NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** BENZENE ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for BENZENE

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 BENZENE.

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.

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of benzene not in excess of 10 parts per million (ppm), averaged over an eight-hour work shift (time weighted average) and not in excess of 25 parts per million (ppm) at anytime during an eight-hour work shift except that an exposure not in excess of 50 parts per million (ppm) at any aggregate of 10 minutes shall be permitted as stated in § 1910.1000, Table Z-2.

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

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which benzene is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of benzene 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 benzene.

(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 benzene;

(ii) Any measurements of benzene taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to benzene; 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 benzene 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 benzene 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 benzene 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 benzene 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 benzene 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.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to benzene 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 the time period appropriate to the permissible exposure (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
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 benzene above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of benzene 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 benzene.

(ii) In the design of open surface tank ventilation for the purposes of —§ 1910.94(d), operations involving benzene shall be classified as A-1 at 21 degrees C (70 degrees F).

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

(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 benzene 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 BENZENE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor concentration	
100 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
500 ppm or less	Any supplied-air respirator with a full facepiece, helmet or hood. Any self-contained breathing apparatus with a full facepiece.
3000 ppm or less	A Type C supplied-air respirator opeated in pressure - demand or other positive pressure or continuous-flow mode.
Greater than 3000 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 benzene. Any escape self-contained breathing apparatus.

(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 benzene.

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

(3) For the purpose of compliance with § 1910.157, benzene 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 benzene shall be Class I, Group D.

(5) For the purpose of compliance with § 1910.106, liquid benzene is classified as a Class IB flammable 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 benzene is present in the ductwork in concentrations greater than 3500 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 benzene presents a fire or explosion hazard.

(10) Benzene shall be stored so as not to come in contact with strong oxidizers including chlorine and bromine in the presence of iron.

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

(2) Employers shall ensure that clothing wet with benzene is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of benzene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the benzene, the employer shall inform the person performing the operation of the hazardous properties of benzene.

(3) Employers shall ensure that any clothing which becomes wet with liquid benzene be removed immediately and that non-impervious clothing which becomes contaminated with benzene be removed promptly. Such clothing shall not be reworn until the benzene is removed from the clothing.

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

(g) Spills and disposal. (1) In the event that liquid benzene is spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

(2) Liquid benzene shall not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive vapors are permitted.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with benzene promptly wash or shower with soap or mild detergent and water to remove any benzene from the skin.

(2) Employers shall ensure that employees who handle liquid benzene wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

(i) Training and information. (1) Each employer who has a workplace in which benzene 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 benzene above the action level without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact with liquid benzene, or employees who work where benzene presents a fire or explosion hazard, shall annually:

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

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

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to benzene 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 benzene.

(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) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to airborne concentrations of benzene above the action level, without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact with liquid benzene, a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the blood, central nervous system and skin;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

(iii) Urinalysis to include specific gravity, albumin, glucose, and a microscopic on centrifuged sediment;

(iv) Determination of phenol concentration in the urine.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of benzene above the action level, without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact

with liquid benzene, twelve months from the date of the employee's first exposure, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the blood, central nervous system and skin to be performed annually;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit to be performed annually;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment to be performed annually;

(iv) Determination of phenol concentration in the urine to be performed quarterly. If a worker's urine phenol is found to be 75 mg/liter or greater, calculated to a specific gravity of 1,024, two followup urine samples shall be obtained within 1 week after receipt of the results, one as close to the beginning and one as close to the end of the same working day as possible. If the original elevated finding is confirmed, steps to reduce the worker's absorption of benzene shall be taken promptly.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) Interim medical examination. The employer shall provide an interim medical examination including a determination of phenol concentration in the urine for the employee if the employee informs the employer of any of the signs or symptoms of exposure to benzene which are listed in Appendix A or anytime overexposure to benzene is suspected.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

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

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

(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 level; and

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

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(8) Physician's written opinion. (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 benzene;

(B) Any recommended limitations upon the employee's exposure to benzene, 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.

(9) Results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician for inclusion in the employee's medical record:

(i) A recording of the results of the blood tests and urinalysis;

(ii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to benzene 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.

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section, with the exception of phenol determinations in the urine, need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) 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.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to benzene.

(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 benzene.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to benzene 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, social security number 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 and social security number 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 and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to benzene;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration of and for thirty years 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 benzene.

(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.

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

(2) When observation of measurement of employee exposure to benzene 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 benzene that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for benzene 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 benzene, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET FOR BENZENE

I. SUBSTANCE IDENTIFICATION

A. Substance: Benzene

B. Permissible Exposure: 10 parts of benzene per million parts of air (ppm) averaged over an eight-hour work shift, where 25 ppm shall not be exceeded during an eight-hour work shift, but that a peak of 50 ppm is permitted for 10 minutes during an eight-hour work shift.

C. Appearance and odor: Colorless liquid with an aromatic odor.

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Benzene can affect your body if you inhale it or if it comes in contact with your eyes or skin or if you swallow it. It may enter your body through your skin.

B. Effects of Overexposure:

1. Short-term Exposure: Inhaling high concentrations of benzene may cause dizziness, headache, excitement and breathlessness. These symptoms may be followed by mental confusion and hysterical symptoms such as shouting or laughing. This is called "a benzene jag" and may be followed by unconsciousness and death. Swallowing benzene may cause abdominal pain, staggering, sleepiness and unconsciousness. Bronchitis or pneumonia may occur after swallowing benzene from the benzene getting into the lungs. Splashing liquid benzene on the skin or eyes may cause irritation.

2. Long-term Exposure: Repeated exposure to benzene may cause anemia, leukemia and other blood abnormalities.

Repeated or prolonged skin contact with benzene may cause a skin rash.

3. 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 benzene.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If liquid benzene gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If liquid benzene gets on your skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid benzene soaks through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

C. Breathing: If you or any other person breathes in large amounts of benzene 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 liquid benzene has been swallowed, get medical attention immediately. Do not attempt to make the exposed person vomit.

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 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 benzene. 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 benzene 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 Clothing: You must wear appropriate protective clothing and equipment to prevent repeated or prolonged skin

contact with liquid benzene. Replace or repair impervious clothing that has developed leaks.

C. Eye Protection: You must wear splash-proof safety goggles where liquid benzene may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Benzene is a flammable liquid. Its vapors can easily form explosive mixtures with air.

B. Benzene must be stored in tightly closed containers in a cool, well ventilated area away from heat and strong oxidizers including chlorine and bromine in the presence of iron.

C. Sources of ignition such as smoking and open flames are prohibited wherever benzene is handled, used or stored in a manner that could create a potential fire or explosion hazard.

D. Metal containers in operations involving the transfer of five gallons or more of benzene should be grounded and bonded.

E. Clothing wet with liquid benzene can be easily ignited. You must immediately remove this clothing and it must not be reworn until the benzene is removed from the clothing.

F. You must promptly remove any non-impervious clothing that becomes contaminated with liquid benzene and this clothing must not be reworn until the benzene is removed from the clothing.

G. If your skin becomes contaminated with benzene, you must promptly wash or shower with soap or mild detergent and water to remove any benzene from your skin.

H. If you handle benzene, you must wash your hands thoroughly with soap or mild detergent and water before eating or smoking.

I. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.

