vessels; or
 - (v) In emergencies.
- (5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR FURFURYL ALCOHOL

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION*
Vapor Concentration	
250 ppm or less	A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 250 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

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* Use of supplied-air suits may be necessary to prevent skin contact and respiratory exposure from airborne concentrations of furfuryl alcohol. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitation and potential life endangering characteristics of supplied-air suits. Where supplied-air suits are used above a concentration which may be immediately dangerous to life and health (250 ppm), an auxiliary positive-pressure self-contained breathing apparatus must also be worn.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for furfuryl alcohol.

(2) For the purpose of compliance with § 1910.309, locations classified as hazardous locations due to the presence of furfuryl alcohol shall be Class I, Group C.

(3) For the purpose of compliance with § 1910.157, furfuryl alcohol is classified as a Class B fire hazard.

(4) For the purpose of compliance with § 1910.178, locations classified as hazardous locations due to the presence of furfuryl alcohol shall be Class I, Group C.

(5) For the purpose of compliance with § 1910.106, liquid furfuryl alcohol is classified as a Class IIIA combustible liquid.

(6) Spray finishing operations shall be performed in accordance with §§ 1910.107 and 1910.94(c).

(7) Dip tank operations shall be performed in accordance with §§ 1910.108 and 1910.94(d).

(8) Where a fan is located in ductwork and where furfuryl alcohol is present in the ductwork in concentrations greater than 4500 ppm (approximately 25% of the lower flammable limit), the fan rotating element shall be of nonsparking material or the casing shall consist of, or be lined with, nonsparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(9) Sources of ignition such as smoking or open flames are prohibited where furfuryl alcohol presents a fire or explosion hazard.

(10) Furfuryl alcohol shall be stored so as not to come in contact with strong oxidizers and strong acids.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent skin contact with liquid furfuryl alcohol, where skin contact may occur. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing contaminated with furfuryl alcohol is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of furfuryl alcohol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the furfuryl alcohol, the employer shall inform the

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person performing the operation of the hazardous properties of furfuryl alcohol.

(3) Where exposure of an employee's body to liquid furfuryl alcohol may occur, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(4) Employers shall ensure that non-impervious clothing which becomes contaminated with furfuryl alcohol be removed immediately and not reworn until the furfuryl alcohol is removed from the clothing.

(5) Employers shall provide and ensure that employees use splash-proof safety goggles which comply with § 1910.133(a)(2)-(a)(6) where liquid furfuryl alcohol may contact the eyes.

(g) Spills and disposal. In the event that liquid furfuryl alcohol is spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with furfuryl alcohol immediately wash or shower to remove any furfuryl alcohol from the skin.

(2) Employers shall ensure that employees who handle liquid furfuryl alcohol wash their hands thoroughly before eating, smoking or using toilet facilities.

(i) Training and information. (1) Each employer who has a workplace in which furfuryl alcohol is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to furfuryl alcohol above the action level without regard to the use of respirators, or employees who may have skin or eye contact with liquid furfuryl alcohol, or employees who work where furfuryl alcohol presents a fire or explosion hazard shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for furfuryl alcohol (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to furfuryl alcohol.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to furfuryl alcohol which are listed in Appendix A of the section;

(iv) Instruct affected employees to inform the employer if they develop any of the medical conditions listed in paragraph (j)(2) of this section; and

(v) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to furfuryl alcohol.

(j) Medical surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) Each employer who has employees exposed to airborne concentrations of furfuryl alcohol above the action level, without regard to the use of respirators, or employees who may have skin or eye contact with liquid furfuryl alcohol shall obtain information as to whether such employee has a history of any of the following medical conditions:

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- (i) Kidney disease;
- (ii) Liver disease; and
- (iii) Chronic lung disease.

(3) The employer shall provide a medical examination for the employee if:

(i) The employee provides a history of any of the medical conditions listed in paragraph (j)(2) of this section; or

(ii) The employee informs the employer of the development of any of the medical conditions listed in paragraph (j)(2) of this section or any of the signs or symptoms of exposure to furfuryl alcohol which are listed in Appendix A which the employee suspects are caused by exposure to furfuryl alcohol.

