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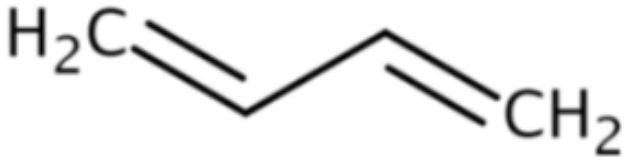
Office of Chemical Safety and
Pollution Prevention

Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure for 1,3-Butadiene

Systematic Review Support Document for the Risk Evaluation

CASRN: 106-99-0



December 2025

This supplemental file contains information regarding the data quality evaluation results for data sources that met the PECO screening criteria for the *Systematic Review Protocol for 1,3-Butadiene*. EPA conducted data quality evaluation and extraction based on author-reported descriptions and results; additional analyses (e.g., statistical analyses) potentially conducted by EPA are not contained in this supplemental file. EPA performs data quality evaluation as a part of the TSCA systematic review process described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances*. The systematic review steps are further described in the *Systematic Review Protocol for 1,3-Butadiene*.

Additionally, the overall quality determination (OQD) for each reference represents the data as a whole for each evidence stream, not for individual scenarios described within a study. For example, a reference that has both monitoring and experimental data would have OQDs using the data quality evaluation metrics for monitoring and experimental data, respectively. An OQD utilizing the data quality evaluation metrics for monitoring data, or any other single evidence stream, would consider all data pertinent to that evidence stream in the reference. Acronyms and abbreviations used within this supplemental file are defined in the table at the end of this file. This supplemental file may also be referred to as "1,3-Butadiene Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure."

Table of Contents

Study Citation:	Kim, Y. M., Harrad, S., Harrison, R. M. (2001). Concentrations and sources of VOCs in urban domestic and public microenvironments. Environmental Science & Technology 35(6):997-1004.
HERO ID:	15526

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling methodology in this paper was described in terms of sampling equipment, procedures, and study site characteristics (Table 1). Insufficient information was provided regarding sample storage conditions or duration, and calibration of sampling pumps.
	Metric 2:	Analytical Methodology	High	Analytic methodology in this paper was described in terms of analytical instrumentation, instrument calibration, and chemical-specific method detection limits.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for air sampling.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Sampling was conducted in Birmingham, England.
	Metric 5:	Currency	Low	Sampling was conducted from 1999-2000.
	Metric 6:	Spatial and Temporal Variability	High	A relatively large sample size was utilized for general indoor and outdoor microenvironment categories, and replicate sampling was conducted 2-3 times per day within microenvironment, with 24-hour sampling results presented in Fig. 1 for the residential microenvironment.
	Metric 7:	Exposure Scenario	High	Authors describe the details of the study setting within various microenvironments in terms of location, smoking environment, use of consumer products, and ventilation as well as the use of field blanks and exposure controls.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Summary statistics detail the number of samples, mean, standard deviation, median, and range of exposure concentration results presented with a description of sampling location, population characteristics in terms of smoking, use of products and sampling date. Insufficient information was provided regarding raw data.
	Metric 9:	Quality Assurance	High	Quality assurance and quality control procedures were described in detail and referenced, and included use of field blanks, analyses of storage stability, lack of breakthrough in air sampling, with method detection limits also reported. This study lacked pre-exposure baseline samples for the main sampling, however authors noted sampling results before and after cleaning and painting (Table 6) for 1,3-butadiene results.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	This study characterized spatial variability across different settings and microenvironments with standard deviations and ranges of sampling results presented. Authors discussed some limitations with regard to sample size and the lack of accounting for ventilation.

Overall Quality Determination High

Study Citation:	Rudolf, W. (1994). Concentration of air pollutants inside cars driving on highways and in downtown areas. Science of the Total Environment 146-147(0):433-444.
HERO ID:	28882

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	The author did not include a formal description of the sampling methodology, which was briefly described on page 444 of the text. Sampling is done by plastic bags, and the analysis is performed by a cryotrapping gas chromatograph in the laboratory.
	Metric 2:	Analytical Methodology	Low	The author did not include a formal description of the analytical methodology, which was briefly described on page 444. Sampling is done by plastic bags, and the analysis is performed by a cryotrapping gas chromatograph in the laboratory.
	Metric 3:	Biomarker Selection	N/A	The author analyzed air samples, thus this metric is not relevant.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Germany.
	Metric 5:	Currency	Low	The manuscript was published in 1994.
	Metric 6:	Spatial and Temporal Variability	Medium	The sample size was not reported by the author, however a description is provided of half-hourly sampling at 6 downtown measuring sites in street canyons.
	Metric 7:	Exposure Scenario	Low	The data may represent a relevant exposure scenario, but the lack of methodological details and sample size details limit the study's validity.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only individual sample concentration data were reported.
	Metric 9:	Quality Assurance	Low	Quality assurance and control techniques were not described.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability was not characterized. Uncertainties and limitations were not discussed.

Overall Quality Determination Low

Study Citation:	Kim, Y. M., Harrad, S., Harrison, R. M. (2002). Levels and sources of personal inhalation exposure to volatile organic compounds. Environmental Science & Technology 36(24):5405-5410.
HERO ID:	36576

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling was conducted using an adsorbent tube packed with Carbopack B and Carbosieve SIII and fitted to a personal pump operated at a flow rate of ca. 40 mL min-1 with tubes changed every 2 hour. Each adsorbent tube was capped with swagelok fittings before and after sampling. Other details of sampling methodology (calibration and storage samples) are cited to Kim et al. (1999) and may merit a higher score.
	Metric 2:	Analytical Methodology	Low	Analysis was conducted using a thermal desorber interfaced with GC/MS. No measure of detection limit was reported. Other details of analytical methodology, including method validation, are cited to Kim et al. (2001, 1999) and may merit a higher score.
	Metric 3:	Biomarker Selection	N/A	This study was testing for the parent chemical of interest in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in central Birmingham, United Kingdom.
	Metric 5:	Currency	Low	All monitoring was conducted between March 1999 and February 2000.
	Metric 6:	Spatial and Temporal Variability	Medium	Personal monitoring sampling was carried out across six two-hour samples per day for 5-10 days per subject, with 12 subjects. Use of replicates was not reported.
	Metric 7:	Exposure Scenario	High	This study assessed personal monitoring samples which provide an excellent representation of ”real life” exposure.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported. Summary statistics include daytime and nighttime concentration mean, median, standard deviation, minimum, and maximum.
	Metric 9:	Quality Assurance	Low	Quality assurance and control measures are not directly reported but may be inferred from the use of ”extensive” method validation. These results are cited to Kim et al. (2001, 1999) and may merit a higher score.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability is well characterized quantitatively and qualitatively within and across individuals. The authors acknowledge the uncertainty introduced from extrapolating 24-hour exposures from only 12 hours of monitoring data, but this limitation is mitigated by the large sample size and preferential coverage of daytime hours, when exposure levels are more likely to vary.

Overall Quality Determination — Medium

Study Citation:	Field, R. A., Phillips, J. L., Goldstone, M. E., Lester, J. N., Perry, R. (1992). Indoor/outdoor interactions during an air pollution event in central London. Environmental Technology 13(4):391-408.
HERO ID:	44391

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The sampling methodology was adequately described.
	Metric 2:	Analytical Methodology	Low	Limits of detection or quantification were not reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in London, UK.
	Metric 5:	Currency	Low	The data was collected in 1991.
	Metric 6:	Spatial and Temporal Variability	Medium	The samples were collected for 25 minutes every hour. No replicates were utilized.
	Metric 7:	Exposure Scenario	High	Indoor and outdoor dynamics (vapor intrusion) were described in ventilated offices and close to roadsides.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data was reported, but data summary statistics were adequately presented.
	Metric 9:	Quality Assurance	Low	Limited information was provided on quality assurance.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Limited information was provided on gaps and limitations

Overall Quality Determination Medium

Study Citation:	Delfino, R. J., Gone, H., Linn, W. S., Pellizzari, E. D., Hu, Y. (2003). Asthma symptoms in Hispanic children and daily ambient exposures to toxic and criteria air pollutants. Environmental Health Perspectives 111(4):647-656.
HERO ID:	50460

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The air sampling methodology, how subjects were chosen and equipment were described. Some information, such as calibration and storage conditions, was not reported.
	Metric 2:	Analytical Methodology	Medium	The analytical methods were analyzed using U.S. EPA method TO-11 but they did not include LOD or recoveries.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed air samples and no biomonitoring was conducted.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Huntington Park, CA.
	Metric 5:	Currency	Low	Data was collected in 1999 and 2000.
	Metric 6:	Spatial and Temporal Variability	Medium	Over 10 samples were collected for a single scenario. Replicate samples were not reported.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to airborne pollutants in Los Angeles, California, including children and those with asthma.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data was not provided, but summary statistics were reported.
	Metric 9:	Quality Assurance	Low	Quality control and assurance techniques were not discussed in detail but can be implied from the study procedures. Recovery samples were not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability was characterized (range, IQR, 90th percentile). Uncertainties and limitations were discussed.

Overall Quality Determination — Medium

Study Citation:	Serrano-Trespalacios, P. I., Ryan, L., Spengler, J. D. (2004). Ambient, indoor and personal exposure relationships of volatile organic compounds in Mexico City metropolitan area. Journal of Exposure Analysis and Environmental Epidemiology 14 Suppl 1(S1):S118-S132.
HERO ID:	56224

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The sampling methodology was described.
	Metric 2:	Analytical Methodology	Medium	Method detection limits, but not limits of detection, were reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted within the Mexico City Metropolitan Area.
	Metric 5:	Currency	Low	Data was collected between March 1998 and February 1999.
	Metric 6:	Spatial and Temporal Variability	Medium	This study adequately described the number of samples, but did not conduct replicate sampling.
	Metric 7:	Exposure Scenario	High	Personal exposure for families living within 5 km radius of 5 central monitoring sites was detailed as well as indoor and outdoor exposures dynamics.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Summary statistics were adequately described, however raw data was not reported.
	Metric 9:	Quality Assurance	High	Quality assurance samples and analytical quality control procedures were provided and described.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Sources of variability were discussed with respect to study goals.

Overall Quality Determination High

Study Citation:	Barrefors, G., Petersson, G. (1995). Volatile hydrocarbons from domestic wood burning. Chemosphere 30(8):1551-1556.
HERO ID:	76240

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	The sampling methodology was briefly described, citing previously published research.
	Metric 2:	Analytical Methodology	Low	The analytical methods were described, but recoveries and LOD were not reported.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed air samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Scandinavia, presumably Sweden based on author's affiliation.
	Metric 5:	Currency	Low	The study was published in 1994.
	Metric 6:	Spatial and Temporal Variability	Low	Five samples were collected, as reported in the footnote of Table 1. No replicates were reported.
	Metric 7:	Exposure Scenario	Medium	The exposure scenario is wood stove for household cooking, which is probably uncommon in developed countries.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only individual sample concentrations were reported. Summary statistics were not available, but can be calculated.
	Metric 9:	Quality Assurance	Low	Quality assurance and quality control techniques were not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability was not characterized. Uncertainties and limitations were not discussed.

Overall Quality Determination Low

Study Citation:	Campbell, M. E., Benson, B. A., Muir, M. A. (1995). Urban air quality and human health: A Toronto perspective. Canadian Journal of Public Health 86(5):351-357.
HERO ID:	79425

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Few sampling methods were reported.
	Metric 2:	Analytical Methodology	Critically Deficient	Analytical methods were not described.
	Metric 3:	Biomarker Selection	N/A	The study is testing for the parent chemical.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Toronto, Canada
	Metric 5:	Currency	Low	Sampling was conducted in 1990 and the study was published in 1995.
	Metric 6:	Spatial and Temporal Variability	Medium	The number of samples was reported as n=100 but no replicate sampling was conducted.
	Metric 7:	Exposure Scenario	Medium	The source of exposure was not well characterized.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Summary statistics were detailed, but raw data was not reported.
	Metric 9:	Quality Assurance	Low	Quality assurance and control details were only implied.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	No gaps or study limitations were reported.

Overall Quality Determination — Uninformative

Study Citation: Mukerjee, S., Ellenson, W. D., Lewis, R. G., Stevens, R. K., Somerville, M. C., Shadwick, D. S., Willis, R. D. (1997). An environmental scoping study in the lower Rio Grande Valley of Texas–III. Residential microenvironmental monitoring for air, house dust, and soil. Environment International 23(5):657-673.