J. Ask your supervisor where benzene 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 benzene. In addition, your employer must instruct you in the safe use of benzene, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to benzene. 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 thirty years 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 benzene 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 benzene, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Benzol, cyclohexatriene, coal tar naptha, phenyl hydride
2. Formula: C_6H_6
3. Molecular weight: 78.1

B. Physical Data

1. Boiling point (760 mm Hg): 80 C (176 F)
2. Specific gravity (water = 1): 0.88
3. Vapor density (air = 1 at boiling point of benzene): 2.7
4. Melting point: 5.4 C (42 F)
5. Vapor pressure at 20 C (68 F): 75 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.18
7. Evaporation rate (butyl acetate = 1): 5.1
8. Appearance and odor: Colorless liquid with an aromatic odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -11.1 C (12 F) (closed cup)
2. Autoignition temperature: 560 C (1040 F)
3. Flammable limits in air, % by volume: Lower: 1.3; Upper: 7.1
4. Extinguishing media: Dry chemical, foam, 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: Benzene is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where benzene is used, handled or stored in a manner that could create a potential fire or explosion hazard. Benzene vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, benzene is classified as a Class IB flammable liquid. For example, 3500 ppm, approximately one-fourth of the lower flammable limit, is one situation in which benzene 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 benzene shall be Class I, Group D.

B. Reactivity
1. Conditions contributing to instability: Heat.
2. Incompatibilites: Contact with strong oxidizers, including chlorine or bromine in the presence of iron, may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving benzene.
4. Special precautions: Benzene will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If benzene is spilled or leaked, the following steps should be taken:
1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Benzene must not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude formation of explosive concentrations of benzene are permitted.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Benzene may be disposed of by atomizing in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure Above the Action Level:
1. Eight hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this

section are best taken such that the average eight-hour exposure may be determined from a single sample or two (2) four-hour samples. Short term samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the eight-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

2. Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of benzene in the employee's breathing zone. A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

3. Peak Above Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentration of benzene. Each measurement should consist of a 5-minute sample or series of consecutive samples totaling five (5) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

4. Monitoring Techniques: The sampling and analyses under this section 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 analyses. The method of measurement must determine the concentration of benzene 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). When sampling for peak exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the employee has or has not, in fact, been exposed in excess of the permissible limit. 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 benzene 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 U" (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

A. Store benzene in tightly closed containers in a cool, well ventilated area.

B. High exposures to benzene can occur when transferring the liquid from one container to another.

C. Metal containers in operations involving the transfer of five gallons or more of benzene should be grounded and bonded.

D. Storage tanks and process lines containing benzene should be maintained above 5 C (42 F) to prevent freezing.

E. Employers should advise employees of all areas and operations where their exposure to benzene could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to benzene is likely to occur are: During its production and its use as a solvent for inks and shoe cements; as an intermediate in the manufacture of styrene, phenol, detergents, dyes, nylon and pesticides; in organic synthesis; as an extraction solvent and a general solvent; and during the production and use of motor fuel blends.

NOTE: The information contained in the following appendix for benzene 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 benzene, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Benzene vapor at high concentrations causes narcosis; repeated exposure results in depression of the hematopoietic system, and is associated with a higher incidence of leukemia. Concentrations in excess of 3000 ppm are irritating to the eyes, nose, and respiratory tract; continued exposure may cause an initial state of euphoria followed by giddiness, headache, nausea, a staggering gait, and narcosis. The most significant toxic effects of repeated exposures to benzene is an insidious and often

irreversible injury to the bone marrow. Human exposure to 150 ppm or more may cause headache, fatigue, anorexia, and lassitude with incipient blood effects including decreased red cell counts with relative lymphocytosis, eosinopenia, and monocytopenia although the total white cell count may remain unchanged. As the condition progresses, the blood abnormalities may be manifested first by anemia and leukopenia, and sometimes by macrocytosis and thrombocytopenia. Leukocytosis, eosinophilia, immature marrow cells in the circulating blood and elevated serum bilirubin may also occur. These findings are manifested clinically by bleeding of the nose and mucous membranes with the appearance of purpuric spots and ecchymoses, shortness of breath, pallor, rapid pulse and low blood pressure. Excessive chromosome aberrations in the nuclei of lymphocytes and bone marrow cells among workers exposed to benzene have been reported. Of 47 workers with benzene hemopathy, 2 had only anemia, 7 had anemia with leukopenia, 5 had anemia with thrombocytopenia, 26 had pancytopenia, 6 had leukemia, and 1 had a leukemoid reaction; this was a marked excess of leukemia among workers with toxic exposure to benzene; all cases of leukemia in this series were of hemocytoblastic type. The liquid splashed in the eyes produces a moderate burning sensation with slight transient injury of the epithelial cells; recovery is rapid. Benzene is a defatting agent and may produce dermatitis upon repeated or prolonged contact with the skin. The major urinary metabolite of benzene is phenol.

III. SIGNS AND SYMPTOMS

Irritation of eyes, nose, respiratory tract; giddiness; headache, nausea, staggering gait; fatigue, anorexia, lassitude; signs and symptoms of bone marrow depression ranging from decreased red cell counts to leukocytosis; dermatitis from repeated or prolonged exposure.

IV. SPECIAL TESTS

Analysis of the urine for phenol, a metabolite of benzene, is necessary in monitoring exposure. Urinary phenol levels in unexposed persons range up to an average of 30 mg/liter of urine; phenol levels of 75 mg/liter or greater are classed as indicative of unacceptable absorption of benzene. A knowledge of the background levels of phenol excretion in the individual is helpful.

V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap or mild detergent and water. Give artificial resuscitation and administer oxygen if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for BENZENE

A. GENERAL

Benzene causes narcosis at high concentrations. Repeated exposure results in depression of the hematopoietic system and has been fatal. Skin absorption is known to occur but is not as important as inhalation. Chronic exposure has been associated with an increased incidence of leukemia. It is important that the physician become familiar with plant operating conditions in which exposure to benzene 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

The following medical procedures must be made available to each employee who is exposed to benzene:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. A history of exposure to benzene, other hematologic toxins, or blood dyscrasias should be obtained. Examination of the blood and central nervous system should be stressed. The skin should be examined for evidence of chronic disorders.

2. A complete blood count -- Benzene has been shown to cause depression of the hematopoietic system in humans. A complete blood count must be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

3. Urinalysis -- Since proper kidney function is necessary for biologic monitoring, a urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose and a microscopic on centrifuged sediment. The urine shall be analyzed for the concentration of phenol in order to establish a baseline.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis, except that the analysis of urine for phenol shall be performed quarterly. If a worker's urine phenol is found to be 75 mg/liter or greater, calculated to a specific gravity of 1.024, two followup urine samples shall be obtained within 1 week after receipt of the results, one as close to the beginning and one as close to the end of the same working day as possible. If the original elevated finding is confirmed, steps to reduce the worker's absorption of benzene shall be taken promptly.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Benzene," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 22.

2. Hygienic Guide Series: "Benzene," American Industrial Hygiene Association Journal, 31:383-388, 1970.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1220-1225.

4. National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: Criteria for A Recommended Standard....Occupational Exposure to Benzene, (NIOSH) 74-137, U.S. Government Printing Office, Washington, D.C., 1974.

5. Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 3-65.

6. Vigliani, E.C. and G. Saita: "Benzene and Leukemia," The New England Journal of Medicine, 271:872-876, 1964.

REFERENCES AND SOURCES
BENZENE
1910.1000

(d) Compliance - Open surface tank classification based on relative evaporation rate of 1.2 hours (from Doolittle).

(e) Fire and Safety

(1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipmen H. Carhart et al., National Academy of Sciences, 1973, report to U. S. Coast Guard, report No. CG-D-92-74, p. 9.

