BOULDER COUNTY PUBLIC HEALTH

Opportunity for a Healthy Life

Benzene Health Impacts and Colorado Monitoring

Benzene is a hazardous air pollutant (HAP) that is regulated by the U.S. Environmental Protection Agency (EPA) under the Clean Air Act (CAA). Sources of benzene include motor vehicle exhaust; vapors from oil and gas production activities and gas stations; emissions from the burning of oil, coal, wood, and cigarettes; and household products containing petroleum-based chemicals (e.g. glue, paint, furniture wax, and lubricants).

Benzene Health Impacts

Cancer from benzene exposure at low to moderate levels for long periods of time is the most common health hazard associated with benzene. Benzene exposure is also linked to reduced lung function, aggravated asthma, and permanent lung damage.

Benzene Inhalation Health Standards

EPA Long-Term Non-Cancer Standards

- The chronic (i.e. non-cancer) inhalation reference concentration (RfC) for benzene is 9 parts per billion (ppb).[1] This means that long-term exposure to benzene concentrations below 9 ppb is considered a non-cancer health risk to non-sensitive groups. Sensitive groups, such as children, people with asthma or other respiratory conditions, and the elderly may be impacted at levels below 9 ppb.

EPA Cancer Risk Standards

- There is a 1 in 1,000,000 lifetime cancer risk with benzene concentrations from 0.04 ppb to 0.14 ppb; this level of exposure will result in 1 additional incidence of cancer in 1,000,000 people. The EPA considers this risk level to be acceptable.[2]
- There is a 1 in 100,000 lifetime cancer risk with benzene concentrations from 0.4 ppb to 1.4 ppb; this level of exposure will result in 1 additional incidence of cancer in 100,000 people. The EPA considers this risk level to be the lowest level of acceptable risk.
- There is a 1 in 10,000 lifetime cancer risk with benzene concentrations from 4 ppb to 14 ppb.[3] This level of exposure will result in 1 additional incidence of cancer in 10,000 people. The EPA considers this risk level to be unacceptable.

The Agency for Toxic Substances and Disease Registry's (ATSDR) Minimum Risk Levels

Minimum Risk Levels (MRLs) are an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. These estimates are intended to serve as screening levels to identify contaminants and potential health effects that may be of concern. MRL for benzene are:

- 3 ppb for 365 days or longer
- 6 ppb for 15-364 days
- 9 ppb for 14 or fewer days[4]

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[1] EPA, Benzene, 71-43-2, https://www.epa.gov/sites/production/files/2016-09/documents/benzene.pdf.

[2] A risk level of one in a million implies that up to 1 out of one million equally exposed people could contract cancer if exposed continuously (i.e. 24 hours per day) to the specific concentration over a lifetime (i.e. 70 years). This would be in addition to cancer cases that would normally occur in an unexposed population of one million people. The EPA typically considers risks below 1 x 10^{-6} to be so small as to be negligible and uses a cancer risk of one in a million (1 x 10^{-6}) as a regulatory goal. In general, risk levels below one in ten thousand (1 in 10,000; 1x10^{-4}) are considered low risk and within the EPA "acceptable" excess cancer risk range.

[3] Id.

The California Air Resources Board Reference Exposure Levels (non-cancer inhalation risk)
The California Air Resources Board (CARB) has set a continuous long-term exposure level of 1 ppb.[5] According to CARB, any long-term exposure above this level is a non-cancer inhalation risk.

The World Health Organization (WHO) Leukemia Risk Levels
The WHO has concluded that because benzene is a carcinogen, no safe level of exposure can be recommended. For general guidance, the associated lifetime leukemia risks are:

- 1 in 1,000,000 = 0.05 ppb
- 1 in 100,000 = 0.5 ppb
- 1 in 10,000 = 5 ppb[6]

Results of Benzene Monitoring in Colorado

The studies below, with the exception of the study conducted by the National Center for Atmospheric Research were conducted to identify general air quality conditions and not specific sources of emissions.

- The Colorado Department of Public Health and Environment (CDPHE) is monitoring benzene levels in Platteville, Colorado, an area heavily impacted by oil and gas development. Recent data from January-December 2017 show an average measurement of 0.63 ppb for benzene. The same sampling and time period in downtown Denver showed an average of 0.29 ppb.
    - CDPHE samples are collected in the morning between 6:00-9:00 a.m. to conform to the EPA ozone precursor guidance.[7] However, benzene levels may increase at night, so these data may not reflect average 24-hour concentrations or average nighttime concentrations.
- The University of Colorado at Boulder funded by Boulder County in conjunction with CDPHE, has been monitoring for volatile organic compounds (VOCs), including benzene, at the Boulder Reservoir since April 2017. The average benzene level at this location from April 2017 through January 2018 was 0.13 ppb.[8]
    - Boulder County Public Health conducted a monitoring study in 2014 where mean benzene levels at five sites in Boulder County ranged from 0.2-1.2 ppb at all sites.
- The Garfield County Public Health Department collects benzene data as part of a hazardous air pollutant analysis at several sites. During 2016, the highest annual average of 0.37 ppb occurred at the Parachute monitor.[9]
- The National Center for Atmospheric Research collected benzene grab samples (i.e. instantaneous, short-term) near single large emitters in the Colorado Front Range. The highest benzene concentration, taken near Platteville, was 120 ppb at a produced water disposal well. Benzene levels ranging from 30-60 ppb were also collected near an oil well waste dumping facility and a compressor facility.[10]
- A study conducted in Platteville in 2014 found that the mean benzene level during July and August was 0.53 ppb, but the nighttime mean was 0.73 ppb. The study concluded that traffic from the Denver area was not the cause of the elevated benzene levels due to wind direction and other factors.[11]

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[4] ATSDR, "ToxGuide for Benzene C_6H_6," CAS# 71-43-2, October 2007.
[5] https://oehha.ca.gov/air/crnr/notice-adoption-revised-reference-exposure-levels-benzene
[6] WHO, Air Quality Guidelines for Europe, Second Edition, 2000, p. 65.
[7] EPA, Technical Assistance Document for Sampling and Analysis of Ozone Precursors, Section 6.0, Guidance for PAMS Meteorological Monitoring, p.3, Sept 30, 1998
[8] http://instaar.colorado.edu/arl/boulder_reservoir.html#monitoring
[9] Air Resource Specialists, Garfield County 2016 Air Quality Monitoring Report, June 12, 2017, https://www.garfield-county.com/air-quality/documents/airquality/GARCO_2016%20Annual%20Report_FINAL.pdf, Table 4-1.
[10] Gabriele Pfister and Frank Flocke, NCAR, Final Report, July 2017, Process-Based and Regional Source Impact Analysis for FRAPPÉ and DISCOVER-AQ 2014, https://www2.acom.ucar.edu/frappe, p. 43-44.
[11] Halliday, H. S., et al at 11,055.