HERO ID: 84908

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Some methods were not reported, such a sampler calibration.
	Metric 2:	Analytical Methodology	Critically Deficient	Key methods for VOC analysis are not reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Brownsville, TX.
	Metric 5:	Currency	Low	The study was published in 1997.
	Metric 6:	Spatial and Temporal Variability	Medium	A total of n=9 residences were sampled, with no mention of duplicates or blank sampling being conducted.
	Metric 7:	Exposure Scenario	High	The exposure source was adequately characterized.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Statistical summary measures were reported, but raw data was not reported.
	Metric 9:	Quality Assurance	Medium	Quality assurance and quality control (QA/QC) was briefly mentioned but the study referred to the USEPA work plan as its source of QA/QC.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	A few gaps and study limitations were reported.

Overall Quality Determination Uninformative

Study Citation:	Bjorkqvist, S., Spetz, A., Ramnas, O., Petersson, G. (1997). Isoprene from expired air inside a private car. Science of the Total Environment 207(1):63-67.
HERO ID:	85886

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling procedure and sampling equipment described and reported. Air samples were collected using triple-layer glass cartridges connected to small air pumps. There was some missing information such as calibration and storage conditions. Further detail is cited to Barrefors and Petersson (1993) and may merit a higher score.
	Metric 2:	Analytical Methodology	Low	Analytical methodology and instrumentation involved thermal desorption and gas chromatography and was reported in good detail. However, no measure of detection limit is reported. Further detail is cited to Barrefors and Petersson (1993) and may merit a higher score.
	Metric 3:	Biomarker Selection	N/A	This study was testing for the parent chemical of interest in environmental media (air). This metric is not applicable to this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	Critically Deficient	Geographic location is not reported, discussed, or referenced.
	Metric 5:	Currency	Low	Sampling was performed in April of 1997.
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	Only a single sample was collected per data set (single 10-minute air samples collected for six different scenarios). Use of replicates was not reported.
	Metric 7:	Exposure Scenario	High	This study collected air samples in a car (sampler placed near steering wheel) or crossing an urban street (inferred to be from personal monitoring), which are highly representative of possible "real life" exposure scenarios.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were reported and summary statistics were not warranted due to the small sample size.
	Metric 9:	Quality Assurance	Low	The authors note that quantitative recovery at all concentrations was indicated by proper concentration ratios between all hydrocarbons, but no specific quality assurance or quality control methods are reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability across sampling in different scenarios was described. The authors note that all concentrations are likely lower than average due to timing of sample collection during a windy period. This introduces considerable uncertainty for the monitoring data. Study limitations, other than sampling during windy conditions, were not reported.

Overall Quality Determination — Uninformative

Study Citation:	Modig, L., Sunesson, A. L., Levin, J. O., Sundgren, M., Hagenbjork-Gustafsson, A., Forsberg, B. (2004). Can NO2 be used to indicate ambient and personal levels of benzene and 1,3-butadiene in air?. Journal of Environmental Monitoring 6(12):957-962.
HERO ID:	89340

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Detailed sampling methodology, equipment and location was reported. The text was missing some information, such as equipment calibration and storage conditions.
	Metric 2:	Analytical Methodology	High	Analytical methods, instrument and calibration curves were reported. Detection limit was also reported.
	Metric 3:	Biomarker Selection	N/A	The study is measuring samples in background air. This metric is not relevant for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Umea, Sweden.
	Metric 5:	Currency	Low	The sampling was conducted in 2001.
	Metric 6:	Spatial and Temporal Variability	Medium	There were 10 weekly samples, and 40 personal exposure samples (with additional readings for half of the participants). No replicates were reported.
	Metric 7:	Exposure Scenario	Medium	The study measured personal air samples. However, the study combined all the measurements into urban background and not into the different environments sampled.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported. Individual points, or raw data, were not reported.
	Metric 9:	Quality Assurance	Medium	The study reported that control samples were analyzed and briefly described Quality assurance and quality control steps. Recoveries were not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	The study characterized variability through the different environments sampled. There is a discussion of study limitations and uncertainties.

Overall Quality Determination Medium

Study Citation:	Gustafson, P., Barregard, L., Strandberg, B., Sallsten, G. (2007). The impact of domestic wood burning on personal, indoor and outdoor levels of 1,3-butadiene, benzene, formaldehyde and acetaldehyde. Journal of Environmental Monitoring 9(1):23-32.
HERO ID:	96315

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Clear sampling methods were described adequately.
	Metric 2:	Analytical Methodology	High	Analytical methods were well described and limits of detection were reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not relevant as this study tested for a parent chemical in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Sweden.
	Metric 5:	Currency	Low	Sampling was conducted in 2003.
	Metric 6:	Spatial and Temporal Variability	High	The total number of samples was reported as n=24.
	Metric 7:	Exposure Scenario	High	Data closely represent relevant exposure scenarios.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported with no description of raw data.
	Metric 9:	Quality Assurance	Medium	Control samples were analyzed with a limited description of quality assurance and control procedures.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	There was a limited discussion of uncertainties and study limitations.

Overall Quality Determination High

Study Citation:	Loscutoff, W. V., Poore, M. V. (1993). Ambient air toxics data from California's toxic air contaminant monitoring program. :191-203.
HERO ID:	666747

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Methodology is briefly described as adaptation of NIOSH or other environmental methods. It's noted at CARB contracted with Batelle to QA/QC/evaluate sampling, analysis and quality control procedures of this study.
	Metric 2:	Analytical Methodology	Medium	LOD provided but methodology is briefly described as adaptation of NIOSH or other environmental methods. It's noted at CARB contracted with Batelle to QA/QC/evaluate sampling, analysis and quality control procedures of this study.
	Metric 3:	Biomarker Selection	N/A	Parent chemical only.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	California.
	Metric 5:	Currency	Low	1989-1990
	Metric 6:	Spatial and Temporal Variability	High	20 sites
	Metric 7:	Exposure Scenario	High	Ambient air exposure pathway
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data not provided, stats include min, max, mean and figures of trends
	Metric 9:	Quality Assurance	Medium	QA processes are discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Discussed seasonality of sampling

Overall Quality Determination Medium

Study Citation:	Yazar, M., Bellander, T., Merritt, A. S. (2011). Personal exposure to carcinogenic and toxic air pollutants in Stockholm, Sweden: A comparison over time. Atmospheric Environment 45(17):2999-3004.
HERO ID:	836290

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Participants selection, sampling methods and equipment were reported. The text is missing some information, such as calibration and storage conditions.
	Metric 2:	Analytical Methodology	Medium	Analytical methods and instrumentation was described briefly, with more information reported in companion source. LOD was reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not relevant for this study as environmental sampling was conducted.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Stockholm, Sweden.
	Metric 5:	Currency	Medium	Sampling was conducted in 2009.
	Metric 6:	Spatial and Temporal Variability	High	39 participant samples, with replicates (3 samplers for the participants) and 9 urban background samples described.
	Metric 7:	Exposure Scenario	Medium	Data represents personal exposure. However, the study combines urban background together and does not present results for the different environments.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported. Individual points were not reported.
	Metric 9:	Quality Assurance	Low	This study analyzed control samples and provided a limited description of quality control and quality assurance techniques. Recoveries were not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was accounted for as different environments were sampled. There was a limited discussion of uncertainties and no discussion of study limitations.

Overall Quality Determination Medium

Study Citation:	Leach, J., Blanch, A., Bianchi, A. C. (1999). Volatile organic compounds in an urban airborne environment adjacent to a municipal incinerator, waste collection centre and sewage treatment plant. Atmospheric Environment 33(26):4309-4325.
HERO ID:	1010015

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling procedure and equipment were described in detail, and lacked a few details on storage conditions.
	Metric 2:	Analytical Methodology	Low	The extraction and analysis were described, but no limit of detection (LOD) was provided.
	Metric 3:	Biomarker Selection	N/A	Sampling was conducted in environmental media, thus this metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The sampling took place in Marchwood, England.
	Metric 5:	Currency	Low	1996-1997
	Metric 6:	Spatial and Temporal Variability	Medium	The samples came from 3 facilities, and were sampled in duplicate.
	Metric 7:	Exposure Scenario	Medium	The exposure scenario was adequately described.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Airborne concentrations were reported as a range in Table 3.
	Metric 9:	Quality Assurance	Medium	The study applied and documented quality assurance measures.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The study had some discussions about variance.

Overall Quality Determination Medium

Study Citation:	Saborit, J. M. D., Aquilina, N. J., Meddings, C., Baker, S., Vardoulakis, S., Harrison, R. M. (2009). Measurement of personal exposure to volatile organic compounds and particle associated PAH in three UK regions. Environmental Science & Technology 43(12):4582-4588.
HERO ID:	1058014

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Personal air sampling equipment, methods, recruitment and calibration are described in sufficient detail and are scientifically sound. Certain aspects, such as sample storage conditions and duration are missing.
	Metric 2:	Analytical Methodology	Low	Analytical methodology, instrument and calibration are described in good detail and is scientifically sound. However, no measure of detection limit is reported.
	Metric 3:	Biomarker Selection	N/A	This study was testing for the parent chemical of interest in environmental media (air). This metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in London, West Midlands, and rural South Wales of the United Kingdom.
	Metric 5:	Currency	Medium	Volunteers were recruited between 2005 and 2007. While sample collection timing is not further specified, the study was received for publication in 2008 and so can be inferred to have taken place between 2005 and 2008.
	Metric 6:	Spatial and Temporal Variability	High	Personal air samples were monitored for 100 volunteers for five consecutive 24-hour periods. Duplicates equivalent to 3% of the samples were taken.
	Metric 7:	Exposure Scenario	High	Personal air samples were monitored for 100 volunteers following their normal lifestyles, capturing highly representative "real life" exposure information.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data are not reported; summary statistics include minimum, maximum, arithmetic mean and standard deviation, and geometric mean and standard deviation for all volunteers as well as stratified by location or other key determinants.
	Metric 9:	Quality Assurance	Low	QA/QC measures included the use of field blanks, travel blanks, and travel and exposure blanks; duplicate analyses; instrument performance check and tuning prior to initial calibration; initial five or six-point calibration curve; analysis of laboratory blank at the beginning of a batch; standard check at the beginning and end of each batch; re-conditioning of highly exposed tubes; and random analysis of duplicate standards. Results of these measures are not reported but cited to Kim et al. (2001) and Delgado-Saborit et al. (Submitted); these results may merit a higher score. However, recoveries are not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability is characterized quantitatively and qualitatively, including influence of key determinants. The authors note limitations on comparison of concentrations by geographical location due to differences in seasonality of sampling in each location; this introduces uncertainty that may impact relative exposure estimates.

Overall Quality Determination Medium

Study Citation: Hecht, S. S., Seow, A., Wang, M., Wang, R., Meng, L., Koh, W. P., Carmella, S. G., Chen, M., Han, S., Yu, M. C., Yuan, J. M. (2010). Elevated levels of volatile organic carcinogen and toxicant biomarkers in Chinese women who regularly cook at home. Cancer Epidemiology Biomarkers and Prevention 19(5):1185-1192.

HERO ID: 1062699

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling methodology for urinary metabolite was described in terms of brief procedures, sample storage conditions and study site characteristics. Details regarding sampling equipment and sample storage duration prior to analysis were lacking.
	Metric 2:	Analytical Methodology	Low	Limits of detection were not reported. The analytical methodology was noted in terms of instrumentation only (abstract) and site of analysis (University of Minnesota).
	Metric 3:	Biomarker Selection	N/A	The study evaluated a not relevant metabolite.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were described as collected from Singapore residents.
	Metric 5:	Currency	Low	Sampling dates were reported as April of 1994 through April of 2005 for this population-based study from which volunteers were derived. However, sampling dates of randomly chosen specimens and controls were not noted.
	Metric 6:	Spatial and Temporal Variability	Low	Samples were described as randomly chosen from participants of population-based study and controls. However, only single spot-urines were taken from n=48 participants and n=50 controls. Replicate sampling was not conducted.
	Metric 7:	Exposure Scenario	Medium	This study reported levels of a 1,3-butadiene metabolite (MHBMA) in n=48 originally chosen volunteer nonsmoking, nonalcohol drinking Chinese women from Singapore that reported home cooking >= 5 days per week. For controls, 50 Chinese women were randomly chosen among participants from the population-based Singapore Chinese Health Study. Exposure sources were discussed in the text as regular home cooking sources.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Data for this study was reported in Table 1. Concentration results were reported only as means. The number of samples was noted as n= 48 volunteers randomly chosen from the original study and n=50 controls. Raw data was not reported. The frequency of detection was not noted.
	Metric 9:	Quality Assurance	Low	Quality assurance was not discussed. However, the text noted utilizing blank samples for the precision analyses. Methods utilized for sampling and analysis were detailed only in terms of instrumentation. Control sampling was conducted.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability of results was not reported. Potential study limitations were described in the last paragraph.