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye"

Skin: Manufacturing Chemists' Association, Chemical Safety Data Sheets; American Industrial Hygiene Association, Hygienic Guide Series; American National Standards Institute, "American National Standard Acceptable Concentrations;" Browning, "Toxicit and Metabolism of Industrial Solvents;" Patty, "Industrial Hygiene and Toxicology;" American Petroleum Institute, "API Toxicology Reviews;" International Labour Office, "Encyclopedia of Occupational Health and Safety;" Christensen, "NIOSH Toxic Substances List"

Ingestion: American National Standards Institute, "American National Standard Acceptable Concentrations;" Thienes and Haley, "Clinical Toxicology;" Spector, "Handbook of Toxicology;" Christensen, "NIOSH Toxic Substances List;" Sax, "Dangerous Properties of Industrial Materials;" Browning, "Toxicity and Metabolism of Industrial Solvents"

COMMENTS

Eye - Classification: 2
Output statement numbers: 10
Exceptions: None

According to Grant, "experimentally, administration of benzene to rabbits has been found to cause no abnormality in the eyes detectable opthalmoscopically. The local effects of benzene vapor or liquid on the eye are slight. Droplet contamination of the eye by benzene causes moderate burning sensation, but only slight transient injury of epithelial cells, and the eye recovers rapidly. Benzene tested on rabbit eyes caused only grade 3 injury on a scale of 1 to 10."

A classification of 2 is concluded to be fully adequate for this substance.

Skin - Classification: 2
Output statement numbers: 2, 7b, 17g and 21 combined, 17i
Exceptions: See below

According to the MCA, "sustained or intermittent skin contact with liquid benzene may produce dermatitis at the site of contact Also reported is that "prolonged or repeated contact of liquid benzene with the skin can cause a defatting action with resulting drying out of the skin and dermatitis." All other sources reviewed agreed with this assessment of the local effects of contact.

The AIHA Hygienic Guide states that "percutaneous absorp-

tion is considered insignificant." According to ANSI, the liquid "is poorly absorbed through intact skin so that systemic intoxication from percutaneous absorption . . . is unlikely to occur." Browning reports that "absorption by the skin is possible, and direct contact . . . does present a risk, though relatively remote in practice, of poisoning." Patty states that "small amounts of benzene are absorbed through the skin wherever the liquid touches the skin. It is not probable that systemic poisoning can arise from immersing the hands in benzene."

The API reports that "skin absorption has received scant attention in the literature. The possibility of percutaneous absorption of benzene has been studied in three cases. Immersion of the hands and forearms from 25 to 35 min. showed no evidence of skin absorption. Unquestionably, small amounts of benzene can be absorbed through the skin, but it is very doubtful that enough would be absorbed by this route to cause systemic poisoning."

The ILO, like others, states that "the outstanding feature of benzene is its ability to injure blood-forming tissues which are chronically exposed to even low concentrations. The onset of chronic benzene poisoning is extremely insidious and its ultimate injury potentially incurable." It also considers the agent to be an agent "possessing established or suspected carcinogenic qualities."

Christensen lists a skin absorption TDLo for the mouse as 1232 mg/kg.

Benzene has a vapor pressure of 75 mm Hg at 20 degrees C. Its melting point is 42 degrees F. It is 0.18% soluble in water and has a flash point of 12 degrees F.

Acute skin exposure to liquid benzene does not appear to present a severe toxic hazard. The substance is, therefore, concluded to warrant a classification of 2. However, because of its potentially severe effects, statements 17g and 17i are used instead of 16g and 16i.

Ingestion - Classification: 2

Output statement numbers: 20b

Exceptions: None

ANSI reports "the ingestion of liquid benzene causes local irritation of the mucous membranes of the mouth, throat, esophagus, and stomach. The ingestion of a tablespoonful (about 15 mg) . . . has been known to cause collapse, bronchitis and pneumonia."

Thienes and Haley report that "two ml by mouth may produce symptoms, and 10 ml may be fatal. The symptoms are due to gastric irritation and to depression of the central nervous system, myocardium and bone marrow."

Spector lists the oral rat LD50 as 5700 mg/kg and Christensen gives the LD50 as 3400 mg/kg.

Sax lists the chronic systemic effects of ingestion as being of high toxic hazard.

Browning reports that more benzene is retained in the

body when the vapor is inhaled than when benzene is taken by mouth.

Benzene has a high chronic toxicity and a considerable vapor pressure. To ensure that ingestion does not occur, a classification of 2 is concluded to be most appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

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

Manufacturing Chemists' Association, Chemical Safety Data Sheet, SD-2 (MCA)

Exxon Co., USA, Material Safety Data Sheet (Exxon)

International Technical Information Institute, "Toxic and Hazardous Industrial Chemical Safety Manual," (THICSM)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, vol.3, p. 367 (K-O)

Sources of data items used:

I.	A.	1.	Synonyms: NFPA-325M
		2.	Formula: NFPA-325M
		3.	Molecular weight: ADL
	B.	1.	Boiling point: NFPA-325M, MCA
		2.	Specific gravity: MCA
		3.	Vapor density: MCA
		4.	Melting point: MCA
		5.	Vapor pressure: MCA
		6.	Solubility in water: K-O
		7.	Evaporation rate: Exxon
		8.	Appearance and odor: NFPA-49, MCA
II.	A.	1.	Flash point: NFPA-325M, MCA
		2.	Autoignition temperature: NFPA-325M
		3.	Flammable limits: NFPA-325M
		4.	Extinguishing media: NFPA-49, MCA
		5.	Special fire fighting procedures: NFPA-325M, NFPA-49
		6.	Unusual fire and explosion hazards: NFPA-49
	B.	1.	Conditions contributing to instability: ADL
		2.	Incompatibilities: NFPA-491M
		3.	Hazardous decomposition products: None
		4.	Special precautions: Exxon
III.	A.		Steps if released or spilled: NFPA-49, MCA, Exxon
	C.		Waste disposal method: MCA
V.			Miscellaneous precautions: NFPA-49, MCA

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

"Benzene," Hazard Process Index, Hazard Entry No. 20, NIOSH, HSM-99-73-62 (HPI)

"Benzene," Hygienic Guide Series, American Industrial Hygiene Association, May - June 1970 (Hygienic Guide)

"Benzene," Chemical Data Sheet No. 3, Massachusetts Department of Labor and Industries, November 1973 (Data Sheet)

Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)

Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw - Hill, 1974 (Considine)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, vol. III, 1964 (K-O)
Stanford Research Institute, "Chemical Economics Handbook," May 1972 (SRI)

References for Specific Use/Exposure

1. Considine, K-O, SRI
2. Data Sheet, HPI
3. Data Sheet, Hygienic Guide
4. ILO
5. Considine, HPI
6. Data Sheet, SRI
7. Browning, ILO
8. Considine, Hygienic Guide, K-O, SRI

References for Specific Control Methods

Hygienic Guide and ILO were the references used in all the Specific Control Methods.

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and Supporting Documentation for BENZENE

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Benzene

D. O. L. STANDARD: 10 ppm time-weighted average, where 25 ppm is the acceptable ceiling concentration except that a peak of 50 ppm is permitted for ten minutes during an 8-hour work shift.

WARNING PROPERTIES:

Odor Threshold: The AIHA Hygienic Guides state that "odor thresholds of 4.68 ppm and 1.5 ppm have been reported. Since benzene has an odor intensity between 1 (very faint) and 2 (faint) on an odor scale ranging from 0 to 5 and an irritation rating of zero, olfactory detection of levels at or in excess of the TLV is not reliable."

Eye Irritation Level: Grant states that "the local effects of benzene vapor or liquid on the eye are slight. Only at very high vapor concentrations, higher than would be safe for systemic absorption, is there any smarting sensation in the eye. Keratitis has been ascribed to industrial contact with benzene vapor, but most likely was caused by other solvents, which were present at the same time."