(4) The employer shall provide to the examining physician the following information:

(i) A copy of this regulation with Appendixes A, B and C for furfuryl alcohol;

(ii) A description of the affected employee's duties as they relate to his exposure to furfuryl alcohol;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(5) Where a medical examination is required by paragraph (j)(3) of this section, following such examination the employer shall obtain a written opinion from the examining physician which conforms with paragraph (j)(6) of this section.

(6)(i) The physician's written opinion by the examining physician shall specifically state: (A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to furfuryl alcohol;

(B) Any recommended limitations upon the employee's exposure to furfuryl alcohol including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to the employee's employment.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(7) No employee shall be exposed to furfuryl alcohol in such a way as would put the employee at increased risk of material impairment of his health from such exposure. The employer shall base this decision on any information available including the physician's written opinion.

(8) The employer shall provide emergency medical treatment for any employee injured through exposure to furfuryl alcohol.

(9) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

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(10) No medical procedure which would be performed pursuant to this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to furfuryl alcohol.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to furfuryl alcohol which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

(D) Number, duration, and results of samples taken; and

(E) Name and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name of the employee;

(B) Information concerning medical conditions obtained from the employee pursuant to paragraph (j)(2) of this section;

(C) Any employee medical complaints relative to exposure to furfuryl alcohol;

(D) A copy of information provided to the physician pursuant to paragraph (j)(4)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

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(F) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of and for one year after termination of the employment of the affected employee.

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

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to furfuryl alcohol.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(1) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to furfuryl alcohol which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to furfuryl alcohol requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of furfuryl alcohol that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for furfuryl alcohol is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent that the information supplements this regulation for furfuryl alcohol, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR FURFURYL ALCOHOL

I. SUBSTANCE IDENTIFICATION

A. Substance: Furfuryl alcohol

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- B. Permissible Exposure: 50 parts of furfuryl alcohol per million parts of air (ppm) (200 milligrams of furfuryl alcohol per cubic meter of air (mg/M3)) averaged over an eight-hour work shift.
- C. Appearance and Odor: Amber liquid with a mildly irritating odor

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Furfuryl alcohol can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.
- B. Effects of Overexposure:
 - 1. Exposure of man and animals to small doses of furfuryl alcohol has been reported to stimulate respiration. Large doses have been reported to depress respiration, lower body temperature and cause watering of the mouth, nausea, diarrhea, dizziness and frequent urination. In animal experiments furfuryl alcohol has caused eye irritation and drowsiness. It may enter your body through your skin.
 - 2. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to furfuryl alcohol.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If liquid furfuryl alcohol gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.
- B. Skin Exposure: If liquid furfuryl alcohol gets on your skin, immediately flush the contaminated skin with water. If liquid furfuryl alcohol soaks through your clothing, immediately remove the clothing and flush the skin with water. If irritation is present after washing, get medical attention.
- C. Breathing: If you or any other person breathes in large amounts of furfuryl alcohol move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- D. Swallowing: When furfuryl alcohol has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
- E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand

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your emergency rescue procedures and know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to furfuryl alcohol. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required. If you can smell furfuryl alcohol while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Protective Suits: In some work situations the wearing of supplied-air suits or other impervious coverings such as acid suits may be necessary. Your employer should instruct you in their proper use and operation.
- C. Protective Clothing: You must wear appropriate protective clothing and equipment to prevent skin contact with liquid furfuryl alcohol when skin contact may occur. Replace or repair impervious clothing that has developed leaks.
- D. Eye Protection: You must wear splash-proof safety goggles where liquid furfuryl alcohol may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Furfuryl alcohol is a combustible liquid. Its vapors can form explosive mixtures with air at elevated temperatures.
- B. Furfuryl alcohol must be stored in tightly closed containers in a cool, well ventilated area away from strong oxidizers and strong acids.
- C. Sources of ignition such as smoking and open flames are prohibited wherever furfuryl alcohol is handled, used or stored in a manner that could create a potential fire or explosion hazard.
- D. You must immediately remove any non-impervious clothing that becomes contaminated with furfuryl alcohol and this clothing must not be reworn until the furfuryl alcohol is removed from the clothing.
- E. If your skin becomes contaminated with furfuryl alcohol, you must immediately wash or shower to remove any furfuryl alcohol from your skin.
- F. If you handle furfuryl alcohol, you must wash your hands thoroughly before eating, smoking or using toilet facilities.
- G. Fire extinguishers and quick drenching facilities, where provided, must be readily available and you should know where they are and how to operate them.