Overall Quality Determination Low

Study Citation:	Gordon, S. M., Callahan, P. J., Nishioka, M. G., Brinkman, M. C., O'Rourke, M. K., Lebowitz, M. D., Moschandreas, D. J. (1999). Residential environmental measurements in the National Human Exposure Assessment Survey (NHEXAS) pilot study in Arizona: Preliminary results for pesticides and VOCs. Journal of Exposure Analysis and Environmental Epidemiology 9(5):456-470.
HERO ID:	1065862

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The air sampling methodology was well described and is scientifically sound.
	Metric 2:	Analytical Methodology	Low	The analytical methods were described in detail but did not include the limit of detection (LOD) or recoveries.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed air samples and this metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Arizona, USA.
	Metric 5:	Currency	Low	The study was published in 1999.
	Metric 6:	Spatial and Temporal Variability	Low	The number of samples was reported as n=38 (<5 replicates) for 1,3 Butadiene, estimated from Table 10.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to airborne 1,3 Butadiene inside and outside of households in Arizona.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported (median, 75 and 90 percentile) within this study.
	Metric 9:	Quality Assurance	High	Quality control and quality assurance techniques were described by the authors, including the use of control samples.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability was characterized (percentiles), and uncertainties were discussed by the authors.

Overall Quality Determination Medium

Study Citation:	Dodson, R. E., Houseman, E. A., Levy, J. I., Spengler, J. D., Shine, J. P., Bennett, D. H. (2007). Measured and modeled personal exposures to and risks from volatile organic compounds. Environmental Science & Technology 41(24):8498-8505.
HERO ID:	1067092

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Key criteria met, sampling methodology details, including sample storage duration prior to analysis, provided within supplemental material.
	Metric 2:	Analytical Methodology	High	Key criteria met. Analytical methodology described within main text and further details within supplemental information, US EPA methods, chemical-specific limits of detection reported within supplemental material; analytic methods referenced and described within supplemental material.
	Metric 3:	Biomarker Selection	N/A	Sampling for parent chemicals of interest.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples provided by participants in Boston, Massachusetts.
	Metric 5:	Currency	Medium	While the paper does not report samples dates it does refer to another paper in the cohort (2442846) which reports samples were collect from 2003-2005
	Metric 6:	Spatial and Temporal Variability	Medium	Participants (n=55) living in and around Boston, Massachusetts contributing at least one 48-hour personal active air sampling exposure results for home and work or school, with n=34 providing both summer and winter sampling sessions, residential indoor and outdoor sampling, and additional area active air sampling conducted in microenvironments of interest of dining retail and transportation locations; years of exposure monitoring not reported.
	Metric 7:	Exposure Scenario	Medium	Microenvironment characteristics described, sources of exposure discussed, lack of exposure controls.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Most key criteria met; lack of raw data, although raw data for time-weighted average exposures reported for formaldehyde in Fig. 2.
	Metric 9:	Quality Assurance	High	Quality assurance procedures described with most key criteria met and US EPA analytic methods.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability described within statistical summary measures, potential study limitations described and comparisons with previous literature presented.

Overall Quality Determination High

Study Citation:	Logue, J. M., Small, M. J., Stern, D., Maranche, J., Robinson, A. L. (2010). Spatial variation in ambient air toxics concentrations and health risks between industrial-influenced, urban, and rural sites. Journal of the Air and Waste Management Association 60(3):271-286.
HERO ID:	1255270

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling procedure was described, and calibration was carried out. Sampling sites were described,
	Metric 2:	Analytical Methodology	Medium	GC-MS was used to analyze the samples, LOD was not reported.
	Metric 3:	Biomarker Selection	N/A	Paper measures concentration of parent compound in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Pittsburgh, PA
	Metric 5:	Currency	Medium	2006 to 2008
	Metric 6:	Spatial and Temporal Variability	High	4 sites in Pittsburgh were sampled. And each site has 70 days of samples, and 103 days of samples were available for at least 3 sites.
	Metric 7:	Exposure Scenario	Medium	Ambient air
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Average concentrations were reported with summary statistics; no individual data were reported.
	Metric 9:	Quality Assurance	High	The study reported that it followed QA.QC procedures outlined in EPA methods TO-11A and TO-15.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The study addressed spatial variability but lacked discussion on limitations.

Overall Quality Determination High

Study Citation:	Sunesson, A. L., Rosén, I., Stenberg, B., Sjöström, M. (2006). Multivariate evaluation of VOCs in buildings where people with non-specific building-related symptoms perceive health problems and in buildings where they do not. Indoor Air 16(5):383-391.
HERO ID:	1313693

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The air sampling methodology , equipment and participants was described in detail. Missing some information such as calibration and storage conditions.
	Metric 2:	Analytical Methodology	Medium	The analytical methods and instrument were described, including the LOD. Missing some information such as recoveries and calibration.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed air samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Sweden.
	Metric 5:	Currency	Low	The air samples were collected in 2003.
	Metric 6:	Spatial and Temporal Variability	Medium	66 total samples, duplicates from 31 sampling sites and single samples from four sites.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to airborne pollutants in buildings from Sweden, including description of different types of buildings sampled.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	The authors provided limited summary statistics (mean and range). Individual points not reported.
	Metric 9:	Quality Assurance	Medium	QA/QC techniques were briefly discussed, recoveries not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability was characterized (range) and different types of buildings studied. Uncertainties and limitations were discussed.

Overall Quality Determination Medium

Study Citation:	Ruchirawat, M., Navasumrit, P., Settachan, D. (2010). Exposure to benzene in various susceptible populations: co-exposures to 1,3-butadiene and PAHs and implications for carcinogenic risk. Chemico-Biological Interactions 184(1-2):67-76.
HERO ID:	1325837

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Air samples were collected with passive air samplers using thermal desorption tubes. Protocols, including storage conditions, were reported in sufficient detail and are scientifically sound.
	Metric 2:	Analytical Methodology	Low	Air samples were thermally desorbed and analyzed by gas chromatography-mass spectrometry, but all other details are cited to a previous reference not retrieved (Navasumrit et al., 2008).
	Metric 3:	Biomarker Selection	N/A	This study was testing for the chemical of interest in environmental media (air). Blood samples collected in this study pertained to determination of health outcomes.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in various locations around Thailand, including Bangkok and the provinces of Chonburi, Samutprakarn, Chachoengsao, and Ayutthaya.
	Metric 5:	Currency	Low	Timing of sample collection for monitoring data is not reported, discussed, or referenced. The article was published in 2010.
	Metric 6:	Spatial and Temporal Variability	Low	Air samples were collected in 12 workplaces, along roadsides, in 6 schools and 3 temples, and in 437 participants' breathing zones across Thailand. While the numbers of locations and participants is reported, ambient samples are noted to be "collected from various sampling areas in the study locations" and total sample size is not reported (only number of samples with detectable levels of the chemical of interest). Additionally, the use of replicates is not reported.
	Metric 7:	Exposure Scenario	High	Sampling locations are well characterized in terms of comparing rural and urban locations, worksites with likely exposure sources, and local conditions such as temperature and relative humidity.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported. Summary statistics include mean, standard error, median, minimum, and maximum concentrations for each sample location/type.
	Metric 9:	Quality Assurance	Low	Air sample QA/QC measures were not reported, but may be included in reference for analytical methodology, which was not retrieved (Navasumrit et al., 2008).
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was characterized quantitatively and qualitatively. However, the discussion of limitations or possible sources of uncertainty is limited to the health outcomes assessed in association with the reported exposure data.

Overall Quality Determination Medium

Study Citation: Perbellini, L., Princivalle, A., Cerpelloni, M., Pasini, F., Brugnone, F. (2003). Comparison of breath, blood and urine concentrations in the biomonitoring of environmental exposure to 1,3-butadiene, 2,5-dimethylfuran, and benzene. International Archives of Occupational and Environmental Health 76(6):461-466.

HERO ID: 1328641

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology for breath, blood and urinary 1,3-butadiene was described in terms of sampling equipment, brief procedures, sample storage conditions, study site characteristics and sample storage duration prior to analysis.
	Metric 2:	Analytical Methodology	Medium	Limits of detection were reported. Analytical methodology was noted in terms of instrumentation, extraction and calibration. Details regarding recoveries were lacking.
	Metric 3:	Biomarker Selection	N/A	Sampling was conducted for parent chemical of interest, thus this metric is not applicable for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were described as collected from North-East Italy volunteers.
	Metric 5:	Currency	Low	Sampling dates were described only as "February". Publication date was noted as 2003.
	Metric 6:	Spatial and Temporal Variability	Low	Single samples of breath, blood and urine were obtained from each participant at a single timepoint for n= 61 participants. Replicate sampling was not conducted.
	Metric 7:	Exposure Scenario	Medium	This study investigated alveolar (breath), blood and urine concentrations of 1,3-butadiene and other chemicals during February after the long, non-working winter season reportedly from non-occupational exposures of n=61 forestry workers living in small mountain villages of North-East Italy. Exposure sources were discussed in the text as automobile exhaust, domestic fires and tobacco.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data was not reported. Relevant data was reported in Table 1. Concentration results were reported as means, standard deviation, median, minimum and maximum. Number of samples was noted as n= 61. Frequency of detection was not noted.
	Metric 9:	Quality Assurance	Low	Quality assurance was not discussed, however the text noted utilizing blank samples for possible contamination analyses. The text notes performance of laboratory blank samples daily with calibration curves.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability of results was reported within statistical summary measures of standard deviation and minimum, maximum. Potential study limitations was not detailed.

Overall Quality Determination Medium

Study Citation:	Alwis, K. U., Blount, B. C., Britt, A. S., Patel, D., Ashley, D. L. (2012). Simultaneous analysis of 28 urinary VOC metabolites using ultra high performance liquid chromatography coupled with electrospray ionization tandem mass spectrometry (UPLC-ESI/MSMS). Analytica Chimica Acta 750:152-160.
HERO ID:	1477266

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampling methods, equipment and storage for a human biomonitoring study (using urine) were reported. However, information about collecting the samples from participants were not reported.
	Metric 2:	Analytical Methodology	High	Analytical methods, instrument, calibration and detection limit were reported.
	Metric 3:	Biomarker Selection	N/A	The metabolites DHBMA and HBMA are not relevant biomarkers of 1,3-Butadiene.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The location of data collection was not reported, however the study authors were noted to be from the National Center for Environmental Health, CDC, and it is assumed that the participants provided samples within the U.S.
	Metric 5:	Currency	Low	The date of sample collection was not reported but the study was published in 2012.
	Metric 6:	Spatial and Temporal Variability	Medium	Samples were collected from 1203 non-smokers and 347 smokers. Replicates were not reported. The timing of the urine samples collected were not reported.
	Metric 7:	Exposure Scenario	Low	This study was mostly focused on the analytical method. The samples came from smokers and non-smokers, but no information on the participants are reported.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	The study made general links between smoking and elevated levels of VOCs (though this study was not exclusively focused on the chemical of interest). Mean and SD were reported. Individual points were not reported.
	Metric 9:	Quality Assurance	High	The study reported all necessary QC, including recoveries above 70% and biomarker stability.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The study did not report variability, gaps, or limitations.