Evaluation of Warning Properties: Since the Hygienic Guides state that "olfactory detection of levels at or in excess of the TLV is not reliable," and since eye irritation occurs only at high vapor concentrations, benzene is treated as a material with poor warning properties. Gas sorbent respiratory equipment is not permitted.

IDLH: 3000 ppm

Basis for IDLH Value: This IDLH is based upon the report in Patty and in several other sources that, for man, a single exposure to 3000 ppm is "endurable for 0.5 to 1 hour."

Other Toxicological Information: Patty states that "acute poisoning by benzene is due to its narcotic action and in many respects resembles that caused by other low molecular weight petroleum hydrocarbons. Flury gives the following figures for a single exposure for man: 3000 ppm -- endurable for 0.5 to 1 hour; 7500 ppm -- dangerous after 0.5 to 1 hour; 20,000 ppm -- fatal after 5 to 10 minutes. The inhalatio of a high concentration of benzene may cause exhilaration followed by drowsiness, fatigue, vertigo, nausea, and headache. With higher concentrations of longer exposure times, convulsions followed by paralysis and loss of consciousness may result. An initially rapid respiration soon diminishes in rate and circulatory collapse may follow. Death may ensue quickly from respiratory paralysis after severe exposure. Dautrebande found that dogs inhaling benzene initially developed hypertension. This was soon followed by paralysis of the vasomotor system due to the effect of benzene on the smooth muscle of the blood vessels. High concentrations of benzene are irritating to the mucous membranes of the eyes, nose, and respiratory tract. Liquid benzene is irritating to the skin and direct contact of liquid benzene with the lung (aspiration) will cause severe pulmonary edema and hemorrhage which may be fatal depending on the volume aspirated."

Patty also reports that "controlled exposures of human beings to concentrations of 50 to 800 ppm indicate that exposure to a concentration of 200 ppm for a period of 8 hours produces mild fatigue, weakness, confusion, and paresthesias of the skin. The fatigue persisted for hours and moderate insomnia and restlessness

resulted. The same symptoms were more pronounced with 300 ppm. With 400 ppm mental confusion was added to the list of symptoms. With 600 ppm extreme fatigue, mental confusion, exhilaration, nausea, headache, and dizziness resulted by the end of 3 hours. After 8 hours, the mental confusion, weakness, dizziness, and nausea were pronounced. The pupils were dilated and accommodation to light was impaired. The subjects lost coordination and had a staggering gait. These effects persisted for hours and the subjects complained of insomnia. Fatigue and nervousness were still present on the second day. With 800 ppm the same symptoms were more pronounced and after effects, characterized by severe nervousness, muscular fatigue, and insomnia, lasted for several days. Exposures to 50 and 100 ppm failed to present distinct symptoms or after effects."

The Hygienic Guides report similar information. In addition, the Guides state that "the LC50 (4-hour) for rats was reported to be 16,000 ppm and the minimum concentration causing death of a mouse was 14,100 ppm."

LFL: 13,000 ppm

VAPOR PRESSURE AT 20 C: 75 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 98,700 ppm

USE/EXPOSURE AND CONTROL DOCUMENT
BENZENE

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid during use in organic synthesis (raw material in the production of extremely large numbers of aromatic compounds and derivatives - ethylbenzene for styrene, cyclohexane, cumene, chlorobenzene, alkylbenzenes, nitrobenzene, benzenesulfonic acid, maleic anhydride, etc.). Benzene derivatives are used for rubber products, polystyrene plastics, fibers, detergents, surface coatings, aspirin, weed killers, insecticides, dyes, solvents, sulfur drugs, films, resins, etc.	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
2.	Inhalation of vapor and skin contact with liquid during the manufacture and processing of benzene (92% is obtained from petroleum sources, 12% is coal derived). Benzene is supplied commercially in five grades according to the amount of impurities present.	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
3.	Inhalation of vapor and skin contact with liquid during use of organic chemicals in which benzene may be an impurity (naphthas, toluene, xylene)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
4.	Inhalation of vapor and skin contact with liquid during the cleaning and maintenance of storage vessels and equipment or during the clean up of accidental spills	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves, protective clothing, respiratory protective devices)

5.	Inhalation of vapor and skin contact with liquid during use as an extraction solvent (selective solvent extraction of lubricating oils - used to separate high- and low-viscosity index constituents of lubricating oils, gas absorption separations, lubricating oil purification)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles); material substitution
6.	Inhalation of vapor and skin contact with liquid during the preparation and use of paint and varnish removers, rubber cements, lacquers, etc. (In spite of its toxicity, extremely small amounts of benzene seem to be used in this capacity)	A,B,D	Process enclosure - when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles) material substitution
7.	Inhalation of vapor and skin contact with liquid during use as a general solvent (waxes, resins, oils, rubber, plastics, fats). Because of its excellent solvent capacity and low cost, benzene was among the most widely used solvents. Recognition of its high toxicity has almost negated its use as a general solvent.	A,B,D	Process enclosure -when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles) material substitution
8.	Inhalation of vapor and skin contact with liquid during manufacture and use of motor fuel blends where benzene is used as an ingredient. Its use in motor fuels has diminished but there are still several current production gasolines containing up to 2.3% benzene.	A,B,D	Process enclosure -when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles) material substitution

A -- Inhalation

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

------ JES2 JOB STATISTICS ------

1,489 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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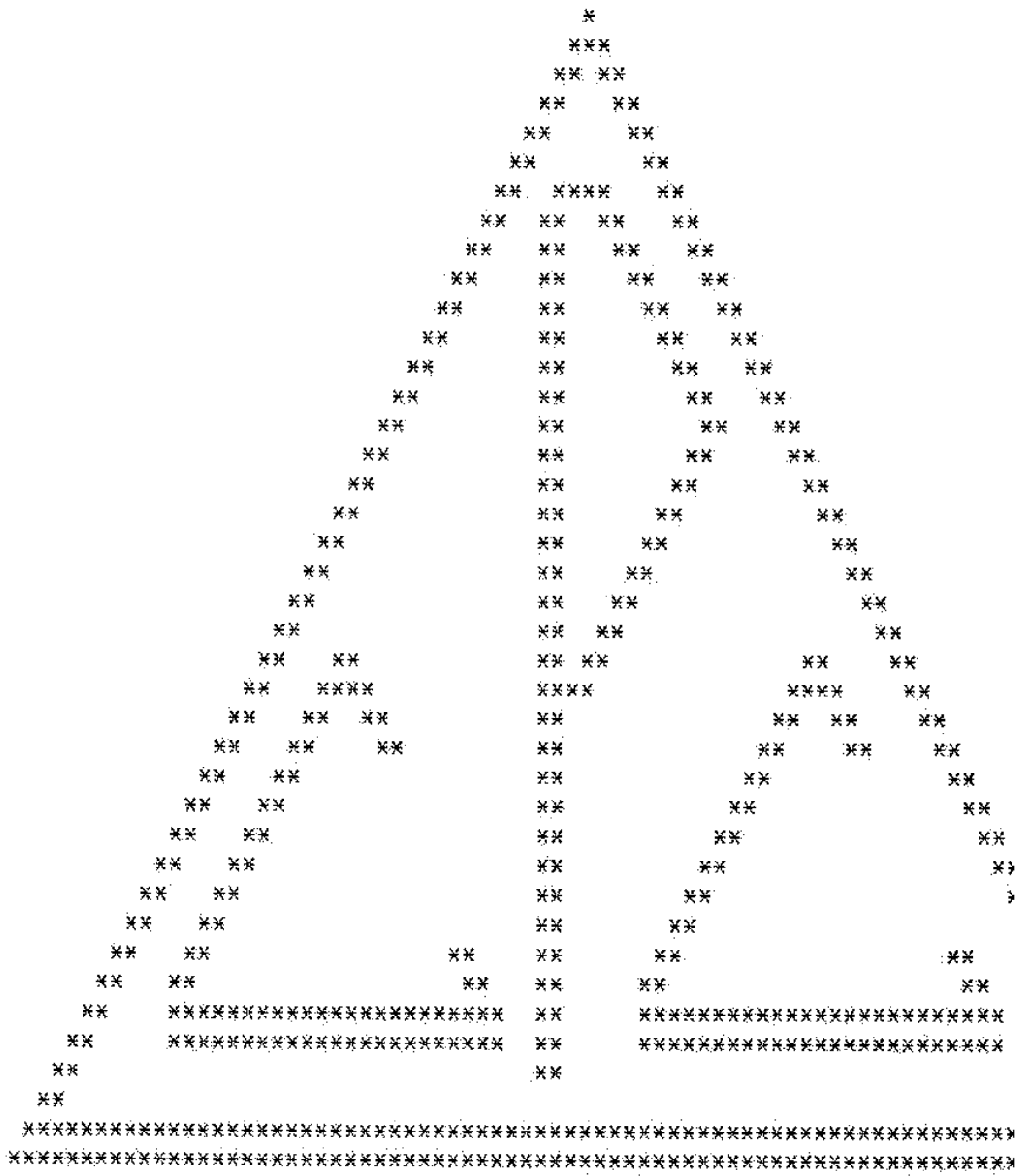

