



ARIZONA STATE UNIVERSITY

Benzene Exposure Management Plan
Pursuant to 29 CFR § 1910.1028

Arizona State University
Department of Environmental Health & Safety, August 2002

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Arizona State University Environmental Health & Safety
Benzene Exposure Management Plan

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Arizona State University Environmental Health & Safety

Benzene Exposure Management Plan

Introduction and Scope

The Occupational Safety and Health Administration's (OSHA) Benzene Standard, 29 CFR §1910.1028, became effective on December 10, 1987. The intent of the Benzene Standard is to protect employees against harmful over-exposures to benzene through inhalation, skin contact or eye contact. The rule making effort is based on studies that indicate long-term exposure to benzene causes leukemia, a cancer of the blood-forming organs, in humans and may cause various blood disorders.

Benzene is a clear, colorless, flammable liquid with a pleasant, sweet odor. Benzene is an aromatic hydrocarbon that is produced by the burning of natural products. It is also a component of products derived from coal and petroleum. It is found in gasoline and other fuels, and is used in the manufacturing of plastics, detergents, pesticides and other chemicals.

The potential for benzene exposure may occur in any laboratory currently using the chemical. Non-laboratory personnel that may come into contact with benzene are in the Facilities Management trades.

The Arizona State University (ASU) Benzene Exposure Management Plan includes a summary of permissible exposure levels, exposure monitoring and training, medical surveillance and medical removal, record keeping, regulated areas, hazard communication, emergency procedures, primary reliance on engineering and work practices to control exposure and maintenance and selection of personal protective equipment.

This plan does not apply the storage, transportation, dispensing or use of gasoline, motor fuels or other fuels containing benzene or work operations where the only exposure to benzene is from liquid mixtures containing 0.1 percent or less of benzene by volume or the vapors released from such liquids.

Responsibilities

Department administrators and laboratory supervisors have the primary responsibility for ensuring that their personnel are trained appropriately and that departmental activities are compliant. Ultimately, each employee is responsible for being knowledgeable about the hazardous materials they work with and complying with applicable institutional, local, State, and Federal regulations. However, ASU Environmental Health & Safety will assist individual departments and units to adequately protect university employees from potential occupational exposures to benzene and to achieve regulatory compliance with the OSHA requirements by:

- Identifying locations where exposure to benzene is possible;
- Evaluating the process(es) in which benzene is used;
- Evaluating the airborne concentration of benzene in areas at higher risk for over-exposure; and
- Educating employees about the risks of over-exposure, and safe handling and use of benzene.

Exposure Control

Exposure Limits

OSHA sets Permissible Exposure Limits (PEL) for many chemicals. The PEL is the allowable exposure that an employee can be exposed to over an eight-hour time weighted average. The current PEL for benzene is 1 part benzene per million parts air (ppm). Since this is an 8-hour average, short-term exposures above the PEL are permitted as long as the average exposure over an 8-hour period does not exceed the PEL.

However, OSHA has set a Short Time Exposure Limit (STEL) for benzene that cannot be exceeded. The STEL is the greatest concentration of benzene in air to which exposure may occur for a fifteen-minute period. The current STEL is 5 ppm.

The action level is 0.5 ppm, measured over 8 hours. At this level, certain provisions of the standard, such as employee exposure monitoring and medical surveillance, are initiated. The action level is set lower than the PEL to better protect against overexposure.

Effects of Exposure

Benzene is a known human carcinogen and causes various blood disorders. It may affect the body through accidental ingestion, inhalation, skin contact, and/or eye contact.

Effects of Short-Term (Acute) Exposure

If ingestion is the route of exposure, benzene may cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal.

Inhaling benzene vapors may cause respiratory tract irritation. Exposure may cause adverse central nervous system effects including headache, convulsions, and possible death. Inhalation may also cause drowsiness, unconsciousness and central nervous system depression. Central nervous system effects may include confusion, ataxia, vertigo, tinnitus, weakness, disorientation, lethargy, drowsiness and finally coma. Inhalation of benzene vapors may also lead to irreversible bone marrow injury, and aplastic anemia. Benzene may be absorbed through the lungs.

Skin absorption (dermal) can result in irritation. Direct contact with benzene may cause erythema (redness) and vesiculation (blistering). Prolonged or repeated contact has been associated with the development of dry, scaly dermatitis or with secondary infections. Accidental splashes into the eyes may cause severe eye irritation and slight transient injury.

Employees must immediately report to their supervisor any adverse signs or symptoms that are suspected to be attributable to benzene exposure.