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- H. Ask your supervisor where furfuryl alcohol is used in your work area and for any additional safety and health rules.
- VI. ACCESS TO INFORMATION
- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for furfuryl alcohol. In addition, your employer must instruct you in the safe use of furfuryl alcohol, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to furfuryl alcohol. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of one year following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

NOTE: The information contained in the following appendix for furfuryl alcohol is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent that the information supplements this regulation for furfuryl alcohol, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR FURFURYL ALCOHOL

- I. PHYSICAL AND CHEMICAL DATA
- A. Substance Identification
1. Synonyms: 2-Hydroxymethylfuran; 2-furylmethanol
 2. Formula: $C_4H_3OCH_2OH$
 3. Molecular weight: 98.1
- B. Physical Data
1. Boiling point (760 mm Hg): 170 C (338 F)
 2. Specific gravity (water = 1): 1.13

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3. Vapor density (air = 1 at boiling point of furfuryl alcohol): 3.4
4. Melting point: -14.6 C (-26 F)
5. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
6. Solubility in water, grams of furfuryl alcohol per 100 grams of water (68 F): Miscible in all proportions. Aqueous solutions not stable.
7. Evaporation rate (butyl acetate = 1): Much less than 1
8. Appearance and odor: Amber liquid with a mildly irritating odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: 65 C (149 F) (closed cup)
2. Autoignition temperature: 391 C (736 F)
3. Flammable limits in air, % by volume (at 162 - 252 F 72 - 122 C): Lower: 1.8; Upper: 16.3
4. Extinguishing media: Alcohol foam, water, dry chemical and carbon dioxide
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: Furfuryl alcohol is a combustible liquid. At elevated temperatures its vapors can form explosive mixtures with air. All ignition sources must be controlled where furfuryl alcohol is used, handled or stored in a manner that could create a potential fire or explosion hazard.
7. For purposes of complying with the requirements of 29 CFR 1910.106, furfuryl alcohol is classified as a Class IIIA combustible liquid. For example, 4500 ppm, approximately one-fourth of the lower flammable limit, is one situation in which furfuryl alcohol is considered to be a potential fire and explosion hazard.
8. For purposes of complying with 29 CFR 1910.309, the classification of hazardous locations as described in Article 500 of the National Electrical Code for furfuryl alcohol shall be Class I, Group C.

B. Reactivity

1. Conditions contributing to instability: Contact with strong acids may cause furfuryl alcohol to polymerize and burst container.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with strong acids (including some organic acids) may cause polymerization to occur with the liberation of much heat and violent spattering.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving furfuryl alcohol.
4. Special precautions: Furfuryl alcohol will attack some forms of plastics, rubber and coatings.

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III. SPILL, LEAK, AND DISPOSAL PROCEDURES

- A. If furfuryl alcohol is spilled or leaked, the following steps should be taken:
1. Ventilate area of spill or leak.
 2. For small quantities, absorb on paper towels. Remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber.
- B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.
- C. Waste disposal methods: Furfuryl alcohol may be disposed of:
1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in sealed containers in a secured sanitary landfill.
 2. By atomizing in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analyses may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analysis. The method of measurement must determine the concentration of furfuryl alcohol to plus or minus 35%.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of furfuryl alcohol to plus or minus 25%.
- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set V" (Order number XXXXXXXXXX).
- D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

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- A. Store furfuryl alcohol in tightly closed containers in a cool, well ventilated area.
- B. Use of supplied-air suits or other impervious coverings (such as acid suits) may be necessary to prevent skin absorption from furfuryl alcohol. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life endangering characteristics of supplied-air suits.
- C. Employers should advise employees of all areas and operations where their exposure to furfuryl alcohol could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to furfuryl alcohol is likely to occur are: During its production and its use in the manufacture of foundry resins, epoxy resins, adhesives, and impregnants for stone and wood; as a resin solvent; as a paint remover; and in the manufacture of corrosion-resistant cements and molded articles.

NOTE: The information contained in the following appendix for furfuryl alcohol is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligations. To the extent the information supplements this regulation for furfuryl alcohol, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Furfuryl alcohol vapor causes narcosis in animals. In rats exposed to 700 ppm, effects were excitement followed by eye irritation and drowsiness. In rats the LC50 for 4 hours was 233 ppm. Repeated exposure of rats to 19 ppm caused moderate respiratory irritation. Small doses given by an unspecified route stimulate respiration in man and animals but large doses depress respiration, lower the body temperature, and cause nausea, salivation, diarrhea, dizziness, and diuresis.

