United States
Environmental Protection Agency

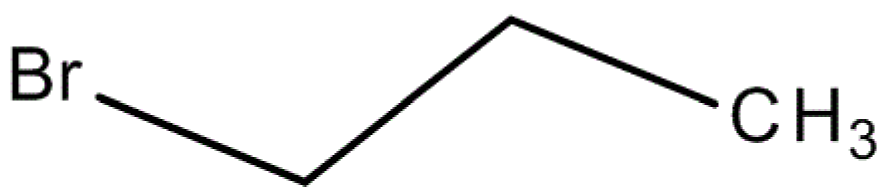
Office of Chemical Safety and
Pollution Prevention

Final Risk Evaluation for 1-Bromopropane (*n*-Propyl Bromide)

Systematic Review Supplemental File:

Data Extraction for Consumer Exposure

CASRN: 106-94-5



August 2020

1-Bromopropane Extracted Data Summaries

Biomonitoring Data for 1-BP

Systematic review identified biomonitoring measurements from two sources. The first source is the National Health and Nutrition Examination Survey (NHANES), conducted by CDC's National Center for Health Statistics (NCHS). The survey is "a complex, stratified, multistage, probability-cluster design survey" designed to collect data on the health and nutrition of a representative sample of the US population. NHANES measured the metabolite Acetyl-S-(n-propyl)-L-cysteine (BPMA) in urine spot samples. In the Fourth Report on Human Exposure to Environmental Chemicals (CDC, 2019), statistics were reported for the geometric mean and for the 50th, 75th, 90th, and 95th percentiles of both uncorrected concentrations and creatinine corrected concentrations for the following 2-year cycles: 2005-2006 (n= 3,334-3,346), 2011-2012 (n=2,464-2,466), and 2013-2014 (n=2,638-2,639). The 50th and 95th percentiles for the uncorrected concentrations were 2.96 and 52.0

Jain et. al. (2015) also investigated the variability of BPMA levels in children aged 6–11 years for the 2011-2012 NHANES survey cycle cited in the same report (CDC, 2019). The geometric mean concentration (with 95% confidence intervals) in urine was 2.6 (2-3.3) µg/L for males (n=203) and 3.3 (2.5- 4.3) µg/L for females (n=214).

Experimental Data for 1-BP

Systematic review identified experimental data to be extracted from four sources relevant to 1-BP consumer exposure scenarios.

Frasch et al. (2011) conducted an experimental study to test dermal penetration characteristics on human skin for different exposure scenarios of 1-BP. The exposure scenarios included infinite doses, finite doses, and transient exposures of neat and saturated 1-BP solutions. Evaporation flux measurements were taken in an open fume hood, and steady state flux measurements were taken at the skin surface, with an area of 0.64 cm^2 and a skin surface temperature of 32 °C. For an infinite dose of neat 1-BP, the steady state flux averaged 625 ± 176 $\mu g/cm^2/h$ based on the total permeated mass of 1876 ± 527 $\mu g/cm^2$ over three hours of exposure.

Turk and Hughes (2008) conducted a radon control study through evaluation of moisture levels and ventilation in houses with basements, after a conceptual model suggested that active soil depressurization (ASD) may cause changes in basement ventilation and interzonal air flows. The parameters used for the basement and house in the conceptual model are described in an appendix of the study. The model parameters included an estimated temperature range for basement air of 10–30 °C (50–86 °F) with monthly values of 17 °C (62.6 °F), 17 °C (62.6 °F), 21 °C (69.8 °F), and 18°C (64.4 °F) for January, April, July, and October respectively. The model basement had a volume of 180 m^3 with a wall area of 85 m^2. The airflow in the model basement was characterized by outdoor ventilation rate of 0.45 h^{-1} and interzonal air flow of 100 m^3/h. The experimental study included three Pennsylvania houses with unfinished basements, one with poured foundation walls and two with foundation walls of open and partially filled concrete block. Clustered temperature and relative humidity (RH) sensors measured moisture levels in the walls and floors, indoor and outdoor air, surrounding soil, and wood frames of the basements. Radon levels were monitored using alpha scintillation cell technology through the foundation material at one floor and wall cluster. Air movement was measured between the basement and outdoors, upstairs, and soil using constant injections of perfluorocarbon tracer (PFT) gas systems. House air leakage was also collected using blower doors at 4 and 50 Pascal (Pa). Outdoor conditions, including moisture in the soil near the foundation, was collected using wood block sensors. Surface moisture samples were collected using hand-held instruments spaced on an established grid of the floors of the houses. With the ASD system turned on, the median outdoor ventilation in the basement was 0.16 air changes per hour (ach), and the average outdoor ventilation in the basement was 0.16 ach with a standard deviation of 0.093. With the ASD system turned off, the median outdoor ventilation in the basement was 0.07 ach, and the average outdoor ventilation in the basement was 0.08 ach with a standard deviation of 0.056. Interzonal air flows during winter at one of the houses are illustrated in Figure 4. With the ASD system on, the airflow was 17 cubic feet per minute (cfm) from the basement to upstairs and 5 cfm from upstairs to the basement. With the ASD system off, the airflow was 20 cfm from the basement to upstairs and 47 cfm from upstairs to the basement. Those measurements are the averages of six, three-hour measurements over three days.