Overall Quality Determination Medium

Study Citation:	Eklund, B., Anderson, E. P., Walker, B. L., Burrows, D. B. (1998). Characterization of landfill gas composition at the Fresh Kills municipal solid-waste landfill. Environmental Science & Technology 32(15):2233-2237.
HERO ID:	1487387

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Surface emission sampling was described as utilizing standard EPA sampling methods. Sampling methodology was described in detail regarding sampling equipment, procedures and study site characteristics, with additional sampling details noted as presented in referenced work (EPA, 1995; not available) for surface emission sampling, and passive vents and gas collection systems representing all four sections of municipal solid waste (MSW) landfill. Insufficient information was provided within the main text regarding sample storage conditions and time prior to analysis as well as calibration of sampling equipment, however it can be assumed that standard EPA methods were utilized.
	Metric 2:	Analytical Methodology	Low	Analytical methodology was reported for sampling of VOCs from three landfill emission sources: passive vents, soil surface flux, and gas collection systems and was described in terms of analytical instrumentation parameters and operation for VOC analysis. Insufficient information was provided regarding instrument calibration, recovery samples and limits of detection within the main text, however the missing information was unlikely to have had a substantial impact on results as analytical methodologies can be assumed to follow standard EPA protocols. Limit of detection was not reported.
	Metric 3:	Biomarker Selection	N/A	Environmental media sampling (landfill gas) was conducted, thus this metric is not relevant for this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Sampling was conducted within the Fresh Kills landfill in New York City, NY.
	Metric 5:	Currency	Low	Dates of sampling were not provided. Study publication date was 1998.
	Metric 6:	Spatial and Temporal Variability	High	Characterization of spatial and temporal variability of landfill gas composition was cited as a specific objective of the current study. Spatial variability was characterized within sampling of all four sections of the landfill. Spatial variability within passive vent sampling was considered within procedures for sampling of every vent with functional flow in the three landfill sections that had passive vents. Authors noted that 10% of the vents did not have flow and were not sampled. Temporal variability in terms of short-term and diurnal variability was evaluated within passive vent sampling of five vents over three days with morning and afternoon sampling on one day. Duplicate canisters were collected at each of the four vents sampled for speciated VOCs. For flux chamber surface emission sampling, spatial variability was limited as sampling was conducted mainly within one area that did not have a surface liner but was thus expected to have the highest landfill air emissions. However, within this area, four sampling points were sampled three to four times each during the three days of sampling. Landfill gas collection spatial variability was characterized as both of the two landfill gas collection headers were sampled, representing the north and south fields, with short-term variability characterized in sampling the headers for VOC's six times each during the monitoring program days. Coefficients of variation (CV) for overall flow rate data were noted as approximately 8%, however CV's for individual VOCs were within the range of 70%. Additionally, 25 individual gas extraction wells were sampled to further assess spatial variability. Authors noted that seasonal variability was not addressed as sampling was conducted during summer only.
	Metric 7:	Exposure Scenario	Medium	The source of exposures within landfill was characterized as each major emission source was sampled, and the microenvironment was characterized in terms of the composition of landfill gas sampled through passive vents, surface emissions and gas collection headers. However, it is unclear what populations would be affected.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Only mean concentrations were reported. Insufficient information was provided regarding raw data and most additional summary statistic measures of variability.
	Metric 9:	Quality Assurance	Low	Quality assurance and control parameters were discussed and referenced (EPA, 1995; not available). Duplicate field canisters for passive vent sampling were described. Additional quality parameters were assumed provided within standard EPA methodologies which were utilized and referenced (EPA, 1995). However, recoveries are not reported.

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Study Citation: Eklund, B., Anderson, E. P., Walker, B. L., Burrows, D. B. (1998). Characterization of landfill gas composition at the Fresh Kills municipal solid-waste landfill. Environmental Science & Technology 32(15):2233-2237.

HERO ID: 1487387

Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 10: Variability and Uncertainty	Medium	Statistical summary measure variability was lacking as results were presented only as sample means. Authors discussed factors potentially influencing landfill gas composition characterization. Authors noted that short-term variability, but not seasonal, was addressed.

Overall Quality Determination Medium

Study Citation:	Bereznicki, S. D., Sobus, J., Vette, A. F., Stiegel, M. A., Williams, R. (2012). Assessing spatial and temporal variability of VOCs and PM-components in outdoor air during the Detroit Exposure and Aerosol Research Study (DEARS). Atmospheric Environment 61(Elsevier):159-168.
HERO ID:	1526164

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling procedures and sampling conditions were described.
	Metric 2:	Analytical Methodology	Low	Analytical methodology was not described, though method detection limit (MDL) was provided.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to this study as environmental sampling was conducted.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Detroit, MI.
	Metric 5:	Currency	Medium	Sampling dates were not directly provided, but can be inferred from the reported tables as being conducted from 2004 - 2007.
	Metric 6:	Spatial and Temporal Variability	Medium	Most sites had more than 20 observations. It was unclear if replicates were taken.
	Metric 7:	Exposure Scenario	High	The exposure scenario was adequately described and sampling was conducted for ambient air with outdoor residential measurements of relevant chemicals.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Mean concentrations were reported within summary statistics. No individual, or raw data were reported.
	Metric 9:	Quality Assurance	Medium	Quality assurance/quality control techniques and results were not directly discussed, but can be implied through the study's use of standard field and laboratory protocols.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The study has a limited discussion of key uncertainties, limitations, and data gaps.

Overall Quality Determination Medium

Study Citation:	Delgado-Saborit, J. M., Aquilina, N. J., Meddings, C., Baker, S., Harrison, R. M. (2011). Relationship of personal exposure to volatile organic compounds to home, work and fixed site outdoor concentrations. Science of the Total Environment 409(3):478-488.
HERO ID:	1788464

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The air sampling methodology was described in detail in the Supplementary (SI) material, with a brief description in the main manuscript.
	Metric 2:	Analytical Methodology	Medium	The analytical methods were described and included limits of detection (LODs) in the SI material, but did not include details on recoveries.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to this study as the authors analyzed environmental samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in the United Kingdom.
	Metric 5:	Currency	Medium	The samples were collected between 2005 and 2007.
	Metric 6:	Spatial and Temporal Variability	High	The total number of study participants was reported as n=100, and duplicate samples were collected.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant personal exposure scenarios related to airborne 1,3-Butadiene.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported (Table 1). No raw data was provided.
	Metric 9:	Quality Assurance	High	QA/QC techniques were described in detail in the supplementary information (SI) material, including the use of control samples.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was characterized (range, standard deviation (SD). Uncertainties were briefly discussed.

Overall Quality Determination High

Study Citation:	Harrison, R. M., Delgado-Saborit, J. M., Baker, S. J., Aquilina, N., Meddings, C., Harrad, S., Matthews, I., Vardoulakis, S., Anderson, H. R., HEI Health Review Committee (2009). Measurement and modeling of exposure to selected air toxics for health effects studies and verification by biomarkers. Research Reports (Health Effects Institute) (143):3-96; discussion 97-96100.
HERO ID:	1940869

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology included the recruitment of subjects, sampling devices, and sampling storage details.
	Metric 2:	Analytical Methodology	High	The analytical methodology included a previously developed and validated technique using a GC-MS. The limit of detection is reported in the appendix 5, table A5.5.
	Metric 3:	Biomarker Selection	N/A	The study is testing for the chemical parent in an environmental media. The metabolites measured in urine are PECO supplemental for 1,3 butadiene.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected from residents of the United Kingdom including London, West Midlands, and South Wales.
	Metric 5:	Currency	High	Samples were collected between May 2005 and May 2007. The dates are reported in the appendix 2, table A2.1.
	Metric 6:	Spatial and Temporal Variability	High	More than 10 samples were collected per location (table 1) and microenvironments (table 5).
	Metric 7:	Exposure Scenario	High	The study evaluates a range of microenvironments and locations, including urban, suburban, and rural residence of the volunteers, as well as microenvironment sampling for street, transport, indoor, and homes.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Statistical summaries were reported in appendix 7, but raw data is not reported.
	Metric 9:	Quality Assurance	High	A set of quality assurance and quality control (QA and QC) record keeping is reported in page 29. The QC included blanks, duplicates, standard checks, precision, accuracy, recovery of internal standards, and calibrations.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Uncertainty was discussed as limitations in the critique section of the report. Variability was reported in appendix 7 and included standard deviation, and geometric standard deviation for a series of statistic summaries.

Overall Quality Determination High

Study Citation:	Kim, Y. M., Harrad, S., Harrison, R. M. (1999). An improved method for the determination of 1,3-butadiene in nonoccupational environments. Environmental Science & Technology 33(23):4342-4345.
HERO ID:	1952807

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling methods and equipment were reported and described. The study is missing some information, such as details regarding calibration of sampling and analytic equipment.
	Metric 2:	Analytical Methodology	High	The study reported descriptions of analytical methods, instrumentation and calibration as well as the method detection limit (MDL).
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to the data source.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in the UK.
	Metric 5:	Currency	Low	The study was published in 1999.
	Metric 6:	Spatial and Temporal Variability	Medium	Eight samples were collected from 8 locations.
	Metric 7:	Exposure Scenario	Low	This study focused on the methods rather than characterizing the exposure scenario. Little information is given on the microenvironments.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were reported in Table 3. There were no other descriptive statistics reported.
	Metric 9:	Quality Assurance	High	All key quality assurance (QA) procedures were reported by the study authors, including validation of sampling method. Recoveries were >95%.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study did not report gaps, limitations, or uncertainties.

Overall Quality Determination Medium

Study Citation:	Hagenbjörk-Gustafsson, A., Tornevi, A., Andersson, E. M., Johannesson, S., Bellander, T., Merritt, A. S., Tinnerberg, H., Westberg, H., Forsberg, B., Sallsten, G. (2014). Determinants of personal exposure to some carcinogenic substances and nitrogen dioxide among the general population in five Swedish cities. Journal of Exposure Science & Environmental Epidemiology 24(4):437-443.
HERO ID:	2234069

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling methodology, equipment, and participant recruitment is clear but brief, and is missing details such as sampler calibration and sample storage which may be reported in the referenced source.
	Metric 2:	Analytical Methodology	Low	The analytical methodology and instrument is brief and missing information such as calibration and LOD. Additional information may be reported in the referenced source.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as the study is testing for a parent chemical in an environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The samples were collected in five Swedish cities.
	Metric 5:	Currency	Medium	The samples were collected from 2000 to 2008.
	Metric 6:	Spatial and Temporal Variability	Medium	295 samples were collected from 195 subjects. No replicates are reported.
	Metric 7:	Exposure Scenario	Low	The exposure scenario is formaldehyde in personal breathing samples from people in Sweden, among both smokers and non-smokers. This is a scenario of interest for the chemical. However, the study does not separate the results from vehicle emissions which is not of interest.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Table 1 has the mean concentration of formaldehyde. No raw data is provided.
	Metric 9:	Quality Assurance	Low	QA/QC measures are not discussed and issues are not identified but can be inferred by the study's protocols. The use of blanks or controls is not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Table 1 provided variance components by city, person, and measurement. Limitations are not reported.
Overall Quality Determination			**Medium**	

Study Citation:	Vainiotalo, S., Vaananen, V., Vaaranrinta, R. (2008). Measurement of 16 volatile organic compounds in restaurant air contaminated with environmental tobacco smoke. Environmental Research 108(3):280-288.
HERO ID:	2331385

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Equipment and methods for air sampling are described in sufficient detail and and are scientifically sound. Details regarding storage conditions and duration are absent, and results of storage stability studies indicated a marked decrease in measured levels after 2.5 weeks of refrigerator studies, suggesting that these details may have a substantial impact on results. However, analytical parameters are provided in table 2.
	Metric 2:	Analytical Methodology	High	Samples were prepared and analyzed by thermal desorption and GC/MS; conditions are described in good detail and are scientifically sound. Limit of quantification (LOQ) is reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as this study was testing for the parent chemical of interest in environmental media (air).
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study used samples collected from restaurants and offices around Helsinki, Finland.
	Metric 5:	Currency	Medium	Samples were collected between November 2005 and May 2006.
	Metric 6:	Spatial and Temporal Variability	Medium	Two 5-hour air samples each were collected in the smoking and non-smoking sections of 10 restaurants, for 40 total samples. The number of office samples was not specified and only treated as a control group. Use of replicates was not reported (the two air samples in each section were collected within one week of each other, but not simultaneously).
	Metric 7:	Exposure Scenario	High	This study determined airborne concentrations inside restaurants and offices and thus is highly representative of a likely ”real life” exposure scenario.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported and one concentration was reported per restaurant section, reported as the mean concentration of the two samples. Summary statistics included arithmetic mean, standard deviation, geometric mean, and range of concentrations by section type (smoking or non-smoking). Office concentrations were only reported as a single average.
	Metric 9:	Quality Assurance	High	Validation parameters reported included precision (relative standard deviation) and linearity for an appropriate range of concentrations.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability is characterized quantitatively across restaurants. Issues related to degradation in storage are acknowledged, but the authors consider the 12% loss after several weeks in storage to be satisfactory. More careful consideration of this topic, modifications to methods, or corrections to results to account for this would merit a higher score. Characterization of office air concentrations is absent, as these results were only treated as a control group.