III. SIGNS AND SYMPTOMS

Dizziness; nausea, diarrhea; diuresis; by analogy to effects caused in animals, it may cause eye irritation, drowsiness.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

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Remove from exposure. Flush eyes and skin with water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation and administer oxygen if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Furfuryl alcohol causes narcosis in animals; information on effects in humans is meager. It is important that the physician become familiar with plant operating conditions in which exposure to furfuryl alcohol occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

Routine medical histories and physical examinations are not required. However, the employer must screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from furfuryl alcohol exposure. Only those giving a positive history of these conditions must be referred for further medical examinations.

1. Chronic respiratory disease -- Furfuryl alcohol causes respiratory irritation in animals. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of furfuryl alcohol might cause exacerbation of symptoms due to its irritant properties.
2. Liver disease -- Although furfuryl alcohol is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.
3. Kidney disease -- Although furfuryl alcohol is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

C. PERIODIC EXAMINATIONS

Routine periodic examinations are not required. However, if the employer becomes aware of an employee with the above-listed conditions, he must refer such employee for further medical examination.

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VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Furfuryl Alcohol," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 323.
2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1489-1491.
3. Browning, Ethyl: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 382-384.
4. Fine, E.A. and J.H. Wills: "Pharmacologic Studies of Furfuryl Alcohol," Archives of Industrial Hygiene and Occupational Medicine, 1:625-632, 1950.
5. The Quaker Oats Company, Chemicals Division: Physiological Data on 20 Furfuryl Alcohol (FA*), *Reg. U.S. Pat. Off., December 26, 1957.

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- (d) Compliance - Open surface tank classification based on relative evaporation rate of 250 hours (98% from Doolittle)
- (e) Fire and Safety
- (1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipment," H. Carhart et al., National Academy of Sciences, 1973, report to U.S. Coast Guard, report no. CG-D-92-74, p. 15.
- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: Deichmann and Gerarde, "Toxicology of Drugs and Chemicals"
- Skin: Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Schwartz, Tulipan and Birmingham, "Occupational Diseases of the Skin;" Fairhall, "Industrial Toxicology;" Hamilton and Hardy, "Industrial Toxicology"
- Ingestion: Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Browning, "Toxicity and Metabolism of Industrial Solvents"

COMMENTS

Eye - Classification: 2

Output statement numbers: 10

Exceptions: None

According to Deichmann and Gerarde, "instillation of one drop of undiluted furfuryl alcohol (FA) produced a reversible irritation of the eyes of adult male rabbits. Two or more drops cause severe but reversible inflammation; the eyes become normal after several weeks."

Since the substance does not produce irreversible effects, it is concluded that a classification of 2 is most appropriate.

Skin - Classification: 2

Output statement numbers: 2, 7a, 8b, 14g, 14i, 20a

Exceptions: See below

Deichmann and Gerarde report, "FA is rapidly and completely absorbed through the skin of the rabbit; the lethal dose by this route is about 400 mg/kg . . . Lethal doses usually produce terminal convulsions."

Schwartz, Tulipan and Birmingham list the substance among those "chemicals known to be primary skin irritants and sensitizers." Fairhall and Hamilton and Hardy agree.

The substance has a boiling point of 338 degrees F, a melting point of -26 degrees F and a vapor pressure of less than 1 mm of Hg as 20 degrees C. It is miscible in all proportions with water and its flash point is 149 degrees F.

The lethal dose by skin absorption indicates that skin contact is definitely hazardous. A classification of 2 is concluded to be sufficient only if statement 2 is used to prevent contact where it "may occur," statement 8b is used, and statements 14g and 14i are specified instead of statements 17g and 17i. This choice of statements is further supported by the fact that furfuryl alcohol is a primary skin sensitizer.

Ingestion - Classification: 2

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Output statement numbers: 20 a

Exceptions: None

Browning reports the lethal dose to rats as a 2% solution to be 275 mg/kg. She adds, "Galewski and Alsdorf found when furfuryl alcohol was administered to rats in drinking water over a period of 20 days it caused marked anorexia and loss of weight."