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NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** BENZENE ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for BENZENE

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 BENZENE.

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.

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of benzene not in excess of 10 parts per million (ppm), averaged over an eight-hour work shift (time weighted average) and not in excess of 25 parts per million (ppm) at anytime during an eight-hour work shift except that an exposure not in excess of 50 parts per million (ppm) at any aggregate of 10 minutes shall be permitted as stated in § 1910.1000, Table Z-2.

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

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which benzene is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of benzene 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 benzene.

(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 benzene;

(ii) Any measurements of benzene taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to benzene; 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 benzene 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 benzene 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 benzene 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 benzene 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 (c) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to benzene 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.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to benzene 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 the time period appropriate to the permissible exposure (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
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 benzene above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of benzene 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 benzene.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving benzene shall be classified as A-1 at 21 degrees C (70 degrees F).

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

(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 benzene 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 BENZENE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor concentration	
100 ppm or less	Any supplied-air respirator.
	Any self-contained breathing apparatus.
500 ppm or less	Any supplied-air respirator with a full facepiece, helmet or hood.
	Any self-contained breathing apparatus with a full facepiece.
3000 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode
Greater than 3000 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 mo
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 benzene.
	Any escape self-contained breathing apparatus.

(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) of this section) for benzene.

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

(3) For the purpose of compliance with § 1910.157, benzene 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 benzene shall be Class I, Group D.

(5) For the purpose of compliance with § 1910.106, liquid benzene is classified as a Class IB flammable 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 benzene is present in the ductwork in concentrations greater than 3500 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 benzene presents a fire or explosion hazard.

(10) Benzene shall be stored so as not to come in contact with strong oxidizers including chlorine and bromine in the presence of iron.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent repeated or prolonged skin contact with liquid benzene. Face shields shall comply with § 1910.133(a)(2), (a)(4), (a)(5), and (b)(6).

(2) Employers shall ensure that clothing wet with benzene is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of benzene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the benzene, the employer shall inform the person performing the operation of the hazardous properties of benzene.

(3) Employers shall ensure that any clothing which becomes wet with liquid benzene be removed immediately and that non-impervious clothing which becomes contaminated with benzene be removed promptly. Such clothing shall not be reworn until the benzene is removed from the clothing.

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

(g) Spills and disposal. (1) In the event that liquid benzene is spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

(2) Liquid benzene shall not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive vapors are permitted.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with benzene promptly wash or shower with soap or mild detergent and water to remove any benzene from the skin.

(2) Employers shall ensure that employees who handle liquid benzene wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

(i) Training and information. (1) Each employer who has a workplace in which benzene 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 benzene above the action level without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact with liquid benzene, or employees who work where benzene presents a fire or explosion hazard, shall annually:

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

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

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to benzene 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 benzene.

(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) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to airborne concentrations of benzene above the action level, without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact with liquid benzene, a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the blood, central nervous system and skin;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit;

(iii) Urinalysis to include specific gravity, albumin, glucose, and a microscopic on centrifuged sediment;

(iv) Determination of phenol concentration in the urine.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of benzene above the action level, without regard to the use of respirators, or employees who may have repeated or prolonged skin contact or who may have eye contact

with liquid benzene, twelve months from the date of the employee's first exposure, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the blood, central nervous system and skin to be performed annually;

(ii) A complete blood count to include at least red and white cell count, a differential smear, hemoglobin and hematocrit to be performed annually;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment to be performed annually;

(iv) Determination of phenol concentration in the urine to be performed quarterly. If a worker's urine phenol is found to be 75 mg/liter or greater, calculated to a specific gravity of 1.024, two followup urine samples shall be obtained within 1 week after receipt of the results, one as close to the beginning and one as close to the end of the same working day as possible. If the original elevated finding is confirmed, steps to reduce the worker's absorption of benzene shall be taken promptly.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) Interim medical examination. The employer shall provide an interim medical examination including a determination of phenol concentration in the urine for the employee if the employee informs the employer of any of the signs or symptoms of exposure to benzene which are listed in Appendix * or anytime overexposure to benzene is suspected.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

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

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

(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 level; and

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

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(8) Physician's written opinion. (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 benzene;

(B) Any recommended limitations upon the employee's exposure to benzene, 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.

(9) Results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician for inclusion in the employee's medical record:

(i) A recording of the results of the blood tests and urinalysis;

(ii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to benzene 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.

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section, with the exception of phenol determinations in the urine, need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) 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.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to benzene.

(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 benzene.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to benzene 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, social security number 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 and social security number 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 and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to benzene;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

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

(iii) This record shall be maintained for the duration of and for thirty years 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 benzene.

(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.

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

(2) When observation of measurement of employee exposure to benzene 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 benzene that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for benzene 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 benzene, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR BENZENE

I. SUBSTANCE IDENTIFICATION

A. Substance: Benzene

B. Permissible Exposure: 10 parts of benzene per million parts of air (ppm) averaged over an eight-hour work shift, where 25 ppm shall not be exceeded during an eight-hour work shift, but that a peak of 50 ppm is permitted for 10 minutes during an eight-hour work shift.

C. Appearance and odor: Colorless liquid with an aromatic odor.

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Benzene can affect your body if you inhale it or if it comes in contact with your eyes or skin or if you swallow it. It may enter your body through your skin.

B. Effects of Overexposure:

1. Short-term Exposure: Inhaling high concentrations of benzene may cause dizziness, headache, excitement and breathlessness. These symptoms may be followed by mental confusion and hysterical symptoms such as shouting or laughing. This is called "a benzene jag" and may be followed by unconsciousness and death. Swallowing benzene may cause abdominal pain, staggering, sleepiness and unconsciousness. Bronchitis or pneumonia may occur after swallowing benzene from the benzene getting into the lungs. Splashing liquid benzene on the skin or eyes may cause irritation.