Overall Quality Determination Medium

Study Citation:	Heck, J. E., Park, A. S., Qiu, J., Cockburn, M., Ritz, B. (2015). Retinoblastoma and ambient exposure to air toxics in the perinatal period. Journal of Exposure Science & Environmental Epidemiology 25(2):182-186.
HERO ID:	2369182

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The air sampling monitoring was briefly described, but the instrumentation and sampling procedure lacked details. Additional information may be in the referenced citations.
	Metric 2:	Analytical Methodology	Low	The analytical methods were briefly described, indicating that the CARB Air Toxics Program provided the data (suggesting proper analytical methods had been used). A detection limit was not reported, although it might be within the referenced sources.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed secondary environmental monitoring data.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in California, USA.
	Metric 5:	Currency	Low	The authors used data that was collected from 1990 to 2007.
	Metric 6:	Spatial and Temporal Variability	Low	The sample size was not reported (but it could be estimated using the range of years and the 24-h sampling interval of 12 days). Sample size may be given in the referenced citations.
	Metric 7:	Exposure Scenario	Medium	The data likely represents relevant exposure scenarios to air toxics of children, but the lack of sample size limits the generalizability of results.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported (mean, SD, IQR). Individual data points, or raw data, were not reported.
	Metric 9:	Quality Assurance	Low	QA/QC techniques were not described, but can be inferred from the study's use of official protocols.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability was characterized within summary statistics (SD, IQR). Uncertainties and study limitations were discussed.

Overall Quality Determination Low

Study Citation:	Yu, C. H., Zhu, X., Fan, Z. H. (2014). Spatial/temporal variations and source apportionment of VOCs monitored at community scale in an urban area. PLoS ONE 9(4):e95734.
HERO ID:	2382561

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling methodology was adequately described and the EPA TO-15 sampling method was cited.
	Metric 2:	Analytical Methodology	Medium	ERG conducted the analysis and the quality assurance and control was overseen by EPA.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as the study assessed environmental samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted near Patterson, NJ.
	Metric 5:	Currency	Medium	This study was conducted during the years 2005-2006.
	Metric 6:	Spatial and Temporal Variability	High	This study reported 25 duplicate samples out of 209 samples and described example spatial and temporal patterns in detail.
	Metric 7:	Exposure Scenario	Medium	The exposure scenario for air sampling was adequately described, but exposure/dose metrics were not quantified.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Statistical summary measures of average, SD, minimum, medium and maximum were reported, but raw data was not reported.
	Metric 9:	Quality Assurance	High	Quality assurance and control procedures included method precision, MDL, and field blanks and were overseen by the EPA.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Spatial and temporal variability were described, and uncertainty was represented by the standard deviation (SD)

Overall Quality Determination High

Study Citation:	Loh, M. M., Houseman, E. A., Gray, G. M., Levy, J. I., Spengler, J. D., Bennett, D. H. (2006). Measured concentrations of VOCs in several non-residential microenvironments in the United States. Environmental Science & Technology 40(22):6903-6911.
HERO ID:	2442846

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Key sampling criteria were described and met. sampling methodology utilized US EPA methods, with details provided within supplemental material.
	Metric 2:	Analytical Methodology	High	Analytical methodology was described as utilizing US EPA standard methods. Further details, including limits of detection (LODs), are within supplemental information. Analytic methods are referenced and described in detail within supplemental material.
	Metric 3:	Biomarker Selection	N/A	This metric was not applicable to this study as sampling was conducted for parent chemicals of interest in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were provided by participants in Boston, Massachusetts.
	Metric 5:	Currency	Medium	Sample collection dates were reported as winter 2004-2005 and summer of 2003.
	Metric 6:	Spatial and Temporal Variability	Medium	Personal active air samples were collected by study staff by walking around various microenvironments during the summer of 2003 and winter of 2004-2005. Microenvironments sampled included multi-purpose stores, dining establishments, and transportation areas. Some of these microenvironments had 5-10 samples (Table 1).
	Metric 7:	Exposure Scenario	Medium	Study analyzed exposure to non-residential indoor sources of VOCs, such as retails stores, restaurants, and transportation modes. Pre-exposure controls/background concentrations were not discussed.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data are not reported, but statistical summary measures are reported in Table 2.
	Metric 9:	Quality Assurance	Low	QA/QC procedures were described and no significant issues were identified. However, recoveries were not mentioned.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability described within statistical summary measures in Table 2. Potential study limitations are described at the end of the paper.

Overall Quality Determination Medium

Study Citation:	Arayasiri, M., Mahidol, C., Navasumrit, P., Autrup, H., Ruchirawat, M. (2010). Biomonitoring of benzene and 1,3-butadiene exposure and early biological effects in traffic policemen. Science of the Total Environment 408(20):4855-4862.
HERO ID:	2583531

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Most key sampling methods were reported in this study. The study did not report sampler calibration.
	Metric 2:	Analytical Methodology	Medium	The study reported the limit of detection (LOD). Recovery samples were not reported.
	Metric 3:	Biomarker Selection	N/A	This study reported not relevant biomarkers.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Bangkok, Thailand.
	Metric 5:	Currency	Medium	Samples were collected in 2006.
	Metric 6:	Spatial and Temporal Variability	Medium	There were >10 samples collected but there were no replicate samples collected.
	Metric 7:	Exposure Scenario	High	The study linked air pollution exposures with ambient air and biomonitoring data.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported. The study reported the mean, median, min, and max.
	Metric 9:	Quality Assurance	Low	The study did not report quality assurance or quality control measures.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study did not report gaps, limitations, or uncertainties.

Overall Quality Determination Medium

Study Citation:	Shin, H. H., Jones, P., Brook, R., Bard, R., Oliver, K., Williams, R. (2015). Associations between personal exposures to VOCs and alterations in cardiovascular physiology: Detroit Exposure and Aerosol Research Study (DEARS). Atmospheric Environment 104:246-255.
HERO ID:	2845868

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling equipment was reported. Some methods were not reported such as sample storage and sampler calibration.
	Metric 2:	Analytical Methodology	Low	Neither the limit of detection (LOD) nor the limit of quantification (LOQ) were reported in this study.
	Metric 3:	Biomarker Selection	N/A	The metric is not applicable to the data source.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Detroit, MI, USA.
	Metric 5:	Currency	Medium	Samples were collected between 2004 and 2007
	Metric 6:	Spatial and Temporal Variability	High	The total number of samples is n=236 and there were replicates collected.
	Metric 7:	Exposure Scenario	Medium	The exposure source is not well characterized. The amount and type of chemical used was not reported.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported. The mean, SD, min, median, and max data summary statistics were reported.
	Metric 9:	Quality Assurance	Low	Limited quality assurance (QA) techniques were reported. Recoveries were not reported. Field controls were not reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Few gaps and limitations were reported. There were, however, measures of variability reported.

Overall Quality Determination Medium

Study Citation:	Domingo, J. L., Rovira, J., Vilavert, L., Nadal, M., Figueras, M. J., Schuhmacher, M. (2015). Health risks for the population living in the vicinity of an Integrated Waste Management Facility: screening environmental pollutants. Science of the Total Environment 518-519:363-370.
HERO ID:	2919960

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampling methodology was only briefly discussed and the text was missing details regarding equipment, procedures, and sample storage conditions.
	Metric 2:	Analytical Methodology	Low	The description of analytical methodology was limited, but included limits of detection (LODs) in supporting information.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to this study which tested for a parent chemical of interest in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Spain.
	Metric 5:	Currency	Medium	Sampling was conducted in 2014.
	Metric 6:	Spatial and Temporal Variability	Low	This study had a total of 13 sampling sites, with no replicate sampling reported.
	Metric 7:	Exposure Scenario	Medium	This study was missing details about the population of interest, and the risk assessment does not describe the exposure assessment in detail.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Individual sample concentrations were reported with no summary statistics.
	Metric 9:	Quality Assurance	Low	Quality assurance was only briefly discussed but control samples were analyzed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	This study did not characterize variability and limitations were only briefly discussed.

Overall Quality Determination Low

Study Citation:	Fustinoni, S., Soleo, L., Warholm, M., Begemann, P., Rannug, A., Neumann, H. G., Swenberg, J. A., Vimercati, L., Colombi, A. (2002). Influence of metabolic genotypes on biomarkers of exposure to 1,3-butadiene in humans. Cancer Epidemiology Biomarkers and Prevention 11(10 Pt 1):1082-1090.
HERO ID:	2958101

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The study authors did not report some sampling methods such as sample storage conditions or sampler calibration.
	Metric 2:	Analytical Methodology	Medium	The study reported the limit of detection (LOD). Recovery samples were not reported.
	Metric 3:	Biomarker Selection	N/A	The study authors reported not relevant biomarkers.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Italy.
	Metric 5:	Currency	Low	The study was published in 2002.
	Metric 6:	Spatial and Temporal Variability	Medium	There were >10 samples and no replicate samples collected.
	Metric 7:	Exposure Scenario	Medium	The background population was not specifically linked to a specific exposure.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported by study authors, but the authors did report descriptive statistics.
	Metric 9:	Quality Assurance	Low	The study authors did not report quality assurance (QA) details.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study authors did not report gaps, limitations, or uncertainties.

Overall Quality Determination — Medium

Study Citation:	Hudson, E. D., Ariya, P. A. (2007). Measurements of non-methane hydrocarbons, DOC in surface ocean waters and aerosols over the Nordic seas during polarstern cruise ARK-XX/1 (2004). Chemosphere 69(9):1474-1484.
HERO ID:	3243268

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The sampling methodology is clear, detailed, and appropriate. Details such as sample storage are provided.
	Metric 2:	Analytical Methodology	Low	The analytical methodology is clear, detailed, and appropriate; however, no limit of detection (LOD) is provided.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as the study is testing for the parent chemical in an environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in Nordic Seas.
	Metric 5:	Currency	Low	Samples were collected June to July 2004.
	Metric 6:	Spatial and Temporal Variability	Medium	The sample size is n=9. No replicates are reported.
	Metric 7:	Exposure Scenario	Low	The study is testing for 1,3-butadiene in ocean air. It is unclear if this scenario is of interest for the chemical, and the exposure scenario is not well characterized.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Both raw data and the mean and standard deviations are provided in Figure 2.
	Metric 9:	Quality Assurance	Medium	Quality assurance and quality control (QA/QC) measures are discussed, including the use of blanks. QA/QC issues were not identified.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The standard deviation is provided in Figure 2. No other characterization of variability or uncertainty is provided.

Overall Quality Determination Medium

Study Citation:	Huang, Y.,u, Ling, Z., Lee, S. C., Ho, S., Cao, J., Blake, D. R., Cheng, Y.,an, Lai, S., Ho, K., Gao, Y., Cui, L., Louie, P. K. K. (2015). Characterization of volatile organic compounds at a roadside environment in Hong Kong: An investigation of influences after air pollution control strategies. Atmospheric Environment 122:809-818.
HERO ID:	3259118

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The air sampling methodology was described in detail (e.g., sampling location, equipment, frequency, calibration) and is scientifically sound.
	Metric 2:	Analytical Methodology	High	The analytical methods were described and included the limit of detection (LOD). Recoveries were described as close to 100% for all target analytes.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed air samples–this metric is not applicable to this study.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Hong Kong.
	Metric 5:	Currency	Medium	The samples were collected in 2011-2012
	Metric 6:	Spatial and Temporal Variability	High	A total of 41 samples were collected across 4 campaigns from May 2011 to February 2012.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios (e.g., roadside monitoring stations surrounded by residential and commercial buildings) related to outdoor airborne 1,3-Butadiene in Hong Kong.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported (mean, 95% CI, range). Raw data were not provided.
	Metric 9:	Quality Assurance	Low	Except for testing of sample stability and regularly calibrating/testing/auditing instruments using standards with known traceability, quality assurance and quality control (QA/QC) techniques were not described.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability was characterized (95% CI, min, max). Uncertainties and study limitations were not discussed.