According to Deichmann and Gerarde, "the oral LD50 for the rat is 132 mg/kg; convulsions usually occur with lethal doses."

A classification of 2 is concluded to be sufficient to prevent excessive ingestion of this compound.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)

Quaker Oats Co., Bulletin 205-B and Material Safety Data Sheet (Qu)

"Beilstein's Handbuch der Organischen Chemie," vol. 17, p. 112 and supplements (Beil)

Sources of data items used:

- I. A. 1. Synonyms: Qu, Beil
2. Formula: NFPA-325M, Qu
3. Molecular weight: Qu
- B. 1. Boiling point: Qu
2. Specific gravity: Qu
3. Vapor density: NFPA-325M
4. Melting point: Qu
5. Solubility in water: Qu
6. Vapor pressure: Qu
7. Evaporation rate: Qu
8. Appearance and odor: Qu
- II. A. 1. Flash point: Qu
2. Autoignition temperature: Qu
3. Flammable limits: Qu
4. Extinguishing media: Qu
5. Special fire fighting procedures: Qu
6. Unusual fire and explosion hazards: Qu
- B. 1. Conditions contributing to instability: Qu
2. Incompatibilities: NFPA-491M, Qu
3. Hazardous decomposition products: None
4. Special precautions: Qu
- III. A. Steps if released or spilled: Qu
C. Waste disposal method: Qu
- V. Miscellaneous precautions: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

-Apol, A., West Foundry Company, Tigard, Oregon, Health Hazard Evaluation Toxicity Determination Report 73-116-85, National Institute of Occupational Safety and Health, 1973 (Apol)

Bates, C. E. and Scheel, L. D.. "Processing Emissions and Occupational Health in the Ferrous Foundry Industry," American Industrial Hygiene Association Journal, 452 - 462, August 1974 (Bates)

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- Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)
- Burton, D. J. and Rivera, R. O., May Foundry, Salt Lake City, Utah, Health Hazard Evaluation Toxicity Determination Report 72-10-15, National Institute of Occupational Safety and Health, 1972 (Burton)
- "Furfuryl Alcohol," Material Safety Data Sheet, Chemicals Division, Quaker Oats, Chicago, Illinois (QO)
- Golding, B., "Polymers and Resins," Van Nostrand, N. Y., 1959 (Golding)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)
- Mellan, I., "Source Book of Industrial Solvents - III," "Monohydric Alcohols," Reinhold Publishing, New York, 1959 (Mellan)
- Patty, F. A., "Industrial Hygiene and Toxicology," vol. II, Interscience Publishers, 1962 (Patty)
- "QO Furfuryl Alcohol," Bulletin 205 - B, Chemicals Division, The Quaker Oats Company, Chicago, Illinois (Quaker Oats)
- Stanford Research Institute, "Chemical Economics Handbook," Menlo Park, California (SRI)
- Tubich, G. E., "The Modern Foundry Environment," American Industrial Hygiene Association Journal, p. 127 - 130, March - April, 1963 (Tubich)

References for Specific Use/Exposure

1. Bates, Tubich, Apol, Burton
2. Golding, Quaker Oats
3. SRI, ADL estimate
4. Golding, SRI
5. Golding, K-O
6. Patty, Browning, Mellan
7. Golding, K-O
8. SRI
9. Quaker Oats, SRI

References for Specific Control Methods

QO was the only reference used in all the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Furfuryl alcohol

D. O. L. STANDARD: 50 ppm

WARNING PROPERTIES:

Odor Threshold: Patty states that "the median detectable concentration of furfuryl alcohol in the atmosphere is reported by Jacobson et al. to be 8 ppm." Patty does not specify how the furfuryl alcohol is detected (i.e. odor, irritation).

Eye Irritation Level: The Documentation of TLV's states that the TLV of 50 ppm might "not be low enough to prevent ocular irritation in the unconditioned worker." For the purposes of this standard, only full facepiece respirators are permitted.

