

Health Consultation

Evaluation of Former Leaking Underground Storage Tanks
at the Fleet Maintenance Facility

OSAGE FLEET MAINTENANCE FACILITY

DENVER, DENVER COUNTY, COLORADO

FEBRUARY 17, 2009

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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DENVER, DENVER COUNTY, COLORADO

Prepared By:

Colorado Department of Public Health and Environment
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)

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Foreword

The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) of the Colorado Department of Public Health and Environment (CDPHE) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of a health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances.

CCPEHA evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings are relevant to conditions at the site during the time the health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

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Summary and Statement of Issues

The purpose of this document is to identify any potential public health implications resulting from current and future exposures to the plume of gasoline that extends under the Fleet Maintenance Facility and recommend actions to reduce the exposure, if necessary. The site is currently operated by the City and County of Denver (the City) as maintenance and fueling facility, as well as for storage of various street maintenance and solid waste motor equipment. The City's Division of Fleet Maintenance is responsible for the maintenance, repair, specification, rental, retirement, and support of more than 1,700 pieces of equipment.

Many chemicals in unleaded gasoline evaporate readily into the air. Namely, benzene, toluene, ethylbenzene, and xylene (BTEX) belong to a class of organic compounds called volatile organic compounds (VOCs). VOCs have high vapor pressures that enable their vapors to readily enter the atmosphere or buildings where people can be exposed. The City requested assistance from CCEPHA to identify any potential public health implications to workers resulting from current and future exposures to VOC-contaminated indoor air within the Fleet Maintenance Facility as well as any potential public health implications to utility or other trench workers resulting from potential future exposures to VOC-contaminated soil vapor should construction or other trench work occur on site.

Indoor air samples and soil vapor were sampled in 2006 and/or 2007. After a thorough review of the available indoor air data, it is concluded that indoor air quality inside the Fleet Maintenance Facility is considered to pose a public health hazard to workers at a high activity level, based on the theoretical cancer risks. It is further concluded that indoor air is considered to pose no apparent public health hazard to workers at a low activity level, based on the theoretical cancer risks. Furthermore, short-term and chronic noncancer hazards for benzene are likely to be of some concern for a high activity scenario because the estimated exposure doses exceed health guidelines, but these exposure doses are well below levels known to cause adverse health effects in animal and human studies. It should be noted that the estimated cancer risks and noncancer hazards are driven by one extremely high concentration of benzene in indoor air (250 ug/m³) in the breathing zone. It is likely that this peak concentration is representative of exposure to gasoline used in the Fleet maintenance facility. It may not be feasible to separate risks attributable to these contaminants coming from vapor intrusion versus those coming from gasoline used in the facility itself. The potential soil vapor pathway for the future utility workers in a trench is considered to pose no apparent public health hazard based on the theoretical cancer risks and noncancer hazards estimated using the available soil vapor data. Since, benzene is a known human carcinogen, no matter what the source, exposure to benzene should be minimized based on prudent public health practice. To ensure a healthy environment inside the Fleet Maintenance Facility, CCEPHA recommends that the City continue with remediation on-site, consider reduction of exposure to contaminated indoor air by implementing

appropriate engineering options for indoor air as well as vapor intrusion sources, and collect and monitor indoor air samples in the breathing zone during the remaining remediation and after remediation is complete.

Background

Site Description and History

The site is currently operated by the City as a satellite fleet maintenance and fueling facility as well as for storage of various street maintenance and solid waste motor equipment. The Osage facility is located at 2013 S. Osage Street, Denver, Colorado 80223. The City's Division of Fleet Maintenance is responsible for the maintenance, repair, specification, rental, retirement, and support of more than 1,700 pieces of equipment. The facility was originally constructed in approximately 1957; therefore, this is the earliest possible date for the underground storage tank (UST) installation. Several subsurface investigations have been conducted on site starting in 1987 and coinciding with the removal or upgrading of USTs operated by the City. One subsurface investigation, completed in early 1995, indicated that a release of gasoline had occurred, and that both soil and groundwater had been impacted. A plume of chlorinated compounds, typically associated with paints and solvents, was also discovered across the site. This plume has been attributed to an upgradient source not owned or operated by the City (Pinyon, 2003).

Much remediation has already taken place. A contractor to the City is currently conducting cleanup of the contamination originating from the leaking UST on site. Approximately 1,407 cubic yards of contaminated soil have been removed from the site since 1995. Although the initial remediation plan had limited effectiveness, new methods were implemented in 2000 and the most recent monitoring data indicate that contamination levels are decreasing. The remaining site-related concerns include the shallow groundwater and very high dissolved benzene levels creating the potential for benzene exposure via vapor intrusion into the Fleet Maintenance Facility and impacting City staff (Pinyon, 2003).

The City requested assistance from the Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) to evaluate the potential health hazards with respect to current and future air quality at this facility. The purpose of this document is to identify any present or future potential health implications to city workers resulting from inhalation of volatile organic compounds inside the Fleet Maintenance Facility and recommend actions to reduce the exposure, if necessary.

Demographics

The Fleet Maintenance Facility is a big warehouse located in an industrial area. No other information is available regarding the size of the facility and the number of employees, etc.