Effects of Long-Term (Chronic) Exposure

The Department of Health and Human Services has determined that benzene is a known human carcinogen. Long-term exposure to high levels of benzene in the air can cause leukemia, cancer of the blood-forming organs. Chronic exposure may cause bone marrow abnormalities with damage to blood forming tissues and anemia. Prolonged or repeated exposure may cause adverse reproductive effects. Animal studies have reported fetotoxicity, degenerative effects in a developing fetus or embryo; and teratogenicity, malformations to an embryo or fetus.

Exposure Determination and Monitoring

ASU Environmental Health & Safety will conduct representative initial and periodic monitoring for each job classification or process where a potential for benzene exposure may exist. Initial monitoring will consist of identifying those employees who may be exposed at or above the action level or STEL. This monitoring process will be repeated each time there is a change in

production, equipment, process, personnel or control measures which may result in new or additional exposure to benzene.

Employees or their designated representative will be able to observe any monitoring under this program. When observation of the measuring or monitoring of employee exposure to benzene requires entry into areas where the use of protective clothing, equipment or respirators is required, ASU must ensure that the observer uses such protective devices and complies with all other applicable safety and health procedures.

Determination of initial monitoring will be based upon the laboratory's current chemical inventory that is submitted yearly by each laboratory to ASU Environmental Health & Safety. Any laboratory that has benzene on its' inventory is given a *Benzene Use Evaluation Form* (Appendix C) to complete. If the chemical is no longer in use, the laboratory must contact ASU's Hazardous Waste Unit to have all benzene products picked up for proper disposal and then submit an updated chemical inventory to reflect this change. If benzene is used in the laboratory, Environmental Health & Safety will evaluate the use forms and determine if monitoring is warranted.

The frequency of monitoring will be determined by the results of the initial monitoring. The frequency is summarized in the following table.

Table 1

Results	Frequency
Less than the action level (0.5 ppm) twice within 7 days	May discontinue monitoring
At or above the action level (0.5 ppm), and at or below the PEL (1 ppm)	Annual
Above the PEL (1 ppm)	Semi-annual*

** ASU may alter the monitoring schedule from every six months to annually for any employee for whom two separate measurements taken at least seven days apart indicate that the employee exposure has decreased to the PEL or below, but is at or above the action level.*

Monitoring for the STEL will be repeated as necessary to evaluate exposures of employees subject to short-term exposures.

ASU Environmental Health & Safety will ensure that personal and area air monitoring is conducted in accordance with OSHA's sampling and analytical method 12, and/or the National Institute for Occupational Safety and Health (NIOSH) recommended methods and that samples are analyzed by an AIHA accredited laboratory. Monitoring techniques will be accurate, at the 95% confidence level, to within plus or minus 25% for airborne concentrations at the PEL (1 ppm) and STEL (5 ppm); and to within plus or minus 35% at the action level (0.5 ppm).

Affected employees will be notified, in writing, within 15 working days after receipt of the monitoring results, either individually or by posting the results in an appropriate locations that is accessible to affected employees. If the PEL is exceeded, the written notification must contain the corrective action being taken by the department to reduce employee exposure to or below the PEL.

Method of Compliance

Each department will institute administrative, engineering and work practice controls to reduce and maintain employees exposure to benzene at or below the PEL and STEL. If these controls cannot reduce employees' exposure below the permissible exposure limits, respiratory protection will be provided to reduce employee exposure to or below the PEL.

Any employee(s) who may be required to wear a respirator or chooses to wear one during certain operations is required to participate in the [ASU Respiratory Protection Program](#), as required by OSHA's Respiratory Protection Standard, 29 CFR § 1910.134.

Protective clothing and equipment resistant to benzene must be provided to employees by their department. Skin and eye contact can be prevented by the use of chemical protective clothing made of material impervious to benzene and the use of other personal protective equipment, such as gloves, goggles and face shields, as appropriate to the operation.

Laboratory supervisors will ensure that all protective clothing is clean, laundered and repaired and/or replaced to maintain its effectiveness. The supervisor will be responsible for the safe disposal of this clothing and equipment.

Each department will ensure that safety showers and eyewash facilities are within the immediate work area for emergency use if there is any possibility that an employees' skin or eyes may become splashed with benzene solutions.

Communication of Hazards to the Employee

Information and Training

The laboratory supervisor will conduct training for ASU employees who are assigned to workplaces where there is a potential for exposure to benzene. This training must occur prior to or at the time of initial assignment, and whenever a new exposure to benzene is introduced into the work area. The training will be repeated annually thereafter if exposures are above the action level.