Evaluation of Warning Properties: Since Patty reports a median detectable concentration of furfuryl alcohol of 8 ppm, this compound is treated as a material with adequate warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 250 ppm

Basis for IDLH Value: The chosen IDLH is based upon the 4-hour, rat LC50 of 233 ppm of a furfuryl alcohol, hydrazine, and aniline mixture. Deichmann and Gerarde state that for rats an 8% mortality resulted from

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6-hour exposure to 47 ppm, and 100% mortality resulted at 243 ppm.
Other Toxicological Information: The Documentation of TLV's states that "mice were exposed for 10 minutes at 700 ppm of furfuryl alcohol with no toxic effects. Among rats exposed by Comstock and Oberst for longer periods to the same concentration, 16% died after a four-hour exposure and 25% after and eight-hour exposure. When rats and mice were exposed daily for six weeks at 19 ppm of furfuryl alcohol, no important signs of toxicity were noted; moderate pulmonary congestion was observed without significant cellular changes. Weight gain among the survivors was similar to that of controls.

"Erdman reported that small doses of furfuryl alcohol stimulated respiration in man and animals; larger doses depressed respiration, reduced body temperature, produced nausea, salivation, diarrhea, dizziness and diureses. Fine and Wills concluded from physiologic and pharmacologic studies that furfuryl alcohol was distributed uniformly throughout most of the body and had little action on specific enzymes in special cell structures.

"Jacobson et al., however, in a study of the toxicity of a mixture of furfuryl alcohol, aniline and hydrazine, found the LC50 for rats, for a four-hour exposure to furfuryl alcohol vapor, to be 233 ppm. They recommended 5 ppm as a threshold limit.

"The TLV of 50 ppm is believed to be sufficiently low to prevent systemic effects but it may not be low enough to prevent ocular irritation in the unconditioned worker."

Patty reports similar information.

Deichmann and Gerarde state that furfuryl alcohol, FA, "is rapidly and completely absorbed through the skin of the rabbit; the lethal dose by this route is about 400 mg/kg. The subcutaneous LD50 for the rat is 85 mg/kg. Lethal doses usually produce terminal convulsions.

"Male albino mice survived one 6-hour exposure to 243 ppm; at 597 ppm the mortality was 92%. For rats, an 8% mortality resulted after one 6-hour exposure to 47 ppm, and 100% mortality at 243 ppm. Rabbits survived one 6-hour exposure to 416 ppm, and dogs survived one 6-hour exposure to 349 ppm. A monkey exposed for one 6-hour period to 260 ppm of FA vapor showed no evidence of toxicity other than a slight irritation as evidenced by slight lacrimation."

LFL AT 162 - 252 F: 18,000 ppm

VAPOR PRESSURE AT 20 C: Less than 1 mm Hg

SATURATED CONCENTRATION AT 20 C: Less than 1320 ppm

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USE/EXPOSURE AND CONTROL DOCUMENT
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Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1. Inhalation of vapor and skin contact with liquid during preparation of furan resins and use as binder in manufacture of foundry cases and molds (including "no-bake" and "hot-box" processes)	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles)
2. Inhalation of vapor and skin contact with liquid during manufacture of corrosion-resistant cements and molded articles (including mortar for industrial flooring and pipe fittings, joints, ducts, and tanks for the chemical, textile, petroleum, and metallurgical industries)	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles)
3. Inhalation of vapor and skin contact with liquid during synthesis and handling of substance	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles)
4. Inhalation of vapor and skin contact with liquid during preparation of furfuryl-dimethylol urea resins as adhesives for woodworking (including processes such as lumber care gluing in plywood manufacture, edge bonding in furniture manufacture and other wood-to-wood gluing)	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles)
5. Inhalation of vapor and skin contact with liquid during use as a solvent and reactant in manufacture of resinoid abrasive wheels	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles)
6. Inhalation of vapor and skin contact with liquid	A,B,D	Local exhaust ventilation; general dilution ventila-

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during use as a solvent in dispersant in textile dyeing (including silk screen printing and dyeing with Indigosol dyes)

tion; personal protective equipment (gloves, goggles)

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| 7. | Inhalation of vapor and skin contact with liquid during use in impregnation of wood or asbestos (including in manufacture of chemical-resistant laboratory bench tops) | A,B,D | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles) |
| 8. | Inhalation of vapor and skin contact with liquid during manufacture of high-density carbon or graphite articles (including electrodes and carbonaceous crucibles) | A,B,D | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles) |
| 9. | Inhalation of vapor or skin contact with liquid during use in sand consolidation for oil and gas recovery operations | A,B,D | Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, goggles) |

- A -- Inhalation
- B -- Skin and eye contact resulting in localized irritation
- C -- Ingestion
- D -- Skin contact resulting in absorption and subsequent systemic poisoning