Vapor Intrusion Pathway

Many chemicals in unleaded gasoline evaporate readily into the air. For example, various combinations of benzene, toluene, ethylbenzene, and xylene (BTEX) are among the most frequently found mixtures in completed exposure pathways at gasoline-contaminated hazardous waste sites. BTEX belong to a class of organic compounds called volatile organic compounds (VOCs). VOCs have high vapor pressures that enable their vapors to readily enter the atmosphere. Vapor intrusion refers to the migration of VOC vapors from a subsurface zone into homes and buildings where people can be exposed. Subsurface sources can include contaminated groundwater and/or soils. Typically, vapors migrate through soils into indoor air spaces of overlaying buildings (EPA, 2006).

It should also be noted that site-related contamination is not the only source of BTEX in indoor air. BTEX are also present in many indoor sources including building materials, cleaners, furniture treatments, paint, plastics, sealants, cosmetics, and glues. For example, smoking indoors increases BTEX levels in indoor air. In general, studies have found that the levels of VOCs in indoor air are higher than in outdoor air (EPA, 2006). The contribution of BTEX from indoor sources to the overall indoor air concentration of BTEX introduces a level of uncertainty to the analysis of indoor air samples since it is often difficult to define the contribution of BTEX from each source.

Discussion

Environmental Sampling and Data Used for Exposure Evaluation

The available data utilized in this evaluation include soil vapor and indoor air samples taken by Summit Scientific for the City (Summit Scientific, 2007). No site – specific background samples are available. For indoor air monitoring, a total of twelve samples were taken; six samples each in August and October of 2007. Because there are more than ten samples collected, the 95% Upper Confidence Level (UCL) concentration was chosen as the Exposure Point Concentration (EPC) used in all analyses. The August 2007 samples were collected at ground level and the October 2007 samples were collected in the breathing zone. The results of the sampling analysis and summary statistics for the data used in this evaluation are presented in Appendix B, Table B1.

For the evaluation of potential outdoor exposures to trench workers, soil vapor was sampled in both 2006 and 2007, but the evaluation of soil vapor is based only on the 2007 data, as it best represents the current and future site conditions. Furthermore, use of the 2007 soil vapor data allows for better comparison with the 2007 indoor air data. A total of seven soil vapor data samples were taken at soil depth intervals of 4 feet, 8 feet, and 15 feet. Here, the maximum concentration was chosen as the EPC used in all analyses. The results of the sampling analysis and summary statistics for the data used in this evaluation are presented in Appendix B, Table B3.

Exposure Evaluation

Selection of Contaminants of Potential Concern (COPCs)

For both the indoor air and soil vapor analyses, the maximum concentration was compared with ATSDR health based environmental guidelines or Comparison Values (CVs) to select contaminants of potential concern (COPCs) for further evaluation of potential health effects. Exposures to contaminants below the health risk-based environmental guidelines are not expected to result in adverse or harmful health effects and thus were not evaluated further. For indoor air, the following contaminants were selected as COPCs: MTBE, benzene, and xylene (Appendix B, Table B2). Benzene alone was retained as a COPC for the outdoor exposure evaluation for utility workers in a trench (Appendix B, Table B4).

The Conceptual Site Model

The conceptual site model describes the primary contaminants of potential concern, contaminated sources, and the potential exposure pathways by which different types of populations (e.g. residents and outdoor workers) might come into contact with contaminated media. Exposure pathways are classified as either complete, potential, or

eliminated. Only complete exposure pathways can be fully evaluated and characterized to determine the public health implications. A complete exposure pathway consists of five elements: a source, a contaminated environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population. Workers in the Fleet Maintenance Facility may be exposed to contaminated indoor air via the vapor intrusion pathway. Future utility or trench workers could be exposed to contaminated soil vapors should their activities lead to the disturbance of soils to a certain depth. Incomplete exposure pathways at the Fleet Maintenance Facility include exposures to contaminated groundwater because of the availability of municipal water supply. The overall conceptual site model at the Fleet Maintenance Facility is presented below.

Pathway Name	Exposure Pathway Elements						
	Source	Contaminated Env't'l. Medium	Point of Exposure	Potentially Exposed Population	Route of Exposure	Time Frame	Pathway Complete?
Indoor Air	Leaking Underground Storage Tank (UST)	BTEX in groundwater and soil vapor	Indoor Air	Employees of the Fleet Maintenance Facility	Inhalation	Past Present Future	Complete
Outdoor Soil Vapor	Leaking UST	BTEX in groundwater and soil vapor (4, 8, and 15 feet deep)	Soil vapor in outdoor trench	Utility or other types of workers in a trench	Inhalation	Future	Potential

Public Health Implications

The purpose of this evaluation is to determine whether exposures to COPCs that exceed the CVs for either the indoor air or soil vapor pathways might be associated with adverse health effects. This requires a calculation of site-specific exposure doses for an estimated duration of exposure on-site and comparison with an appropriate toxicity value (or health guideline). For indoor air, MTBE, benzene, toluene, and xylene were selected as COPCs. For the outdoor exposure evaluation for utility workers in a trench, benzene alone was retained as a COPC. The results of health risk calculations are presented in Tables 1-2. The possible cancer and noncancer effects of risk driving COPCs are discussed in Appendices C and D.