The training program will be conducted in a manner which the employee is able to understand and will include:

- Requirements of OSHA's Benzene Standard and information available in Appendices A and B of the standard as well as how to access or obtain a copy of it in the workplace;
- Description of the medical surveillance program and the information contained in Appendix C of OSHA's Benzene Standard; and
- Information on the quantity, location, manner of use, release and storage of benzene and the specific operations in the workplace that could result in exposure to benzene.

The supervisor will inform all affected employees of the location of written training materials and will make these materials readily available, without cost, to the affected employees.

In addition, all laboratory employees are required to attend [ASU's Laboratory Safety Training](#), which reviews ASU's Chemical Hygiene Plan (CHP), Material Safety Data Sheets, chemical inventories and labeling, general laboratory safety, personal protective equipment, respirators, audits and compliance, local ventilation and emergency procedures for laboratory incidents.

Labeling and Material Safety Data Sheets

Laboratory supervisors will ensure that hazard-warning labels are affixed to all containers of benzene, which must include the following legend:

DANGER
CONTAINS BENZENE
CANCER HAZARD

As with all chemicals, a Material Safety Data Sheet (MSDS) must be in the laboratory for each chemical containing benzene.

Regulated Areas

In areas where the concentrations of airborne benzene exceeds the PEL and STEL, all entrances and access-ways will be posted with signs bearing the following information:

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE - NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

Only those employees who have been trained to recognize the hazards of benzene will be allowed to enter these areas.

Emergency Procedures

In order to prevent emergencies in those areas using benzene, laboratory supervisors will establish a procedure to detect leaks and spills, including regular visual inspections and preventative maintenance on equipment. Supervisors will ensure that spills are contained and cleaned up promptly, only by those individuals wearing suitable personal protective equipment and who are trained in proper methods of cleanup and decontamination. Any benzene-generated waste must be appropriately contained and labeled in accordance with ASU's [Hazardous Waste Management Compliance Guidelines](#). If the spill may lead to employee overexposure, the supervisor must contact Environmental Health & Safety to perform area or personal monitoring to ensure that exposures have returned to the level that existed prior to the incident.

Employees who discover or are involved in an emergency involving benzene are responsible for notifying the appropriate authorities and following established protocol. This protocol is outlined in the [Arizona State University Emergency Procedures Flipchart](#), the [Arizona State University Emergency Operations Manual](#) and the [ASU Chemical Hygiene Plan](#).

Medical Surveillance

Each department administrator or laboratory supervisor will institute medical surveillance programs for all employees exposed to benzene at concentrations at or exceeding the action level on 30 or more days per year, or exceeding the PEL or STEL for 10 or more days per year.

All medical procedures, including administration of medical disease questionnaires, will be performed by or under the supervision of a licensed physician and will be provided without cost to the employee, without loss of pay, and at a reasonable time and place. An accredited laboratory will conduct all laboratory tests.

Initial medical surveillance must occur prior to assignment to a job. The initial examination must consist of the following elements:

- A detailed occupational history which includes:
 - Past work exposure to benzene or any other hematological toxins;
 - A family history of blood dyscrasias including hematological neoplasms;
 - Blood dyscrasias including genetic hemoglobin abnormalities, bleeding abnormalities, abnormal function of formed blood elements;
 - Renal or liver dysfunction;
 - Medicinal drugs routinely taken;
 - Previous exposure to ionizing radiation; and
 - Exposure to marrow toxins outside of the current work situation;

- A complete physical examination;
- Laboratory tests, which must consist of a complete blood count including a leukocyte count with differential, a quantitative thrombocyte count, hematocrit, hemoglobin, erythrocyte count, and erythrocyte indices (mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and MCH concentration (MCHC)). The examining physician will review the results of these tests;
- Additional tests as necessary in the opinion of the examining physician, based on alterations to the components of the blood or other signs which may be related to benzene exposure; and
- The physical examination must pay special attention to the cardiopulmonary system and shall include a pulmonary function test for all employees required to wear respirators for at least 30 days a year.

The department will provide each affected employee with a medical examination annually following the initial examination. These periodic examinations must include at least the following elements:

- A brief history regarding any new exposure to potential marrow toxins, changes in medicinal drug use and the appearance of physical signs relating to blood disorders;
- A complete blood count including a leukocyte count with differential, quantitative thrombocyte count, hemoglobin, hematocrit, erythrocyte count and erythrocyte indices (MCV, MCH, MCHC); and
- Appropriate additional tests as necessary, in the opinion of the examining physician, in consequence of alterations in the components of the blood or other signs which may be related to benzene exposure.