2. Long-term Exposure: Repeated exposure to benzene may cause anemia, leukemia and other blood abnormalities. Repeated or prolonged skin contact with benzene may cause a skin rash.

3. 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 benzene.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If liquid benzene gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If liquid benzene gets on your skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid benzene soaks through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

C. Breathing: If you or any other person breathes in large amounts of benzene 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 liquid benzene has been swallowed, get medical attention immediately. Do not attempt to make the exposed person vomit.

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 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 benzene. 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 benzene 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 Clothing: You must wear appropriate protective clothing and equipment to prevent repeated or prolonged skin contact with liquid benzene. Replace or repair impervious clothing that has developed leaks.

C. Eye Protection: You must wear splash-proof safety goggles where liquid benzene may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Benzene is a flammable liquid. Its vapors can easily form explosive mixtures with air.

B. Benzene must be stored in tightly closed containers in a cool, well ventilated area away from heat and strong oxidizers including chlorine and bromine in the presence of iron.

C. Sources of ignition such as smoking and open flames are prohibited wherever benzene is handled, used or stored in a manner that could create a potential fire or explosion hazard.

D. Metal containers in operations involving the transfer of five gallons or more of benzene should be grounded and bonded.

E. Clothing wet with liquid benzene can be easily ignited. You must immediately remove this clothing and it must not be reworn until the benzene is removed from the clothing.

F. You must promptly remove any non-impervious clothing that becomes contaminated with liquid benzene and this clothing must not be reworn until the benzene is removed from the clothing.

G. If your skin becomes contaminated with benzene, you must promptly wash or shower with soap or mild detergent and water to remove any benzene from your skin.

H. If you handle benzene, you must wash your hands thoroughly with soap or mild detergent and water before eating or smoking.

I. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.

J. Ask your supervisor where benzene 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 benzene. In addition, your employer must instruct you in the safe use of benzene, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to benzene. 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 thirty years 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 benzene 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 benzene, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Benzol, cyclohexatriene, coal tar naptha, phenyl hydride
2. Formula: C_6H_6
3. Molecular weight: 78.1

B. Physical Data

1. Boiling point (760 mm Hg): 80 C (176 F)
2. Specific gravity (water = 1): 0.88
3. Vapor density (air = 1 at boiling point of benzene): 2.7
4. Melting point: 5.4 C (42 F)
5. Vapor pressure at 20 C (68 F): 75 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.1%
7. Evaporation rate (butyl acetate = 1): 5.1
8. Appearance and odor: Colorless liquid with an aromatic odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -11.1 C (12 F) (closed cup)
2. Autoignition temperature: 560 C (1040 F)
3. Flammable limits in air, % by volume: Lower: 1.3; Upper: 7.1

4. Extinguishing media: Dry chemical, foam, 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: Benzene is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where benzene is used, handled or stored in a manner that could create a potential fire or explosion hazard. Benzene vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, benzene is classified as a Class IB flammable liquid. For example, 3500 ppm, approximately one-fourth of the lower flammable limit, is one situation in which benzene 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 benzene shall be Class I, Group D.

B. Reactivity
1. Conditions contributing to instability: Heat.
2. Incompatibilites: Contact with strong oxidizers, including chlorine or bromine in the presence of iron, may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving benzene.
4. Special precautions: Benzene will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If benzene is spilled or leaked, the following steps should be taken:
1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Benzene must not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude formation of explosive concentrations of benzene are permitted.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Benzene may be disposed of by atomizing in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure Above the Action Level:

1. Eight hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average eight-hour exposure may be determined from a single sample or two (2) four-hour samples. Short term samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the eight-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

2. Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of benzene in the employee's breathing zone. A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

3. Peak Above Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentration of benzene. Each measurement should consist of a 5-minute sample or series of consecutive samples totaling five (5) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

4. Monitoring Techniques: The sampling and analyses under this section 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 analyses. The method of measurement must determine the concentration of benzene 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). When sampling for peak exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the

employee has or has not, in fact, been exposed in excess of the permissible limit. 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 benzene 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 U" (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

A. Store benzene in tightly closed containers in a cool, well ventilated area.

B. High exposures to benzene can occur when transferring the liquid from one container to another.

C. Metal containers in operations involving the transfer of five gallons or more of benzene should be grounded and bonded.

D. Storage tanks and process lines containing benzene should be maintained above 5 C (42 F) to prevent freezing.

E. Employers should advise employees of all areas and operations where their exposure to benzene could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to benzene is likely to occur are: During its production and its use as a solvent for inks and shoe cements; as an intermediate in the manufacture of styrene, phenol, detergents, dyes, nylon and pesticides; in organic synthesis; as an extraction solvent and a general solvent; and during the production and use of motor fuel blends.

NOTE: The information contained in the following appendix for benzene 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 benzene, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Benzene vapor at high concentrations causes narcosis; repeated exposure results in depression of the hematopoietic system, and is associated with a higher incidence of leukemia. Concentrations in excess of 3000 ppm are irritating to the eyes, nose, and respiratory tract; continued exposure may cause an initial state of euphoria followed by giddiness, headache, nausea, a staggering gait, and narcosis. The most significant toxic effects of repeated exposures to benzene is an insidious and often irreversible injury to the bone marrow. Human exposure to 150 ppm or more may cause headache, fatigue, anorexia, and lassitude with incipient blood effects including decreased red cell counts with relative lymphocytosis, eosinopenia, and monocytopenia although the total white cell count may remain unchanged. As the condition progresses, the blood abnormalities may be manifested first by anemia and leukopenia, and sometimes by macrocytosis and thrombocytopenia. Leukocytosis, eosinophilia, immature marrow cells in the circulating blood and elevated serum bilirubin may also occur. These findings are manifested clinically by bleeding of the nose and mucous membranes with the appearance of purpuric spots and ecchymoses, shortness of breath, pallor, rapid pulse and low blood pressure. Excessive chromosome aberrations in the nuclei of lymphocytes and bone marrow cells among workers exposed to benzene have been reported. Of 47 workers with benzene hemopathy, 2 had only anemia, 7 had anemia with leukopenia, 5 had anemia with thrombocytopenia, 26 had pancytopenia, 6 had leukemia, and 1 had a leukemoid reaction; this was a marked excess of leukemia among workers with toxic exposure to benzene; all cases of leukemia in this series were of hemocytoblastic type. The liquid splashed in the eyes produces a moderate burning sensation with slight transient injury of the epithelial cells; recovery is rapid. Benzene is a defatting agent and may produce dermatitis upon repeated or prolonged contact with the skin. The major urinary metabolite of benzene is phenol.

III. SIGNS AND SYMPTOMS

Irritation of eyes, nose, respiratory tract; giddiness; headache, nausea, staggering gait; fatigue, anorexia, lassitude; signs and symptoms of bone marrow depression ranging from decreased red cell counts to leukocytosis; dermatitis from repeated or prolonged exposure.

IV. SPECIAL TESTS

Analysis of the urine for phenol, a metabolite of benzene, is necessary in monitoring exposure. Urinary phenol levels in unexposed persons range up to an average of 30 mg/liter of urine; phenol levels of 75 mg/liter or greater are classed as indicative of unacceptable absorption of benzene. A knowledge of the background levels of phenol excretion in the individual is helpful.

V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap or mild detergent and water. Give artificial resuscitation and administer oxygen if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Benzene causes narcosis at high concentrations. Repeated exposure results in depression of the hematopoietic system and has been fatal. Skin absorption is known to occur but is not as important as inhalation. Chronic exposure has been associated with an increased incidence of leukemia. It is important that the physician become familiar with plant operating conditions in which exposure to benzene 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

The following medical procedures must be made available to each employee who is exposed to benzene:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. A history of exposure to benzene, other hematologic toxins, or blood dyscrasias should be obtained. Examination of the blood and central nervous system should be stressed. The skin should be examined for evidence of chronic disorders.