Indoor Air Vapor Intrusion Pathway

Indoor air inhalation cancer risks and noncancer hazards were estimated using exposure assumptions of 8 hours/day for 250 days/year for 25 years, and two different inhalation rates to account for a range of physical activity (i.e., low and high) by Fleet Maintenance workers. These calculations yield estimated theoretical cancer risks for benzene that range from 8.21 E-05 (82 excess cancer cases per million persons exposed) at a low activity level to 1.77 E-04 (177 excess cancer cases per million persons exposed) at a high activity level (Table 1). For workers at a high activity level, theoretical cancer risks for benzene exceed the EPA acceptable value of 1.00 E-04. The theoretical cancer risks for MTBE are below the acceptable 1.00 E-06 and are not likely to be of concern (Table 1).

For noncancer adverse health hazards from exposure to benzene, toluene, and xylene in indoor air at the Fleet Maintenance Facility, the estimated exposure doses for workers are about 2 to 6 times higher than the health guidelines for EPA and ATSDR (i.e., Hazard Quotient = 1 to 6 ; Table 1). Thus, short-term and/or chronic noncancer health effects are likely to be of some concern, especially, for benzene. However, significant noncancer health effects are not likely from indoor air exposures to benzene, toluene, and xylene because the estimated exposure doses for these chemicals are significantly below the known health effect levels in animals or humans, i.e., Lowest-Observed-Adverse-Affect-Level (LOAEL) (Table 1).

It is noteworthy that the estimated cancer risks and noncancer hazards are driven by one of the samples collected in the breathing zone that has much higher concentrations of benzene, toluene, ethylbenzene, and xylene than those detected in other samples (Appendix B, Table B1). Although it is unknown why these values are elevated in one sample, these high values could represent an indoor source due to chemical use during maintenance activities in an area of the Fleet Maintenance Facility where ventilation or air exchange is limited, and vapors may be accumulating. We do know that workers inside the Fleet Maintenance facility are exposed to gasoline as part of their normal duties. This known indoor exposure to benzene and other VOCs in gasoline could represent that indoor source that periodically exposes workers to significantly higher than ambient concentrations of VOCs. In considering the estimated theoretical potential carcinogenic health risk for the exposure duration of 25 years, it is important to note that remedial action to remove the source of contamination is ongoing. This will reduce the timeframe of exposure and, subsequently, the potential to experience adverse health effects.

Benzene is ubiquitous in the atmosphere. It has been identified in outdoor and indoor air samples of both rural and urban environments (ATSDR, 2005). For example, benzene is a component of gasoline vapors or vehicle exhaust, cigarette smoke, wood smoke, paints, adhesives, and particle board. EPA, IARC, and the Department of Health and Human Services have concluded that benzene is a human carcinogen. The Department of Health and Human Services determined that benzene is a known carcinogen based on human evidence showing a causal relationship between exposure to

benzene and cancer. Under EPA's most recent guidelines for carcinogen risk assessment, benzene is characterized as a known human carcinogen for all routes of exposure. Since, benzene is a known human carcinogen, no matter what the source, exposure to benzene should be minimized based on prudent public health practice.

Outdoor Soil Vapor Pathway

For outdoor utility workers in a trench, both acute and chronic exposures to soil vapors are evaluated. As such, the estimated theoretical cancer risks are below the acceptable risk range of $1 \text{ E-}04$ to $1\text{E-}06$, and the estimated exposure doses for noncancer acute and chronic hazards are also below the health-based guidelines; thereby, indicating adverse health effects are unlikely (Table 2). The soil vapor concentration of benzene in a trench is diluted as a result of mixing with ambient air. Thus, a trench worker in this scenario would be exposed to a mixture of contaminated soil vapor and 'clean' ambient air rather than undiluted soil vapors. No USEPA models are available to predict air concentrations in a trench. Therefore, risk has been calculated, semi-quantitatively, with the EPC diluted 100 times and 1000 times. This allows for a range of risks to better represent the uncertainty associated with mixing of air in a trench exposure scenario. The assumption of 100 to 1000-fold dilution is based on the 10-fold (0.1) dilution factor from sub-slab soil gas to indoor air concentrations recommended by the USEPA vapor intrusion guidance (Pers. Comm. Dr. Helen Dawson of EPA Region 8). This assumption appears to be conservative based on a recent compilation of information by EPA which indicates a 95th percentile attenuation factor of about 0.02 for subslab vapor to indoor air (Dawson et al., 2007 as Cited in ATSDR Vapor Intrusion Guidance).