In addition to the monitoring required above, if an employee is exposed to benzene in an emergency situation, the department will have the employee provide a urine sample at the end of the employee's shift and have a urinary phenol test performed on the sample within 72 hours. The urine specific gravity shall be corrected to 1.024. If the result of the urinary phenol test is below 75 mg phenol/L of urine, no further testing is required. If the result of the urinary phenol test is equal to or greater than 75 mg phenol/L of urine, the department will provide the employee with a complete blood count including an erythrocyte count, leukocyte count with differential and thrombocyte count at monthly intervals for a duration of three (3) months following the emergency exposure.

If the results of the complete blood count required for the initial, periodic and emergency examinations indicate any of the following abnormal conditions exist, then the blood count shall be repeated within 2 weeks:

- The hemoglobin level or the hematocrit falls below the normal limit [outside the 95% confidence interval (C.I.)] as determined by the laboratory for the particular geographic area and/or these indices show a persistent downward trend from the individual's pre-exposure norms, provided these findings cannot be explained by other medical reasons;
- The thrombocyte (platelet) count varies more than 20 percent below the employee's most recent values or falls outside the normal limit (95% C.I.) as determined by the laboratory; and
- The leukocyte count is below 4,000 per mm³ or there is an abnormal differential count.

If the abnormality persists, the examining physician shall refer the employee to a hematologist or an internist for further evaluation unless the physician has good reason to believe such referral is unnecessary. The hematologist's or internist's evaluation shall include a determination as to the need for additional tests, and the department will assure that these tests are provided.

The supervisor will provide the following information to the examining physician:

- A copy of OSHA's Benzene Standard and Appendix A, B, and C of the standard;
- A description of the affected employee's duties as they relate to the employee's exposure to benzene;
- The employee's actual or representative exposure level;
- A description of any personal protective equipment used or to be used; and
- Information from previous employment-related medical examinations of the affected employee which is not otherwise available to the examining physician.

The examining physician must provide a written opinion to the department administrator that contains the results of the affected employees medical examination within 15 days of the examination. The written opinion should be limited to the following information:

- The occupationally pertinent results of the medical examination and tests;
- The physician's opinion concerning whether the employee has any detected medical condition(s) that would place the employee's health at increased risk of material impairment from exposure to benzene;
- Any recommended limitations upon the employee's exposure to benzene, including removal from benzene exposure, or upon the employee's use of respirators, protective clothing, or other protective equipment; and
- A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions resulting from benzene exposure which require further explanation or treatment.

The written opinion obtained by the department will not reveal specific records, findings, and diagnoses that have no bearing on the employee's ability to work in a benzene-exposed workplace.

Medical Removal Plan

When a physician refers an employee to a hematologist/internist, the affected employee will be removed from areas where exposures to benzene may exceed the action level until being evaluated by the hematologist/internist. Following the examination, a decision will be made with the primary physician to allow the employee to return to areas where benzene exposure is above the action level or remove the employee from those areas. This decision will be reported, in writing, to the department and the employee. In the case of removal, the physician will state the required probable duration of removal from occupational exposure to benzene above the action level and the requirements for future medical examinations to review the decision.

For any employee that is removed, the department will provide a follow-up examination where the physician, in consult with the hematologist/internist, will decide within six months of the date the employee was removed as to whether the employee will be returned to the usual job or whether the employee should be removed permanently.

Whenever an employee is temporarily removed from benzene exposure, the department will transfer the employee to a comparable job for which the employee is qualified (or can be trained for in a short period) and where benzene exposures are as low as possible, but in no event higher than the action level. The department will maintain the employee's current wage rate, seniority and other benefits. If there is no such job available, the department will provide medical removal protection benefits until such a job becomes available or for 6 months, whichever comes first.

In the case that an employee is removed permanently from benzene, the employee shall be given the opportunity to transfer to another position which is available or later becomes available for which the employee is qualified (or can be trained for in a short period) and where benzene exposures are as low as possible but in no event higher than the action level. The department will assure that such employee suffers no reduction in current wage rate, seniority or other benefits as a result of the transfer.

Medical Removal Protection Benefits

The department will provide to the affected employee six months of medical removal protection benefits immediately following each occasion an employee is removed from exposure to benzene because of hematological findings, unless the employee has been transferred to a comparable job where benzene exposures are below the action level. Those benefits include the current wage rate, seniority and other benefits of an employee as though the employee had not been removed.

The department's obligation to provide medical removal protection benefits to a removed employee will be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or from employment with another employer made possible by virtue of the employee's removal.