2. A complete blood count -- Benzene has been shown to cause depression of the hematopoietic system in humans. A complete blood count must be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

3. Urinalysis -- Since proper kidney function is necessary for biologic monitoring, a urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose and a microscopic on centrifuged sediment. The urine shall be analyzed for the concentration of phenol in order to establish a baseline.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis, except that the analysis of urine for phenol shall be performed quarterly. If a worker's urine phenol is found to be 75 mg/liter or greater, calculated to a specific gravity of 1.024, two

followup urine samples shall be obtained within 1 week after receipt of the results, one as close to the beginning and one as close to the end of the same working day as possible. If the original elevated finding is confirmed, steps to reduce the worker's absorption of benzene shall be taken promptly.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Benzene," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 22.

2. Hygienic Guide Series: "Benzene," American Industrial Hygiene Association Journal, 31:383-388, 1970.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1220-1225.

4. National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: Criteria for a Recommended Standard....Occupational Exposure to Benzene, (NIOSH) 74-137, U.S. Government Printing Office, Washington, D.C., 1974.

5. Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 3-65.

6. Vigliani, E.C. and G. Saita: "Benzene and Leukemia," The New England Journal of Medicine, 271:872-876, 1964.

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1910.1000

(d) Compliance - Open surface tank classification based on relative evaporation rate of 1.2 hours (from Doolittle).

(e) Fire and Safety

(1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipm H. Carhart et al., National Academy of Sciences, 1973, report to U. S. Coast Guard, report No. CG-D-92-74, p. 9.

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye"

Skin: Manufacturing Chemists' Association, Chemical Safety Data Sheets; American Industrial Hygiene Association, Hygienic Guide Series; American National Standards Institute, "American National Standard Acceptable Concentrations;" Browning, "Toxic and Metabolism of Industrial Solvents;" Patty, "Industrial Hygiene and Toxicology;" American Petroleum Institute, "API Toxicology Reviews;" International Labour Office, "Encyclopedi of Occupational Health and Safety;" Christensen, "NIOSH Toxic Substances List"

Ingestion: American National Standards Institute, "American National Standard Acceptable Concentrations;" Thienes and Haley, "Clinical Toxicology;" Spector, "Handbook of Toxicology;" Christensen, "NIOSH Toxic Substances List;" Sax, "Dangerous Properties of Industrial Materials;" Browning, "Toxicity and Metabolism of Industrial Solvents"

COMMENTS

Eye - Classification: 2

Output statement numbers: 10

Exceptions: None

According to Grant, "experimentally, administration of benzene to rabbits has been found to cause no abnormality in the eyes detectable opthalmoscopically. The local effects of benz vapor or liquid on the eye are slight. Droplet contamination of the eye by benzene causes moderate burning sensation, but only slight transient injury of epithelial cells, and the eye recovers rapidly. Benzene tested on rabbit eyes caused only grade 3 injury on a scale of 1 to 10."

A classification of 2 is concluded to be fully adequate for this substance.

Skin - Classification: 2

Output statement numbers: 2, 7b, 17g and 21 combined, 17i

Exceptions: See below

According to the MCA, "sustained or intermittent skin contact with liquid benzene may produce dermatitis at the site of cont Also reported is that "prolonged or repeated contact of liquid benzene with the skin can cause a defatting action with resulting drying out of the skin and dermatitis." All other sources reviewed agreed with this assessment of the local effects of contact.

The AIHA Hygienic Guide states that "percutaneous absorp-

tion is considered insignificant." According to ANSI, the liquid "is poorly absorbed through intact skin so that systemic intoxication from percutaneous absorption . . . is unlikely to occur." Browning reports that "absorption by the skin is possible, and direct contact . . . does present a risk, though relatively remote in practice, of poisoning." Patty states that "small amounts of benzene are absorbed through the skin wherever the liquid touches the skin. It is not probable that systemic poisoning can arise from immersing the hands in benzene."

The API reports that "skin absorption has received scant attention in the literature. The possibility of percutaneous absorption of benzene has been studied in three cases. Immersion of the hands and forearms from 25 to 35 min. showed no evidence of skin absorption. Unquestionably, small amounts of benzene can be absorbed through the skin, but it is very doubtful that enough would be absorbed by this route to cause systemic poisoning."

The ILO, like others, states that "the outstanding feature of benzene is its ability to injure blood-forming tissues which are chronically exposed to even low concentrations. The onset of chronic benzene poisoning is extremely insidious and its ultimate injury potentially incurable." It also considers the agent to be an agent "possessing established or suspected carcinogenic qualities."

Christensen lists a skin absorption TDLo for the mouse as 1232 mg/kg.

Benzene has a vapor pressure of 75 mm Hg at 20 degrees C. Its melting point is 42 degrees F. It is 0.18% soluble in water and has a flash point of 12 degrees F.

Acute skin exposure to liquid benzene does not appear to present a severe toxic hazard. The substance is, therefore concluded to warrant a classification of 2. However, because of its potentially severe effects, statements 17g and 17i are used instead of 16g and 16i.

Ingestion - Classification: 2

Output statement numbers: 20b

Exceptions: None

ANSI reports "the ingestion of liquid benzene causes local irritation of the mucous membranes of the mouth, throat, esophagus, and stomach. The ingestion of a tablespoonful (about 15 ml) . . . has been known to cause collapse, bronchitis and pneumonia."

Thienes and Haley report that "two ml by mouth may produce symptoms, and 10 ml may be fatal. The symptoms are due to gastric irritation and to depression of the central nervous system, myocardium and bone marrow."

Spector lists the oral rat LD50 as 5700 mg/kg and Christensen gives the LD50 as 3400 mg/kg.

Sax lists the chronic systemic effects of ingestion as being of high toxic hazard.

Browning reports that more benzene is retained in the

body when the vapor is inhaled than when benzene is taken by mouth.

Benzene has a high chronic toxicity and a considerable vapor pressure. To ensure that ingestion does not occur, a classification of 2 is concluded to be most appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

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

Manufacturing Chemists' Association, Chemical Safety Data Sheet, SD-2 (MCA

Exxon Co., USA, Material Safety Data Sheet (Exxon)

International Technical Information Institute, "Toxic and Hazardous Industrial Chemical Safety Manual," (THICSM)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, vol. 3, p. 307 (K-O)

Sources of data items used:

I. A. 1. Synonyms: NFPA-325M
2. Formula: NFPA-325M
3. Molecular weight: ACL

B. 1. Boiling point: NFPA-325M, MCA
2. Specific gravity: MCA
3. Vapor density: MCA
4. Melting point: MCA
5. Vapor pressure: MCA
6. Solubility in water: K-O
7. Evaporation rate: Exxon
8. Appearance and odor: NFPA-49, MCA

II. A. 1. Flash point: NFPA-325M, MCA
2. Autoignition temperature: NFPA-325M
3. Flammable limits: NFPA-325M
4. Extinguishing media: NFPA-49, MCA
5. Special fire fighting procedures: NFPA-325M, NFPA-49
6. Unusual fire and explosion hazards: NFPA-49

B. 1. Conditions contributing to instability: ACL
2. Incompatibilities: NFPA-491M
3. Hazardous decomposition products: None
4. Special precautions: Exxon