Limitations

There are inherent uncertainties associated with any risk assessment and indoor air sampling. For instance, the USEPA (2002) notes in the vapor intrusion guidance that concentrations of compounds found in indoor air are often subject to temporal and spatial variations, which may complicate estimates of exposure. Additionally, pressure differences between the inside and outside of a building can cause air to be drawn into the building. The findings of this health consultation are further limited by the inability to model or measure concentration of contaminants in a trench, the inability to distinguish indoor sources of benzene or gasoline from those that may be a result of vapor intrusion, and minimal knowledge of the existing air exchange system in the Fleet Maintenance Facility. Thus, the findings of this health consultation are relevant to conditions at the site during the time the health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and behavioral differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous

substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

It should be noted that children are not expected to be exposed in the Fleet Maintenance building or from trench digging. Therefore, the health effects of BTEX on young children are not discussed further in this evaluation.

Conclusions

Based on the review of the available 2007 indoor data and soil vapor data, the following conclusions are drawn for the indoor workers of Fleet Maintenance Facility and the future potential outdoor workers (e.g., utility workers or excavation workers).

- For current exposures, based on the theoretical cancer risks for benzene, the indoor air quality inside the Fleet Maintenance Facility poses: (a) a public health hazard for workers at a high activity level; and (b) no apparent public health hazard for workers at a low activity level. In addition, short-term and chronic noncancer hazards from benzene are likely to cause some concern for a high activity scenario because the estimated exposure doses exceed health guidelines, but these exposure doses are well below levels known to cause adverse health effects in animal and human studies. It should be noted that the estimated cancer risks and noncancer hazards are driven by one extremely high concentration of benzene in indoor air (250 ug/m³) in the breathing zone. It is likely that this peak concentration is representative of exposure to gasoline used in the Fleet maintenance facility. It may not be feasible to separate risks attributable to these contaminants coming from vapor intrusion versus those coming from gasoline used in the facility itself.

- Past and future exposures inside the Fleet Maintenance Facility are considered to represent an indeterminate public health hazard because indoor air data are not available.
- Based on the 2007 data and estimated theoretical cancer risks and noncancer hazards, potential exposure to VOC-contaminated soil vapors is considered to pose no apparent public health hazard to future trench or utility workers.

Recommendations

Based on prudent public health practice, the following recommendations should be implemented:

- Continue with remediation on-site.
- The City should consider reduction of exposure to contaminated indoor air by taking appropriate measures such as implementing engineering controls for indoor air as well as vapor intrusion sources.
- Collect and monitor indoor air samples in the breathing zone during the remaining remediation and after remediation is complete.

Public Health Action Plan

The public health action plan describes the actions designed to mitigate or prevent adverse human health effects that might result from exposure to hazardous substances associated with site related contamination. CCEPHA and the City commit to do the following public health actions to reduce exposure to site related contamination:

- By request, CCEPHA will evaluate any additional data that may be collected in the future.
- Upon request, CCEPHA will collaborate with the City to conduct health education and outreach activities.
- CCEPHA will make this document available to the public through the CCEPHA website.

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Tables and Figures

Figure 1. Ariel Photograph Outlining Approximate Location of Fleet Maintenance Facility, Google Earth