Record Keeping

The Department of Environmental Health & Safety and each individual department will establish and maintain an accurate record of the following:

- Exposure measurements, which must be maintained for at least thirty years, including:
 - The dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures;
 - A description of the sampling and analytical methods used;
 - A description of the type of respiratory protective devices worn, if any; and
 - The name, social security number or ASU ID number, job classification and exposure levels of the employee monitored and all other employees whose exposure the measurement is intended to represent.
- Medical surveillance records, which will be maintained for the at least the duration of the employment plus thirty years, including:
 - The name and social security number or ASU ID number of the employee;
 - The department's copy of the physicians written opinion on the initial, periodic and special examinations, including results of medical examinations and all tests, opinions and recommendations;
 - Any employee medical complaints related to benzene exposure;
 - A copy of the information provided to the physician; and
 - A copy of the employee's medical and work history related to exposure to benzene or any other hematologic toxins.

Upon request, ASU will make available all records maintained as a requirement of this policy for examination and copying to OSHA. In addition, employee exposure and medical records required by this policy shall be provided upon request for examination and copying, to the subject employee or former employee or to anyone having the specific written consent of the subject employee or former employee.

Plan Evaluation

The effectiveness of this plan will be evaluated periodically using the criteria listed below:

- Maintain compliance with applicable institutional, local, State and Federal regulations;
- Maintain 100% participation in mandatory laboratory safety training;
- Processes involving benzene are evaluated at least annually;
- Periodic personal and area air monitoring is conducted in accordance with OSHA and/or NIOSH recommended methods and samples are analyzed by an AIHA accredited laboratory; and
- Maintain exposures below applicable limits or provide appropriate protection.

Related and Supporting Documents

[ASU Chemical Hygiene Plan](#)

[ASU Hazard Communications Plan](#)

[ASU Hazardous Waste Guidelines](#)

[ASU Respiratory Protection Plan](#)

Appendix A

Definitions

Action level: An airborne concentration of benzene of 0.5 ppm calculated as an 8-hour time weighted average.

Authorized person: Any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures.

Benzene: Liquefied or gaseous benzene, CAS Registry No. 71-43-2, including benzene contained in liquid mixtures and the benzene vapors released by these liquids. It does not include trace amounts of unreacted benzene contained in solid materials.

Emergency: Any occurrence such as, but not limited to, equipment failure, ruptures of containers, or failure of control equipment which may or does result in an unexpected significant release of benzene.

Employee exposure: Exposure to airborne benzene that would occur if the employee were not using respiratory protective equipment.

Mean Corpuscular Volume (MCV): This test measures the size of red blood cells.

Mean Corpuscular Hemoglobin (MCH): This test measures the amount of hemoglobin in red blood cells. Both hemoglobin and hematocrit are used to calculate this number.

Mean Corpuscular Hemoglobin Concentration (MCHC): This test measures the amount of hemoglobin in red blood cells. Both hemoglobin and hematocrit are used to calculate this number.

Permissible Exposure Limit: The allowable exposure of benzene than an employee can be exposed to over an eight-hour time weighted average. For benzene, the limit is 1 ppm.

Regulated areas: Any area where airborne concentrations of benzene exceed or can reasonably be expected to exceed, the permissible exposure limits, either the 8-hour time weighted average exposure of 1 ppm or the short-term exposure limit of 5 ppm for 15 minutes.

Short term exposure limit (STEL): A limit of 5 ppm of benzene, averaged over a 15 minute period.

Time-weighted average (TWA): The average exposure to benzene an individual receives for a full eight-hour day.

Appendix B
Benzene Use Evaluation Form

Arizona State University Environmental Health & Safety
Benzene Use Evaluation Form

Department:

Room:

Building:

PI:

Use:

Safety Contact:

- This laboratory does not use benzene or mixtures containing benzene that serve as sources of the substance. I will update the current chemical inventory to reflect this change and submit the updated inventory to Environmental Health & Safety.
- This laboratory currently has benzene, its solutions, mixtures containing benzene that serve as sources of the substance; however, it is no longer in use. I will contact the Hazardous Waste Unit (965-0647) to arrange to have all benzene products picked up for proper disposal. I will update the current chemical inventory to reflect this change and submit the updated inventory to Environmental Health & Safety.

- This laboratory currently uses benzene:

_____ Times a day for _____ hours. The quantity typically used is _____
The number employees involved in this process is _____
The process in which benzene is used: _____

_____ Times a week for _____ hours. The quantity typically used is _____
The number employees involved in this process is _____
The process in which benzene is used: _____

_____ Times a month for _____ hours. The quantity typically used is _____
The number employees involved in this process is _____
The process in which benzene is used: _____

_____ Times a year for _____ hours. The quantity typically used is _____
The number employees involved in this process is _____
The process in which benzene is used: _____

Additional Comments:

Date: _____ Signature: _____

Please return the completed form to Environmental Health & Safety at mail code 3804 or fax 480-965-0736.