III. A. Steps if released or spilled: NFPA-49, MCA, Exxon

C. Waste disposal method: MCA

V. Miscellaneous precautions: NFPA-49, MCA

USE/EXPOSURE AND CONTROL DOCUMENT

References used in the preparation of this document include:

"Benzene," Hazard Process Index, Hazard Entry No. 20, NIOSH, HSM-99-73-62 (HPI)

"Benzene," Hygienic Guide Series, American Industrial Hygiene Association, May - June 1970 (Hygienic Guide)

"Benzene," Chemical Data Sheet No. 3, Massachusetts Department of Labor and Industries, November 1973 (Data Sheet)

Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)

Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw - Hill, 1974 (Considine)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 2nd edition, vol. III, 1964 (K-O)
Stanford Research Institute, "Chemical Economics Handbook," May 1972 (SRI)
References for Specific Use/Exposure
1. Considine, K-O, SRI
2. Data Sheet, HPI
3. Data Sheet, Hygienic Guide
4. ILO
5. Considine, HPI
6. Data Sheet, SRI
7. Browning, ILO
8. Considine, Hygienic Guide, K-O, SRI
References for Specific Control Methods
Hygienic Guide and ILO were the references used in all the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Benzene

O. S. L. STANDARD: 10 ppm time-weighted average, where 25 ppm is the acceptable ceiling concentration except that a peak of 50 ppm is permitted for ten minutes during an 8-hour work shift.

WARNING PROPERTIES:

Odor Threshold: The AIHA Hygienic Guides state that "odor thresholds of 4.68 ppm and 1.5 ppm have been reported. Since benzene has an odor intensity between 1 (very faint) and 2 (faint) on an odor scale ranging from 0 to 5 and an irritation rating of zero, olfactory detection of levels at or in excess of the TLV is not reliable."

Eye Irritation Level: Grant states that "the local effects of benzene vapor or liquid on the eye are slight. Only at very high vapor concentrations, higher than would be safe for systemic absorption, is there any smarting sensation in the eye. Keratitis has been ascribed to industrial contact with benzene vapor, but most likely was caused by other solvents, which were present at the same time."

Evaluation of Warning Properties: Since the Hygienic Guides state that "olfactory detection of levels at or in excess of the TLV is not reliable," and since eye irritation occurs only at high vapor concentrations, benzene is treated as a material with poor warning properti Gas sorbent respiratory equipment is not permitted.

IDLH: 3000 ppm

Basis for IDLH Value: This IDLH is based upon the report in Patty and in several other sources that, for man, a single exposure to 3,000 ppm is "endurable for 0.5 to 1 hour."

Other Toxicological Information: Patty states that "acute poisoning by benzene is due to its narcotic action and in many respects resembles that caused by other low molecular weight petroleum hydrocarbons. Flury gives the following figures for a single exposure for man: 3000 ppm -- endurable for 0.5 to 1 hour; 7500 ppm -- dangerous after 0.5 to 1 hour; 20,000 ppm -- fatal after 5 to 10 minutes. The inhala of a high concentration of benzene may cause exhilaration followed by drowsiness, fatigue, vertigo, nausea, and headache. With higher concentrations of longer exposure times, convulsions followed by paralysis and loss of consciousness may result. An initially rapid respiration soon diminishes in rate and circulatory collapse may follow. Death may ensue quickly from respiratory paralysis after severe exposure. Dautrebande found that dogs inhaling benzene initially developed hypertension. This was soon followed by paralysi of the vasomotor system due to the effect of benzene on the smooth muscle of the blood vessels. High concentrations of benzene are irritating to the mucous membranes of the eyes, nose, and respiratory tract. Liquid benzene is irritating to the skin and direct contact of liquid benzene with the lung (aspiration) will cause severe pulmonary edema and hemorrhage which may be fatal depend on the volume aspirated."

Patty also reports that "controlled exposures of human beings to concentrations of 50 to 800 ppm indicate that exposure to a concentration of 200 ppm for a period of 8 hours produces mild fatigue, weakness, confusion, and paresthesias of the skin. The fatigue persisted for hours and moderate insomnia and restlessness

resulted. The same symptoms were more pronounced with 300 ppm. With 400 ppm mental confusion was added to the list of symptoms. With 600 ppm extreme fatigue, mental confusion, exhilaration, nausea, headache, and dizziness resulted by the end of 3 hours. After 6 hours, the mental confusion, weakness, dizziness, and nausea were pronounced. The pupils were dilated and accommodation to light was impaired. The subjects lost coordination and had a staggering gait. These effects persisted for hours and the subjects complained of insomnia. Fatigue and nervousness were still present on the second day. With 800 ppm the same symptoms were more pronounced and after effects, characterized by severe nervousness, muscular fatigue, and insomnia, lasted for several days. Exposures to 50 and 100 ppm failed to present distinct symptoms or after effects."

The Hygienic Guides report similar information. In addition, the Guides state that "the LC50 (4-hour) for rats was reported to be 10,000 ppm and the minimum concentration causing death of a mouse was 14,100 ppm."

LFL: 13,000 ppm

VAPOR PRESSURE AT 20 C: 75 mm Hg

SATURATED CONCENTRATION AT 20 C: Approximately 98,700 ppm

USE/EXPOSURE AND CONTROL DOCUMENT
BENZENE

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid during use in organic synthesis (raw material in the production of extremely large numbers of aromatic compounds and derivatives - ethylbenzene for styrene, cyclohexane, cumene, chlorobenzene, alkylbenzenes, nitrobenzene, benzenesulfonic acid, maleic anhydride, etc.). Benzene derivatives are used for rubber products, polystyrene plastics, fibers, detergents, surface coatings, aspirin, weed killers, insecticides, dyes, solvents, sulfur drugs, films, resins, etc.	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing goggles)
2.	Inhalation of vapor and skin contact with liquid during the manufacture and processing of benzene (92% is obtained from petroleum sources, 12% is coal derived). Benzene is supplied commercially in five grades according to the amount of impurities present.	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing goggles)
3.	Inhalation of vapor and skin contact with liquid during use of organic chemicals in which benzene may be an impurity (naphthas, toluene, xylene)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing goggles)
4.	Inhalation of vapor and skin contact with liquid during the cleaning and maintenance of storage vessels and equipment or during the clean up of accidental spills	A,B,D	Local exhaust ventilation; general dilution ventilation; personal protective equipment (goggles, gloves, protective clothing respiratory protective devices)

5.	Inhalation of vapor and skin contact with liquid during use as an extraction solvent (selective solvent extraction of lubricating oils - used to separate high- and low-viscosity index constituents of lubricating oils; gas absorption separations; lubricating oil purification)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles); material substitution
6.	Inhalation of vapor and skin contact with liquid during the preparation and use of paint and varnish removers, rubber cements, lacquers, etc. (In spite of its toxicity, extremely small amounts of benzene seem to be used in this capacity)	A,B,D	Process enclosure - when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (glove protective clothing, google material substitution
7.	Inhalation of vapor and skin contact with liquid during use as a general solvent (waxes, resins, oils, rubber, plastics, fats). Because of its excellent solvent capacity and low cost, benzene was among the most widely used solvents. Recognition of its high toxicity has almost negated its use as a general solvent.	A,B,D	Process enclosure -when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (glove protective clothing, google material substitution
8.	Inhalation of vapor and skin contact with liquid during manufacture and use of motor fuel blends where benzene is used as an ingredient. Its use in motor fuels has diminished but there are still several current production gasolines containing up to 2.3% benzene.	A,B,D	Process enclosure -when possible; local exhaust ventilation; general dilution ventilation; personal protective equipment (glove protective clothing, google material substitution

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

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------ J652 JOB STATISTICS ------

1,508 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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