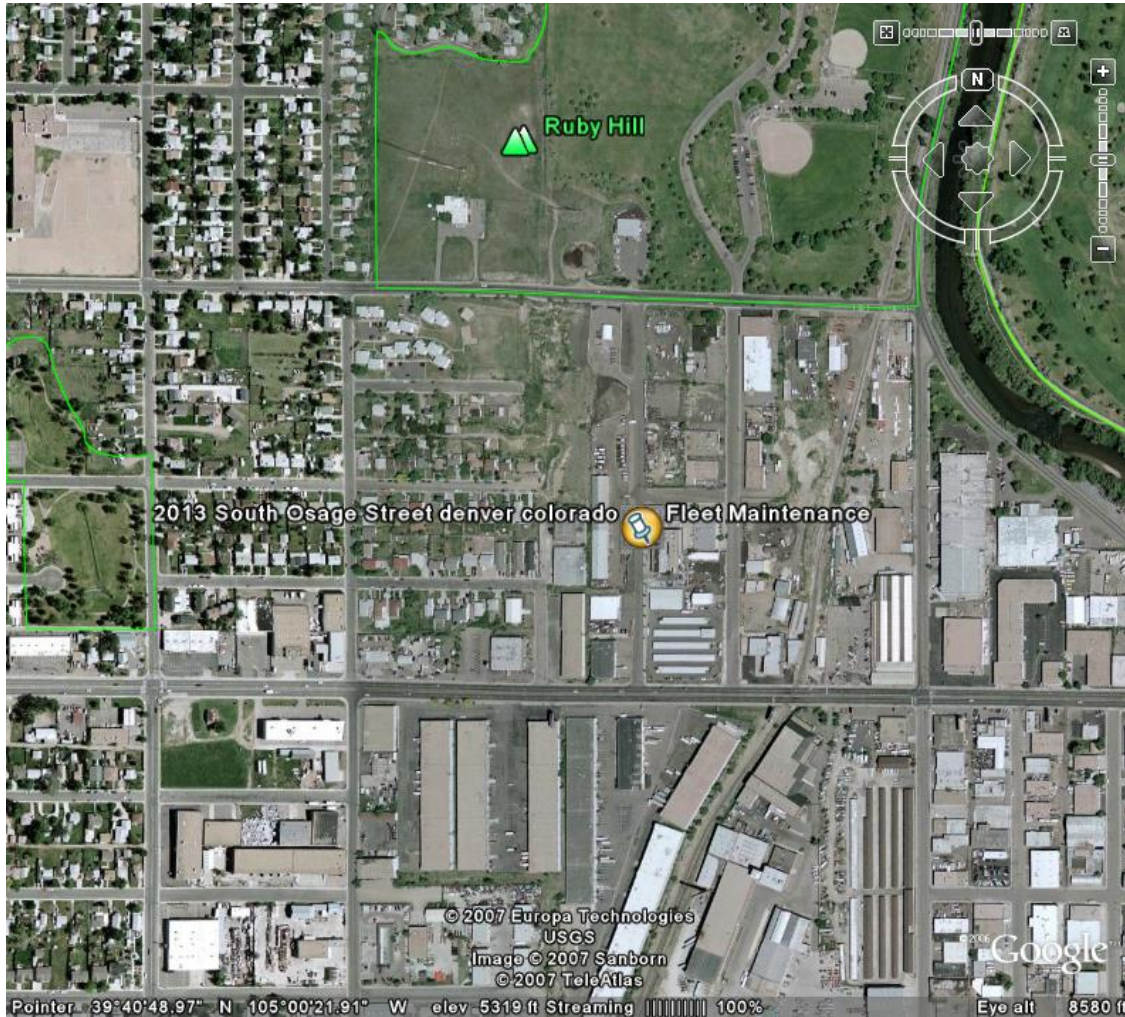


Table 1. Theoretical Cancer Risks and Noncancer Hazards for Benzene, Xylene and MTBE Using Risk-Based Concentrations in Indoor Air

Contaminant	EPC ($\mu\text{g}/\text{m}^3$)	Activity Level	Cancer Risk	Noncancer HQ _{Health guideline}	Noncancer HQ _{LOAEL}
Benzene	93.55	Low	8.21E-05	0.99 ^c	0.004 ^d
MTBE	7.99	Low	2.36E-07	0.0008	NA
Toluene	408.8	Low	NA	0.03	NA
Xylene	343.60	Low	NA	1.04	0.0004 ^b
Benzene ^a	93.55	High	1.77E-04	2.13 ^c	0.008 ^d
MTBE	7.99	High	5.08E-07	0.002	NA
Toluene ^e	408.8	High	NA	0.08	NA
Xylene ^b	343.60	High	NA	2.24	0.0009 ^b

^a The EPC of $93.55 \mu\text{g}/\text{m}^3$ for benzene is also 3-fold above the ATSDR acute MRL of $30 \mu\text{g}/\text{m}^3$ and about 4-fold higher than the intermediate MRL of $20 \mu\text{g}/\text{m}^3$. However, the EPC is significantly below the acute Lowest-Observed-Adverse-Affect-Level (LOAEL) of $8262 \mu\text{g}/\text{m}^3$ as well as the intermediate LOAEL of $5832 \mu\text{g}/\text{m}^3$ in mice used for ATSDR-MRLs derivation.

^b HQ LOAELs are calculated using the EPA IRIS selected LOAEL of $78,000 \mu\text{g}/\text{m}^3$. However, the EPC of $343.6 \mu\text{g}/\text{m}^3$ for xylene is significantly below the intermediate Lowest-Observed-Adverse-Affect-Level (LOAEL) of $2604 \mu\text{g}/\text{m}^3$ in mice, and also below the chronic LOAEL of $6075 \mu\text{g}/\text{m}^3$ in workers used for ATSDR-MRLs derivation.

^c These HQs will be 3-fold higher based on the ATSDR chronic MRL of $10 \mu\text{g}/\text{m}^3$ (vs. EPA RfC of $30 \mu\text{g}/\text{m}^3$ used to derive HQs in Table 1).

^d HQ_{LOAELs} are calculated using the EPA IRIS selected LOAEL represented by the Benchmark Confidence Level (BMCL) of $8200 \mu\text{g}/\text{m}^3$ in humans. However, the ATSDR chronic MRL NOAEL is represented by the BMCL_{0.25sd} of $97.0 \mu\text{g}/\text{m}^3$ in humans (ATSDR, 2005) and results in HQs of 0.3 and 0.7 for low and high activity, respectively. These HQs are based on doses estimated using exposure assumptions and equation noted below. For example, for a high activity level the estimated dose of $0.0183 \text{ mg}/\text{kg} \text{ day}$ is divided by the LOAEL of $0.0277 \text{ mg}/\text{kg} \text{ day}$ (or $97.0 \mu\text{g}/\text{m}^3$) resulting in an HQ of 0.66 (rounded to 0.7).

° These HQs for toluene are calculated using EPA RfC of 5000 µg/m³. However, HQs based on ATSDR MRL of 300 µg/m³ are also below and acceptable level of 1.0 (i.e., HQs are 0.4 and 0.9 for low and high activity, respectively).