Overall Quality Determination Medium

Study Citation:	Gallego, E., Roca, F. J., Perales, J. F., Guardino, X., Gadea, E., Garrote, P. (2016). Impact of formaldehyde and VOCs from waste treatment plants upon the ambient air nearby an urban area (Spain). Science of the Total Environment 568:369-380.
HERO ID:	3449325

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The air sampling methodology was well described.
	Metric 2:	Analytical Methodology	High	The analytical methods were well described and included limits of detection (LODs). Recoveries were not reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study as the authors analyzed air samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Spain.
	Metric 5:	Currency	Medium	The study was conducted in 2014 and 2015.
	Metric 6:	Spatial and Temporal Variability	Medium	The authors took<10 samples for each sampling site.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to airborne pollutants near waste treatment plants in Spain.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	The authors only reported summary statistics with no individual sample concentrations or raw data.
	Metric 9:	Quality Assurance	High	Quality assurance and/or quality control (QA/QC) techniques were described, including the use of control samples.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was characterized (SD, range). Uncertainties were briefly discussed.

Overall Quality Determination High

Study Citation:	Forster, M., Mcaughey, J., Prasad, K., Mavropoulou, E., Proctor, C. (2017). Assessment of tobacco heating product THP1.0. Part 4: Characterisation of indoor air quality and odour. Regulatory Toxicology and Pharmacology 93:34-51.
HERO ID:	4168692

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The air sampling methodology was described and is scientifically sound.
	Metric 2:	Analytical Methodology	Medium	The analytical methods were described but recoveries were not reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as the authors analyzed air samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in the United Kingdom.
	Metric 5:	Currency	Low	The article was published in 2017.
	Metric 6:	Spatial and Temporal Variability	Low	The number of samples was n=9 and was estimated from Table 4.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to indoor airborne formaldehyde in controlled environments.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported.
	Metric 9:	Quality Assurance	Low	Quality assurance and quality control (QA/QC) techniques were briefly described in the manuscript.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was not characterized, but limitations and uncertainties were discussed.

Overall Quality Determination Medium

Study Citation:	Radian Corp, (1989). Monitoring near refineries for airborne chemicals on the Sara Title III Section 313 List - Volume I, validated ambient air concentration around 3 refineries - cover ltr dtd 041789. :0489-0687.
HERO ID:	4214481

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling methodology is reported. Tables 2-5 report field QC.
	Metric 2:	Analytical Methodology	High	The Analytical approach is reported in tables 3-5, including limit of detection (LOD).
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable as the study assessed the parent chemical in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Louisiana, Kentucky and California, USA.
	Metric 5:	Currency	Low	The study was conducted in 1989.
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	One 24-hour sample was taken per refinery.
	Metric 7:	Exposure Scenario	High	The exposure scenario was described as air contamination near 3 refineries.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Critically Deficient	The quality of the document prevents reading of the results in tables 2-3.
	Metric 9:	Quality Assurance	High	QA/QC procedures were described in section 4.0. Tables 4-3 to 4-7 report QA /QC results.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability was depicted across different refineries.

Overall Quality Determination Uninformative

Study Citation:	Grosjean, E., Rasmussen, R. A., Grosjean, D. (1999). Toxic air contaminants in Porto Alegre, Brazil. Environmental Science & Technology 33(12):1970-1978.
HERO ID:	4697228

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling procedure, equipment, and matrix characterization were discussed.
	Metric 2:	Analytical Methodology	Medium	The extraction and analytical method (GC/MS) were described. The limit of detection (LOD) was not reported, but the method detection limit (MDL) was reported as 0.1 ppbv.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study which conducted sampling within environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Porto Alegre, Brazil.
	Metric 5:	Currency	Low	The study was conducted during the years 1996-1997.
	Metric 6:	Spatial and Temporal Variability	Medium	Most compounds have more than 23 sample points.
	Metric 7:	Exposure Scenario	Medium	The exposure scenario was adequately described for ambient air samples.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Range and average of the concentrations were reported with standard deviation and background concentration.
	Metric 9:	Quality Assurance	Low	Quality assurance measures were not described in detail.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	The study discussed in details the variability from one urban area to the next area.

Overall Quality Determination Medium

Study Citation:	Deng, Y., Bonilla, M., Ren, H., Zhang, Y. (2018). Health risk assessment of reclaimed wastewater: A case study of a conventional water reclamation plant in Nanjing, China. Environment International 112:235-242.
HERO ID:	4728647

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling collection details are reported in section 2.1.1, including sampling methods, equipment, volume, transport, and storage.
	Metric 2:	Analytical Methodology	Medium	Analytical methods including sample extraction and quantification methods are reported in section 2.1.2. Detection limits are reported in section 2.1.4. Calibration information is missing.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study as the study tested for the parent chemical in an environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in a water reclamation plant in Nanjing China.
	Metric 5:	Currency	Medium	Samples were collected from October 2013 to September 2014.
	Metric 6:	Spatial and Temporal Variability	High	A total of 48 samples were collected in 12 locations.
	Metric 7:	Exposure Scenario	High	The study evaluates the concentration of pollutants in reclaimed wastewater and the potential health risks.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data is not reported, but table 1 reports mean and standard deviation concentrations.
	Metric 9:	Quality Assurance	High	Quality assurance methods included blanks, standard reference material, and samples replicates.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Variability is reported as the standard deviation of each treatment process, and uncertainty is discussed in section 3.5.

Overall Quality Determination High

Study Citation:	Huang, Y., Su, T., Wang, L., Wang, N., Xue, Y., Dai, W., Lee, S. C., Cao, J., Ho, S. S. H. (2019). Evaluation and characterization of volatile air toxics indoors in a heavy polluted city of northwestern China in wintertime. Science of the Total Environment 662:470-480.
HERO ID:	5431563

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Field blanks were used. Storage temp provided. Equipment calibration and flow rates provided. Detailed sampling procedures in other publications (Spaulding et al., 1999; Ho et al., 2011).
	Metric 2:	Analytical Methodology	Medium	Details on method shown in Dai et al., 2012, but relatively robust description provided. Limits only provided as a range.
	Metric 3:	Biomarker Selection	N/A	Paper reports chemical concentrations in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	China
	Metric 5:	Currency	High	2016-2017
	Metric 6:	Spatial and Temporal Variability	High	44 samples from 11 homes.
	Metric 7:	Exposure Scenario	High	Questionnaire provided details to characterize the building and activity patterns of occupants. No known pollution sources near buildings.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Mean and sd in main report. Individual samples appear o have been provided in SI. Conducted source apportionment for indoor sources.
	Metric 9:	Quality Assurance	Medium	Calibration curve was established. Precision was <25%. Recoveries not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability assessed via factor analysis. No discussion of uncertainties.
Overall Quality Determination			**High**	

Study Citation:	Heavner, D. L., Morgan, W. T., Ogden, M. W. (1996). Determination of volatile organic compounds and respirable suspended particulate matter in New Jersey and Pennsylvania homes and workplaces. Environment International 22(2):159-183.
HERO ID:	5544873

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Detailed description of methods including sampling equipment, operations, and participant selection.
	Metric 2:	Analytical Methodology	Medium	Some analytical methods not reported, such as recovery samples
	Metric 3:	Biomarker Selection	N/A	air sampling
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	New Jersey and Pennsylvania
	Metric 5:	Currency	Low	data collected in 1992
	Metric 6:	Spatial and Temporal Variability	Medium	No replicate samples collected
	Metric 7:	Exposure Scenario	High	Home and work exposure
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data reported
	Metric 9:	Quality Assurance	Low	Limited QA/QC information reported
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	No gaps nor limitations reported

Overall Quality Determination Medium

Study Citation:	Drakou, G., Zerefos, C., Ziomas, I., Voyatzaki, M. (1998). Measurements and numerical simulations of indoor O3 and NOx in two different cases. Atmospheric Environment 32(4):595-610.
HERO ID:	5549843

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Most necessary sampling methods were reported. The study did not report sample storage conditions.
	Metric 2:	Analytical Methodology	Low	Limit of detection (LOD) and limit of quantification (LOQ) were not reported. The study did not report sample storage conditions.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to the data source.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Greece.
	Metric 5:	Currency	Low	Samples were collected in 1994.
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	The number of samples collected was not reported.
	Metric 7:	Exposure Scenario	Low	The exposure scenario was not well characterized.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Raw data and summary statistics were not reported.
	Metric 9:	Quality Assurance	Low	The study did not report quality assurance (QA) procedures.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Gaps, limitations, and uncertainties were not reported.

Overall Quality Determination — Uninformative

Study Citation:	Yimrungruang, D., Cheevapom, V., Boonphakdee, T., Watchalayann, P., Helander, H. F. (2008). Characterization and Health Risk Assessment of Volatile Organic Compounds in Gas Service Station Workers. EnvironmentAsia 1(2):21-29.
HERO ID:	5708436

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology for air samples was described in section 2.1.1.
	Metric 2:	Analytical Methodology	Low	Samples were analyzed following the Instruction Manual TO-17 (USEPA, 1999). Detection limits are not reported.
	Metric 3:	Biomarker Selection	N/A	The study evaluated the parent chemical in air samples. The metabolites are non-relevant.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in offices of gas stations in Thailand.
	Metric 5:	Currency	Medium	Samples were collected from October to December of 2007.
	Metric 6:	Spatial and Temporal Variability	Low	Control samples were collected only for 3 individuals.
	Metric 7:	Exposure Scenario	High	Control samples were for office workers with no direct contact with 1,3-Butadiene.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Data for the control is reported in table 3 with mean, SD, min and max.
	Metric 9:	Quality Assurance	High	Quality assurance and control (QA QC) included the use of an external standard, and field and laboratory blanks.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	Uncertainty was reported in the discussion session and variability was reported in terms of standard deviation.

Overall Quality Determination Medium

Study Citation:	Phillips, K., McKenna, A. M., Howard, D. A., Bentley, M. C., Cook, J. N. (1997). The concentration of volatile organic compounds inside and outside the homes of the residents of six European cities. Advances in Occupational Medicine and Rehabilitation 3:33-46.
HERO ID:	5714153

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	There was a limited description in the text of study sampling methodology and no description of sample handling after collection.
	Metric 2:	Analytical Methodology	Low	This study provided a very brief description of analytical methodology and there was no report of limit of detection or quantification (LOD or LOQ).
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to this study which sampled for chemicals of interest within environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted within six European cities–Turin, Paris, Bremen, Lisbon, Basle, and Prague.
	Metric 5:	Currency	Low	The data for this study was collected in the year 1995.
	Metric 6:	Spatial and Temporal Variability	High	193 indoor measurements and 120 outdoor measurements were summarized within this study.
	Metric 7:	Exposure Scenario	High	The exposure scenario was adequately depicted within indoor and outdoor exposure sampling.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data was reported.
	Metric 9:	Quality Assurance	Low	No quality assurance or control (QA/QC) procedures were reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	No limitations were reported.

Overall Quality Determination Medium

Study Citation:	Karman, D., Oguz, O., Tuncel, G. (2003). Measurement of Traffic Related Toxic Air Pollutants in an Urban Atmosphere. Water, Air, and Soil Pollution: Focus 3(5-6):181-198.
HERO ID:	6174199

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	All key sampling methods for a study on air quality measurements from traffic were reported.
	Metric 2:	Analytical Methodology	Medium	The limit of quantification (LOQ) was reported. Recovery samples were not reported.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to the data source.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in Ottawa, Canada.
	Metric 5:	Currency	Low	The study was conducted in 2000.
	Metric 6:	Spatial and Temporal Variability	Medium	The study collected >10 samples but there were no replicates collected.
	Metric 7:	Exposure Scenario	High	This study establishes the exposure scenario as a commuter in urban traffic at different commute times and in winter/summer seasons to determine the contribution of motor vehicle trafficto the measured toxic substance concentrations.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data were not reported by the study authors. The study authors reported the mean summer and winter concentrations. Additional summary statistics were reported by the graphics in the study.
	Metric 9:	Quality Assurance	Medium	Most necessary quality assurance (QA) procedures were reported. The study did not report some metrics, such as recovery samples.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study did not report gaps and limitations but described a few uncertainties.