Batterman et al. (2007) conducted a study to measure and characterize volatile organic compound (VOC) concentrations, exposures, airflows, and source apportionments in single family houses with attached garages in southeast Michigan. This study acted as an expansion of an initial longitudinal study of just one house with a garage. In total, fifteen houses with attached garages were sampled between Ann Arbor and Ypsilanti, Michigan. Air exchange rates and air flows were measured using passive samplers, miniature perfluorocarbon tracer (PFT) emitters, and the constant injection technique. The houses and garages used in the study represented a range of volume, structure, and organization of rooms and space. The mean volume of the houses was 444 m^3, and the mean volume of the garages was 118 m^3.

Emmerich et al. (2003) reviewed existing literature and conducted a small field study to measure airflow between houses and garages where they are attached. The study included five homes in the Washington, DC area: four single-family homes and one townhouse. Pressurization tests using blower doors were conducted with three configurations in each house according to ASTM Standard E 779-99. For each blower door test, air flows were measured at varying pressures (10 to 70 Pa) in the garage, the house, and the garage-house interface. Effective leakage area (ELA) was also calculated for each house and garage. The average air change rate at 50 Pa (ACH_{50}) for the garage was 48.4 h^{-1}. The results of the study were validated by similar studies from other regions, such as one study in Canada resulting in an average air change rate of about 47 h^{-1} at 50 Pa (ACH_{50}) for the garage.

Modeling Data for 1-BP

Systematic review identified modeling data to be extracted from three sources relevant to 1-BP consumer exposure scenarios.

Begley et al. (2005) intended to demonstrate that the migration modeling described could be accepted by the European Commission as a safe and reliable model to calculate the migration rates from food-contact plastics. The paper summarized and explained the development and validation of the migration model already used by the US Food and Drug Administration (FDA). The maximum initial concentration of migrant was derived from the analytical solution of Fick's second law. The diffusion coefficient, D_p, and partition coefficient, $K_{p,f}$, are identified as key input parameters to using a migration model. From more complicated and involved theoretical estimations, a simpler equation was developed to estimate the diffusion coefficients in polymer at varied temperatures. These mathematical calculations were validated, and Begley et al. concluded that the model could be used as a reliable tool and should be certified by the EU Commission.

Jayjock (1994) presents a back-pressure model for volatilizing sources found indoors that are either in a large room and greater than a few hundred square meters or are in a small room (i.e., less than 30 m^3) and 1/10th the floor surface area. Jayjock expanded on the previously developed two-film theory of volatilization to demonstrate a model that calculates the airborne concentration in a stepwise manner until equilibrium is reached. This model assumes the concentration in the room is uniform and backpressure is acting to slow down the net volatilization rate. The model illustrated that back-pressure is not a significant factor with small volatilizing sources but may contribute with larger volatilizing sources. Additionally, Jayjock concluded that the efforts to control the volatilization rate may be more effective than efforts to increase ventilation for large volatizing indoor sources.

Chang and Krebs (1992) developed a mathematical model and evaluated emission data of para-dichlorobenzene released from mothcakes placed indoors. Mothcakes are used as an insect repellent and typically slowly release para-dichlorobenzene into the room in which they are. The mathematical model was tested in three different facilities: dynamic chamber, static chamber, and IAQ (Indoor Air Quality) test house. The theoretical model proposed by the authors hypothesized that the emission rate was governed by the sublimation of para-dichlorobenzene. This emission rate can be calculated by multiplying three factors: the mass transfer coefficient, the surface area of the mothcake exposed, and the difference between the bulk gas-phase concentration and the equilibrium concentration. The data from the dynamic chamber test fit this model and were verified by the static chamber test.