Note:

- Exposure dose (mg/kg/day) estimated using the following assumptions and equation:
 - Low activity level inhalation rate = 1.1625 m³/hour or 9.3 m³/day
 - High activity level inhalation rate = 2.5 m³/hour or 20 m³/day
 - Exposure duration (ED) = 25 years
 - Exposure frequency (EF) = 250 days/year
 - Exposure time (ET) = 8 hours/day
 - Body weight (BW) = 70 kg
 - Averaging Time (AT) = 365x25 = 9125 days

$$\text{Exposure dose} = \frac{\text{Air Conc. (mg/m}^3\text{)} \times \text{ET} \times \text{Inhalation rate (m}^3\text{/hour)} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

- HQ = Hazard Quotient = Calculated by dividing the estimated exposure dose with the EPA health guideline or LOAELs (Table 1). ATSDR MRLs or LOAELs are also taken into consideration through discussions in the text.
- µg/m³ = Micrograms per Cubic Meter of Air
- EPC = Exposure Point Concentration (the 95% UCL)
- NA=Not applicable

Table 2. Theoretical Cancer Risk Estimates and Non-cancer hazards for Outdoor Trench Workers Exposed to Benzene Contaminated Soil Vapor – 2007

Soil Depth	SVC ($\mu\text{g}/\text{m}^3$)	EPC (SVC diluted by 100x) ($\mu\text{g}/\text{m}^3$)	Cancer Risk	Noncancer HQ Health guideline
4 feet	170	1.7	3.08E-07	0.009
8 feet	340	3.4	6.16E-07	0.019
15 feet	180	1.8	3.26E-07	0.010

Note:

- It should be noted that the cancer risk estimates and noncancer hazards (HQs) would be 10-fold lower at the EPC based on 1000x dilution of soil vapor concentration in a trench
- Exposure concentrations are also below the ATSDR acute health guideline.
- Chronic exposure doses estimated using the following assumptions:
 - Exposure duration = 10 years
 - Exposure frequency = 60 days/year
 - Exposure time = 8 hours/day
 - Inhalation rate = 2.5 m³/hour or 20 m³/day
 - Body weight = 70 kg
- HQ = Hazard Quotient = Calculated by dividing the estimated exposure dose with the health guideline
- $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter of Air
- EPC = Exposure Point Concentration (the maximum concentration)
- SVC = Soil Vapor Concentration

APPENDICES

Appendix A. ATSDR Plain Language Glossary of Environmental Health Terms

Absorption: How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure: Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Additive Effect: A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

Adverse Health Effect: A change in body function or the structures of cells that can lead to disease or health problems.

Antagonistic Effect: A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

ATSDR: The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level: An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Bioavailability: See **Relative Bioavailability**.

Biota: Used in public health, things that humans would eat - including animals, fish and plants.

BTEX: Mixture of benzene, toluene, ethylbenzene, and xylene.

Cancer: A group of diseases, which occur when cells in the body become abnormal and grow, or multiply, out of control

Carcinogen: Any substance shown to cause tumors or cancer in experimental studies.

CCEPHA: The Colorado Cooperative Program for Environmental Health Assessments

CDPHE: The Colorado Department of Public Health and Environment.

CERCLA: See Comprehensive Environmental Response, Compensation, and Liability Act.

Chronic Exposure: A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

City (the): The City and County of Denver Department of Environmental Health.

Completed Exposure Pathway: See **Exposure Pathway**.

Comparison Value (CVs): Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):

CERCLA was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concern: A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Delayed Health Effect: A disease or injury that happens as a result of exposures that may have occurred far in the past.

Dermal Contact: A chemical getting onto your skin. (See **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration: The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemical of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Exposure: Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

- Source of Contamination,
- Environmental Media and Transport Mechanism,
- Point of Exposure,
- Route of Exposure; and,
- Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, and twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: Lowest Observed Adverse Effect Level. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: Minimal Risk Level. An estimate of daily human exposure - by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

MTBE: Methyl tertbutyl ether.

NPL: The National Priorities List. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: No Observed Adverse Effect Level. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each is defined in the Glossary. The categories are:

- Urgent Public Health Hazard
- Public Health Hazard
- Indeterminate Public Health Hazard
- No Apparent Public Health Hazard
- No Public Health Hazard

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Relative Bioavailability: The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:

- Breathing (also called inhalation),
- Eating or drinking (also called ingestion), and/or
- Getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

SARA: The Superfund Amendments and Reauthorization Act in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

Sample: A small number of people chosen from a larger population (See **Population**).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Synergistic effect: A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together is greater than the effects of the chemicals acting by themselves.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

UST: Underground Storage Tank.