Overall Quality Determination Medium

Study Citation:	Kanellopoulos, P. G. A.,UCEAUKKAUVEAUKCAUSCAUBE (2020). Polar organic compounds in PM10 and PM2.5 atmospheric aerosols from a background Eastern Mediterranean site during the winter period: Secondary formation, distribution and source apportionment. Atmospheric Environment 237:117622.
HERO ID:	6821328

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Some sampling methods were not reported, such as sampler calibration.
	Metric 2:	Analytical Methodology	Medium	Key analytical methods were reported. LOD for PA might be located within the supplemental materials.
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable for this study which measured the parent chemical within environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	This study was conducted in Cyprus.
	Metric 5:	Currency	Low	The sampling date is not specifically stated but is most likely between 2010-2017 based on results section.
	Metric 6:	Spatial and Temporal Variability	Medium	132 samples were collected, but it is unclear if there were replicates.
	Metric 7:	Exposure Scenario	Medium	The exposure source was not well characterized.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Summary statistics were provided. Individual points may be within supplemental material.
	Metric 9:	Quality Assurance	Medium	Not all quality assurance (QA) criteria were reported, such as control samples.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Few gaps and limitations were reported. There was not much variation in the location and dates of samples.

Overall Quality Determination Medium

Study Citation:	Baek, K. M., Kim, M. J., Seo, Y. K., Kang, B. W., Kim, J. H., Baek, S. O. (2020). Spatiotemporal variations and health implications of hazardous air pollutants in Ulsan, a multi-industrial city in Korea. Atmosphere 11(5):547.
HERO ID:	6950643

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sampling equipment and methods are described in sufficient detail and are referenced to an accepted methodology (USEPA TO-17), but certain aspects (e.g. duration of storage) were absent that are unlikely to have a substantial impact on results.
	Metric 2:	Analytical Methodology	Medium	Analytical instrumentation and methods are described in excellent detail. However, method detection limits are only provided as a range across all analytes in each class.
	Metric 3:	Biomarker Selection	N/A	This study is testing for the parent chemical in an environmental medium (air).
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Ulsan, Korea
	Metric 5:	Currency	Medium	2009-2010
	Metric 6:	Spatial and Temporal Variability	High	Air samples were collected over eight days per season from five sampling sites for a total of 40 samples per season, and replicate samples were collected via the use of sequential samplers.
	Metric 7:	Exposure Scenario	High	Each air sampling site is assigned either industrial or residential and thoroughly described in terms of surrounding buildings, traffic conditions, etc.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Raw data are not reported; so summary statistics can not be preproduced. Summary statistics include the mean and standard deviation for each sampling site. Supplemental information also provides mean and maximum concentrations for combined sites (industrial or residential).
	Metric 9:	Quality Assurance	High	QA/QC measures included independent analysis of duplicate samples by two labs, for which the mean duplicate precisions were mostly less than 30%, which is the recommended criterion of USAEPA TO-17.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Standard deviation is reported for each mean concentration. While there is some discussion of uncertainty and limitations, it focuses on health risk assessment subsequent to monitoring data and not the monitoring data itself.

Overall Quality Determination Medium

Study Citation:	CTEH, (2021). Shell Puget Sound Refinery 9-29-2020 flaring event: Supplemental report.
HERO ID:	11273432

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling was completed using 1.4 L MiniCans(TM). Sample sites are also reported.
	Metric 2:	Analytical Methodology	High	Samples were analyzed via the USEPA Method TO-15 by a third-party analytical laboratory. Reported detection limit range is referenced in each sample results.
	Metric 3:	Biomarker Selection	N/A	The parent chemical was tested in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in Anacortes, Washington, USA.
	Metric 5:	Currency	High	Samples were collected in October 2020.
	Metric 6:	Spatial and Temporal Variability	Medium	Six samples were collected for a 24h period
	Metric 7:	Exposure Scenario	High	This study measures air concentrations after a flare event at a refinery.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Individual data is reported in attachment B.
	Metric 9:	Quality Assurance	High	Attachment B reports a range of laboratory quality controls.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability is not reported but the chemical data is all reported as ND, the study also reports qualifier of the results for uncertainty.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2006). Air toxics field investigation report: EPA Method TO-15/Cerex UV Sentry comparison.
HERO ID:	11273457

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology described including equipment, procedures, conditions, and calibration following EPA methods.
	Metric 2:	Analytical Methodology	Medium	Samples analyzed by publicly available methods as described in Section 3.4, including TO-15 method. MDL is mentioned but actual number not reported.
	Metric 3:	Biomarker Selection	N/A	Study measured parent chemical in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples collected in Louisville, Kentucky.
	Metric 5:	Currency	Medium	Samples collected in 2006.
	Metric 6:	Spatial and Temporal Variability	Medium	3-day study: Samples collected over a week from 3 monitoring locations over 3-hr sampling intervals. 5 sample results total in Appendix B. SESD lab: Lab reporting sheets of App D are hard to read.
	Metric 7:	Exposure Scenario	High	Samples measuring urban ambient air from the following monitoring locations: firearms training facility, rubber company, and university with a potential to affect the general population.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Raw data provided in appendix, however quality of the PDF makes the headers unreadable. Limited concentration data provided in the text and tables.
	Metric 9:	Quality Assurance	Medium	Discussed QA/QC procedures in Section 3.5 and 5.0. Recoveries are reported.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	High	The paper discusses problems/concerns and uncertainties observed during the study and from the results. Variation accounted for different days and locations sampled.

Overall Quality Determination Medium

Study Citation:	UofL, (2004). American Synthetic Rubber study: Analysis of contribution of 1,3-butadiene to Louisvilles ambient air quality.
HERO ID:	11273459

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampling methodology is only briefly discussed. Study site characteristics and calendar of monitoring presented. Sampling equipment and procedures not provided.
	Metric 2:	Analytical Methodology	High	Samples were analyzed according to EPA Method TO-15. MQL provided.
	Metric 3:	Biomarker Selection	N/A	Samples collected in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in the Louisville, Kentucky area.
	Metric 5:	Currency	Low	Samples were collected in 2003.
	Metric 6:	Spatial and Temporal Variability	Medium	Eight samples were taken from each of the three monitoring stations. Also sample collected before shutdown and then again after start-up. 93 samples where collected from baseline ambient air stations. Replicates not taken.
	Metric 7:	Exposure Scenario	High	Air collected within 2 miles of a rubber plant, represents exposure to general population.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Raw data provided in Table 2 and 3.
	Metric 9:	Quality Assurance	Medium	Baseline samples collected. Recoveries not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Uncertainties, limitations, and data gaps not discussed. Variability addressed from the various monitoring stations and times.

Overall Quality Determination Medium

Study Citation:	Sallsten, G., Gustafson, P., Johansson, L., Johannesson, S., Molnar, P., Strandberg, B., Tullin, C., Barregard, L. (2006). Experimental wood smoke exposure in humans. Inhalation Toxicology 18(11):855-64.
HERO ID:	97958

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology and Conditions	Medium	Sample storage conditions were not reported.
	Metric 2:	Analytical Methodology	Low	LODs were not reported and there was limited description of analytical methodology.
	Metric 3:	Biomarker Selection	N/A	Biomarkers were not addressed in this reference.
Domain 2: Representative				
	Metric 4:	Testing Scenario	Medium	Wood smoke was introduced into a chamber with personal and stationary sampling. Testing was conducted under one set of temperature and relative humidity conditions. Two smoke dilution ratios were used for the experiments (one for each of the two wood smoke sessions).
	Metric 5:	Sample Size and Variability	Medium	Two stationary and 3 personal sample measurements were used for each of the two sessions.
	Metric 6:	Temporality	Medium	Source(s) of tested items is less consistent with when current or recent exposures are expected.
Domain 3: Accessibility/Clarity				
	Metric 7:	Reporting of Results	Medium	Individual data points are reported and medians are provided in the text.
	Metric 8:	Quality Assurance	Low	QA/QC procedures not discussed but implied through the study's used of standard laboratory protocols.
Domain 4: Variability and Uncertainty				
	Metric 9:	Variability and Uncertainty	Medium	There was some discussion of variability, uncertainties, and data gaps.
Overall Quality Determination			**Medium**	

Study Citation:	Carteret, M., Pauwels, J. F., Hanoune, B. (2012). Emission factors of gaseous pollutants from recent kerosene space heaters and fuels available in France in 2010. Indoor Air 22(4):299-308.
HERO ID:	1290538

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology and Conditions	High	The samples for VOCs are collected with TENAX tubes; this is common and acceptable. The authors describe the collection sources for the fuels and claim that the two space heaters used were selected at random from a commercial source.
	Metric 2:	Analytical Methodology	Medium	The authors describe the analytical equipment used and specify the conditions. The authors provide the LOD for VOCs (in Table 2). The authors do not mention calibration or recoveries for VOCs.
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not addressed in this reference.
Domain 2: Representative				
	Metric 4:	Testing Scenario	Low	The authors employed a high air exchange rate to accommodate one of the heaters (a wick heater, to maintain a temperature below approximately 40 degrees Celsius); the consequence of this setting is that the test conditions no longer matched the typical scenarios for use in a residence.The authors designed the experimental chamber to draw ambient air from the laboratory through the chamber during the burning tests. The authors tested the incoming air for VOCs during the burning tests, but did not report the measurements or state whether the background measurements were deducted from the measurements determined from the interior of the chamber. They suggest, without explicit evidence, that they checked for variations in the background (they assumed no significant change). It is unclear the extent to which the results may be inaccurate for the concentrations of VOCs in the fuels. The authors also tested for background (unspecified conditions) 30 minutes before the burning tests.
	Metric 5:	Sample Size and Variability	Low	The authors do not provide the sample size for the summaries shown in Table 6 for any of the tests; I presume, since they provided the test duration, that these results are from one test each.
	Metric 6:	Temporality	Medium	The article was published in 2011, which is between five and fifteen years prior to the current year (2021).
Domain 3: Accessibility/Clarity				
	Metric 7:	Reporting of Results	High	The authors provide the calculated emission factors for 1,3-betadiene from three tests (averaged over the duration of the tests) in Table 6. These appear to be raw data; as there is only one measurement for each test, summaries are not applicable.
	Metric 8:	Quality Assurance	Medium	The authors do not describe issues with quality in the experiment. The authors do not describe testing for recoveries or any control tests for the analytical processes. The authors claim to have monitored VOCs inside and outside the chamber (to detect variations in background concentrations), but do not specify that they also monitored carbonyls in the same way. The authors measured the background VOC concentrations in the chamber 30 minutes before the heater was turned on (I presume that this was before every test); the authors do not present the results of the background tests or explain whether they deducted the background measurements from the measured concentrations.
Domain 4: Variability and Uncertainty				
	Metric 9:	Variability and Uncertainty	Low	The authors do not describe comparisons between their results and those of other studies. The results in Table 6 suggest that the authors conducted only one test for each type, despite the results indicating amounts of several VOCs that could present a risk to human health (as stated by the authors, but not cited), including 1,3-butadiene.

Overall Quality Determination Medium

Study Citation:	Lee, S., Valenti, J. C., Tabor, D. G., Hendriks, R. V., Lee, C. W. (1997). Characterization of pic emissions from combustion of pentachlorophenol-treated wood wastes. Fifth Annual North American Waste-to-Energy Conference :809.
HERO ID:	2529910

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology and Conditions	High	The authors state that the sampling and analytical methods followed EPA protocols.
	Metric 2:	Analytical Methodology	High	The authors followed EPA SW Method 0030 for measuring VOC samples.
	Metric 3:	Biomarker Selection	N/A	This metric is not relevant as a biomarker was not used.
Domain 2: Representative				
	Metric 4:	Testing Scenario	High	The combustion chamber was a device used by the EPA for conducting tests. The authors clarify that the results from these tests may differ from results from other combustion chambers.
	Metric 5:	Sample Size and Variability	Low	The authors did not state the estimated amount of wood burned for each test; nor did they include the time for each test, which would have facilitated an estimated of the amount (although they said that they did this). The authors did not suggest an amount of wood (even number of poles) that contributed to each of the three tests.
	Metric 6:	Temporality	Low	The most recent reference was dated 1995.
Domain 3: Accessibility/Clarity				
	Metric 7:	Reporting of Results	Medium	The authors report the raw data for the emissions tests (three tests per sample type). They did not clarify which chemicals were tested and below LOD.
	Metric 8:	Quality Assurance	High	The authors did not include detailed descriptions of the laboratory analysis. They followed an EPA method, which likely included QA/QC methods and that the results were satisfactory. They mention a pilot study and calibration controls.
Domain 4: Variability and Uncertainty				
	Metric 9:	Variability and Uncertainty	High	The authors include descriptions of their assessments of the differences seen among the tests. They also clarify that these results apply to the combustion chamber used in the study and may not necessarily correlate with results from other studies.