Appendix B. Data Summary and Selection of Contaminants of Potential Concern (COPCs)

Table B1. Summary of Indoor Air Data Collected at the Fleet Maintenance Facility

Sample Location	Date	Benzene ($\mu\text{g}/\text{m}^3$)	Toluene ($\mu\text{g}/\text{m}^3$)	Ethylbenzene ($\mu\text{g}/\text{m}^3$)	Xylenes ($\mu\text{g}/\text{m}^3$)	MTBE ($\mu\text{g}/\text{m}^3$)
FM-IAS1	8/1/2007	72	68	21	100	6.0
FM-IAS2	8/1/2007	17	17	<4.3	41	<3.7
FM-IAS3	8/1/2007	23	56	11	220	3.7
FM-IAS4	8/1/2007	10	11	5.6	26.5	15
FM-IAS5	8/1/2007	4.1	12	<4.3	9.4	<3.7
FM-IAS6	8/1/2007	66	93	43	202	<3.7
FM-VP1	10/5/2007	<4.2	130	35	200	<4.9
FM-VP2	10/5/2007	11	58	12	64	<3.7
FM-VP3	10/5/2007	250	1100	200	870	<13
FM-VP4	10/5/2007	56	330	37	153	<4.8
FM-VP5	10/5/2007	29	240	29	211	<4.8
FM-VP6	10/5/2007	31	200	27	141	<5.0
95% UCL		93.55	408.80	68.32	343.60	7.99

Note:

- $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter of Air
- UCL = Upper Confidence Limit

Table B2. Selection of Chemicals of Potential Concern (COPCs) in Indoor Air at the Fleet Maintenance Facility

Compound	Maximum Conc. ($\mu\text{g}/\text{m}^3$)		ATSDR Comparison Value CREG/EMEG ($\mu\text{g}/\text{m}^3$)	Selected COPCs
MTBE	13.0	1.6	NA	YES
Benzene	250.0	0.23	0.1	YES
Toluene	1100.0	5100	300	YES
Ethylbenzene	200.0	1100	3,000	No
Xylenes	870.0	110	3,000	YES

Note:

- $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter of Air
- UCL = Upper Confidence Limit
- CREG = Cancer Risk Evaluation Guide
- EMEG = Environmental Media Evaluation Guide
- COPC = Contaminant of Potential Concern
- Xylene was retained as a COPC based only on exceedance of EPA Region 3 CV

Table B3. Summary of Available Data for Soil Vapor Sampling 2007

Medium	Depth (Feet)	No. of Samples	Contaminants	Min Value (µg/m ³)	Max Value (µg/m ³)	Mean Value (µg/m ³)
Soil Vapor	4	3	MTBE	ND	ND	90
			Benzene	ND	170	110
			Toluene	ND	1100	430
			Ethylbenzene	ND	540	253.33
			m, p – Xylene	ND	3800	1413.33
			o- Xylene	ND	1600	606.67
Soil Vapor	8	3	MTBE	90	550	243.33
			Benzene	320	340	330
			Toluene	370	720	513.33
			Ethylbenzene	280	560	390
			m, p – Xylene	850	1200	1050
			o- Xylene	270	360	306.67
Soil Vapor	15	1	MTBE	ND	ND	NA
			Benzene	180	180	180
			Toluene	640	640	640
			Ethylbenzene	ND	ND	NA
			m, p – Xylene	830	830	830
			o- Xylene	300	300	300

Note:

- µg/m³ = Micrograms per Cubic Meter of Air

Table B4. Selection of Contaminants of Potential Concern – Soil Vapor – 2007 For outdoor exposure to trench workers

Location	Time period	Chemical	Maximum soil vapor concn. (SVC) ($\mu\text{g}/\text{m}^3$)	Maximum SVC diluted by 100x ($\mu\text{g}/\text{m}^3$)	CV ($\mu\text{g}/\text{m}^3$)	COPC? (If Maximum SVC > CV)
Soil Vapor – 4 feet	2007	Benzene	170	1.7	0.23	Yes
		Toluene	1100	11	5100	No
		Ethylbenzene	540	5.4	1100	No
		M,p-Xylene	3800	38	110	No
		o-Xylene	1600	16	110	No
Soil Vapor – 8 feet	2007	Benzene	340	3.4	0.23	Yes
		Toluene	720	7.2	5100	No
		Ethylbenzene	560	5.6	1100	No
		M,p-Xylene	1200	12	110	No
		o-Xylene	360	3.6	110	No
Soil Vapor – 15 feet	2007	Benzene	180	1.8	0.23	Yes
		Toluene	640	6.4	5100	No
		Ethylbenzene	ND	ND	1100	NA
		M,p-Xylene	830	8.3	110	No
		o-Xylene	300	3	110	No

Note:

- $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter of Air
- SVC = Soil Vapor Concentration
- CV = EPA Region 3 RBC Comparison Value
- COPC = Contaminant of Potential Concern
- The extent of mixing of soil vapors with ambient air in a trench exposure scenario for the utility workers causes uncertainty in the predicted cancer risks and noncancer hazards because no air models are available to predict the concentration of chemical vapors in a trench. Therefore, the risk estimates presented in this evaluation are derived semi-quantitatively, based on the assumption of 100-1000 times dilution (Pers. Commun. Dr. Helen Dawson of EPA region 8), and may over or underestimate the actual risks to utility workers in a trench.

Appendix C: ATSDR ToxFAQs for Benzene



BENZENE
CAS # 71-43-2

Division of Toxicology and Environmental Medicine ToxFAQs™

August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 1,000 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- Industrial processes are the main source of benzene in the environment.
- Benzene can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.
- Benzene in the air can attach to rain or snow and be carried back down to the ground.

- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure.
- Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- Working in industries that make or use benzene.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone

ToxFAQs™ Internet address is <http://www.atsdr.cdc.gov/toxfaq.html>

marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

How likely is benzene to cause cancer?

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

How can benzene affect children?

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults.

Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How can families reduce the risks of exposure to benzene?

Benzene exposure can be reduced by limiting contact with gasoline and cigarette smoke. Families are encouraged not to

smoke in their house, in enclosed environments, or near their children.

Is there a medical test to determine whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is a test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood; however, since benzene disappears rapidly from the blood, this test is only useful for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. The metabolite S-phenylmercapturic acid in urine is a sensitive indicator of benzene exposure. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 5 parts benzene per billion parts of water (5 ppb).

The Occupational Safety and Health Administration (OSHA) has set limits of 1 part benzene per million parts of workplace air (1 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Benzene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.



Appendix D: Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on dose. In addition, the toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (acute, subchronic, chronic or lifetime). It is important to note that estimates of human health risks may be based on evidence of health effects in humans and/or animals depending on the availability of data. This evaluation, like most other toxicity assessments, is divided into two parts: the cancer effects and the non-cancer effects of the chemical.

EPA, IARC, and the Department of Health and Human Services have concluded that benzene is a human carcinogen. The Department of Health and Human Services determined that benzene is a known carcinogen based on human evidence showing a causal relationship between exposure to benzene and cancer. IARC classified benzene in Group 1 (carcinogenic to humans) based on sufficient evidence in both humans and animals. EPA classified benzene in Category A (known human carcinogen) based on convincing evidence in humans supported by evidence from animal studies. Under EPA's most recent guidelines for carcinogen risk assessment, benzene is characterized as a known human carcinogen for all routes of exposure. Based on human leukemia data, EPA derived a range of inhalation unit risk values of 2.2×10^{-6} – 7.8×10^{-6} ($\mu\text{g}/\text{m}^3$)⁻¹ for benzene. For cancer risks ranging from 1×10^{-4} to 1×10^{-6} , the corresponding the corresponding air concentrations range from 13.0–45.0 $\mu\text{g}/\text{m}^3$ (4–14 ppb) to 0.013–0.045 $\mu\text{g}/\text{m}^3$ (0.004–0.014 ppb), respectively. The high-end unit risk factor corresponds to the cancer slope factor of 0.027 per mg/kg/day. The consensus conclusion that benzene is a human carcinogen is based on sufficient inhalation data in humans supported by animal evidence, including the oral studies in animals. The human cancer induced by inhalation exposure to benzene is predominantly acute nonlymphocytic (myelocytic) leukemia, whereas benzene is a multiple site carcinogen in animals by both the inhalation and oral routes (ATSDR, 2005).

The above noted high-end cancer slope factor is used to calculate EPA Region 3 Risk Based Concentrations (RBCs) that are used in this assessment to estimate risks. The RBC used in this assessment is based on age-adjusted theoretical cancer risks spanning 30 years from the time of birth to the age of 30. They account for exposure for 350 days per year over the thirty-year time period and lower body weights of children.

ATSDR has derived acute, chronic, and intermediate duration inhalational minimal risk levels (MRLs) or health guidelines to assess noncancer hazards. An MRL is the dose of a compound that is the estimate of daily human exposure that is likely to be without an appreciable risk of adverse non-cancerous health effects for each specified exposure duration. The acute, intermediate, and chronic MRLs address exposures of 14 days or less, 14-365 days, and 1 year – lifetime, respectively. For BTEX, there are additional considerations of noncancer toxicity. These chemicals can cause a wide range of symptoms that include dizziness, headaches, GI problems, anemia, kidney problems,

and even death. For more detailed health information, please see Appendix C for health effect fact sheets (Tox FAQs) on benzene the major chemicals of potential concern.

The ATSDR MRLs and EPA RfC for benzene are noted below:

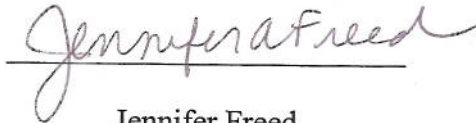
- . • Acute inhalation MRL = $30 \mu\text{g}/\text{m}^3$
- . • Intermediate Inhalation MRL = $20 \mu\text{g}/\text{m}^3$
- . • Chronic inhalation MRL = $10 \mu\text{g}/\text{m}^3$
- . • EPA chronic inhalation RfC = $30 \mu\text{g}/\text{m}^3$

Appendix E: ATSDR Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
<p>A. Urgent Public Health Hazard</p> <p>This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.</p>
<p>B. Public Health Hazard</p> <p>This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.</p>
<p>C. Indeterminate Public Health Hazard</p> <p>This category is used for sites in which “critical” data are <i>insufficient</i> with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.</p>	<p>This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.</p>	<p>The health assessor must determine, using professional judgment, the “criticality” of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.</p>
<p>D. No Apparent Public Health Hazard</p> <p>This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.</p>
<p>E: No Public Health Hazard</p> <p>This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.</p>	<p>Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future</p>	

Certification

This Fleet Maintenance Facility health consultation was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time, the health consultation was conducted. Editorial review was completed by the cooperative agreement partner.



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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.



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