Overall Quality Determination High

Study Citation:	Abe, Y., Yamaguchi, M., Mutsuga, M., Kawamura, Y., Akiyama, H. (2014). Survey of volatile substances in kitchen utensils made from acrylonitrile-butadiene-styrene and acrylonitrile-styrene resin in Japan. Food Science & Nutrition 2(3):236-243.
HERO ID:	2857233

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology and Conditions	High	Sampling methods, material location, calibration, sampling preparation for analysis and sample storage conditions all reported.
	Metric 2:	Analytical Methodology	High	The authors used a headspace gas chromatography/mass spectrometer in the analysis for the samples. The authors provided the LOQ for the technique. The authors ran recovery tests.
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not addressed in this reference.
Domain 2: Representative				
	Metric 4:	Testing Scenario	Medium	The authors describe the test conditions and procedures for the laboratory analysis in another study, which could represent real life scenarios. The authors did not include information about laboratory blanks.
	Metric 5:	Sample Size and Variability	Medium	The investigators prepared and tested one sample of each type of kitchen utensil in two trials. This is suitable for tests of product concentration. Replicates are not reported.
	Metric 6:	Temporality	Medium	The source of the tested items is moderately consistent with current exposures (publication date 2011).
Domain 3: Accessibility/Clarity				
	Metric 7:	Reporting of Results	Medium	The investigators report one mean value from tests of each of the kitchen utensils (not clarified). They do not present the raw data in cases where the target chemical was detected.
	Metric 8:	Quality Assurance	Medium	The investigators do not identify any problems with quality issues. They do not describe laboratory controls or blanks. The results of the recovery tests were over 60% for 1,3 BTD.
Domain 4: Variability and Uncertainty				
	Metric 9:	Variability and Uncertainty	Medium	The investigators briefly describe some variation in the results for the target chemical in the tests of the ABS products and tested different utensils. They do not compare the results of their study with other studies or describe issues with limitations of the study.

Overall Quality Determination — Medium

Study Citation:	Abe, Y., Yamaguchi, M., Mutsuga, M., Akiyama, H., Kawamura, Y. (2013). Volatile substances in polymer toys made from butadiene and styrene. American Journal of Analytical Chemistry 4:229-237.
HERO ID:	12392230

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology and Conditions	Medium	Toy samples were collected from the Japanese market. No information was provided on the sample selection process.
	Metric 2:	Analytical Methodology	Medium	HS-GC/MS was used. While no analytical method source was cited, the instrument conditions, calibration, LOQ, and recovery were provided.
	Metric 3:	Biomarker Selection	N/A	Biomarkers were not addressed in this reference.
Domain 2: Representative				
	Metric 4:	Testing Scenario	Medium	Data represent consumer exposure for infants and children, however product descriptions for the analyzed toys were not provided.
	Metric 5:	Sample Size and Variability	Medium	73 toy samples were tested, however replicate tests were not performed.
	Metric 6:	Temporality	Medium	Toy samples were collected in 2011.
Domain 3: Accessibility/Clarity				
	Metric 7:	Reporting of Results	Medium	Raw data was not provided. Summary stats include detection frequency, minimum, maximum and mean residual level.
	Metric 8:	Quality Assurance	Medium	QA/QC measures were applied. Calibration curves were constructed and recovery ranged from 98 to 102%.
Domain 4: Variability and Uncertainty				
	Metric 9:	Variability and Uncertainty	Low	No standard deviation was provided and there was limited discussion of uncertainties and data gaps.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2023). UCMR 3 (2013-2016) Occurrence Data: 1,3-Butadiene (CAS RN: 106-99-0).
HERO ID:	11147672

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sample location, date, and other information provided in the database output; however, there is no specific information about the sample method. No information was provided on transportation or storage conditions for any sample.
	Metric 2:	Analytical Methodology	High	A Method ID and MRL is provided in Columns P and Q. More information is provided here: https://www.epa.gov/sites/default/files/2017-02/documents/ucmr3-data-summary-january-2017.pdf
Domain 2: Representative				
	Metric 3:	Geographic Area	High	Data was collected in the United States. The state is reported in Column W.
	Metric 4:	Temporal	High	Data was collected from 2013-2016. Date is reported in column M.
	Metric 5:	Exposure Scenario	Medium	The exposure scenario is contaminants in drinking water in the US. Some specific details about scenarios (location, date) are provided in the output file.
Domain 3: Accessibility/Clarity				
	Metric 6:	Availability of Database and Supporting Documents	High	The database is widely accepted and guidance materials are available which describes all of the data fields.
	Metric 7:	Reporting Results	High	The database is organized, and key information is readily accessible. Raw data is provided in the output file.
Domain 4: Variability and Uncertainty				
	Metric 8:	Variability and Uncertainty	Low	No measurement of variability or characterization of uncertainty is provided.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2022). Ambient Monitoring Technology Information Center (AMTIC) - Ambient Monitoring Archive for HAPs.
HERO ID:	11195094

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Widely accepted sampling methodologies, the sampling frequency, duration, and description of sampling collection are reported in columns SAMPLING_FREQUENCY_CODE, DURATION_DESC, and SAMPLE_COLLECTION_DESC.
	Metric 2:	Analytical Methodology	High	Analytical methodology described at the SAMPLE_ANALYSIS_DESC column. A description of all the methods is reported in the compendium: https://www.epa.gov/amtic/compendium-methods-determination-toxic-organic-compounds-ambient-air.
Domain 2: Representative				
	Metric 3:	Geographic Area	High	Data was collected in the United States. Columns MONITOR_LATIDUDE and MONITOR_LONGITUDE report the exact monitoring location.
	Metric 4:	Temporal	High	The database reports data from 1990-2020.
	Metric 5:	Exposure Scenario	High	The exposure scenario is the measurement of key hazardous air pollutants across cities, regions and specific areas of interest.
Domain 3: Accessibility/Clarity				
	Metric 6:	Availability of Database and Supporting Documents	High	The database is widely accepted, and guidance materials are available which describes all of the data fields.
	Metric 7:	Reporting Results	High	The database is organized, and key information is readily accessible. Raw data is provided in the output file, and a summary of statistics is presented here: https://www.epa.gov/system/files/documents/2022-10/AMA2020_annual.xlsx
Domain 4: Variability and Uncertainty				
	Metric 8:	Variability and Uncertainty	High	Variability reported in the annual statistics as variance of daily averages and percentiles. Uncertainty reported as data qualifiers.

Overall Quality Determination High

Study Citation: U.S. EPA, (1989). Health and environmental effects document for 1,3-butadiene.
HERO ID: 3454

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses methodologies that are clear and appropriate. Assumptions and models have been documented and described.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The exposure scenario is of interest for the chemical; however, detailed information about the microclimate is not provided.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available for all reported data; however, some references may not be publicly available as they are older.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	The characterization of variability is absent. Key uncertainties, limitations, and data gaps are not discussed.

Overall Quality Determination Medium

Study Citation:	Sax, S. N., Bennett, D. H., Chillrud, S. N., Ross, J., Kinney, P. L., Spengler, J. D. (2006). A cancer risk assessment of inner-city teenagers living in New York City and Los Angeles. Environmental Health Perspectives 114(10):1558-1566.
HERO ID:	156950

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The methodology is scientifically sound and the assumptions made for the risk assessment associated with airborne chemicals of interest are appropriate.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to adolescents exposed to airborne pollutants in Los Angeles and New York City.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	High	References are available for all reported data in the manuscript.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	High	This study characterized variability (mean,SD, range) and discussed uncertainties in detail.

Overall Quality Determination High

Study Citation:	Loh, M. M., Levy, J. I., Spengler, J. D., Houseman, E. A., Bennett, D. H. (2007). Ranking cancer risks of organic hazardous air pollutants in the United States. Environmental Health Perspectives 115(8):1160-1168.
HERO ID:	632519

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The techniques used in the assessment are scientifically sound.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to air pollutants through inhalation in the United States.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	High	References are available for all reported data on the manuscript.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	High	Variability was characterized (GM and GSD), uncertainties were discussed.

Overall Quality Determination High

Study Citation:	Huang, Y., Ho, S. S., Ho, K. F., Lee, S. C., Yu, J. Z., Louie, P. K. (2011). Characteristics and health impacts of VOCs and carbonyls associated with residential cooking activities in Hong Kong. Journal of Hazardous Materials 186(1):344-351.
HERO ID:	1063110

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment reported study site details, equipment, methods and storage conditions for sampling, including using EPA techniques. The analytical methods, instrumentation calibration and LOD are reported.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	High	The data likely represent relevant exposure scenarios related to airborne formaldehyde and 1,3-Butadiene exposures relevant for residential cooking activities in Hong Kong.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	High	References are available and most likely public for all reported data.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Medium	Variability was characterized through SD and different types of dwellings. There is no discussion of study limitations and uncertainties.

Overall Quality Determination High

Study Citation:	Zhou, J., You, Y., Bai, Z., Hu, Y., Zhang, J., Zhang, N. (2011). Health risk assessment of personal inhalation exposure to volatile organic compounds in Tianjin, China. Science of the Total Environment 409(3):452-459.
HERO ID:	1255292

Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The sampling methods, equipment and study population were described and reported. Analytical methods and instrumentation descriptions are reported. Some information, such as instrument calibration, storage conditions and LOD, were missing.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The data represents relevant exposure scenarios through personal sampling but the small sample size limits the generalizability of results.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	High	References are available for all reported data.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	High	Variability was characterized (SD) and different areas were sampled. Uncertainties and limitations were discussed.

Overall Quality Determination Medium

Study Citation:	ENSR, (1991). Letter from Texaco Refining and Marketing Inc to U.S. EPA submitting enclosed information and studies concerning several 8(d) chemicals with attachments.
HERO ID:	1270201

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The sources for modeling inputs cited in the footnotes of the data tables and modeling methods were outlined with equations, and the assumptions for predicted exposures were presented.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The exposure activity assessed likely represents the scenario of interest. Study limitations within exposure estimations were not directly discussed, however assumptions within the calculations were presented.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	Study characterization of variability within the population/media concentration data was lacking, however key assumptions in calculations were presented.

Overall Quality Determination Medium

Study Citation:	Luft Environmental Consulting, (1994). AB 2588 health risk assessment for Texaco Refining and Marketing Inc's Bakersfield Plant-Area 3, reporting year 1991, with cover letter dated 06/02/94.
HERO ID:	1356123

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment used proper techniques, although the hazard assessment step was not detailed and did not include information on environmental sampling methods.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	Medium	The data likely represent exposure scenarios relevant to the emission of pollutants into the air at a petroleum refinery, but the details regarding sample size for the assessment are missing.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	Low	Few references were provided in the report.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Low	Variability was not characterized. Uncertainties and limitations were not discussed.

Overall Quality Determination Low

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment (volume I {\&} II) (final reports) with attachments and cover letter dated 032991. 910000774:#86-910000774.
HERO ID:	1356137

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Modeling methodologies of ambient air concentrations from emissions data were presented with equations and model inputs, with assumptions and uncertainties reported and described.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	Characterization of the population at risk through census tract, city data was presented, and temporality in risk data was calculated for 70-year lifetime. The range of dates for data used in emissions calculations was unclear.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	The complete assessment provides a discussion of key uncertainties within the risk assessment, however it does not provide a measure of variance for modeled ambient air data results.

Overall Quality Determination Medium

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment - Shell Oil Company Martinez Refinery (volume I and II) with attachments, cover sheets and letter 040291. 910000771:#86-910000771.
HERO ID:	1356138

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Modeling methodologies of ambient air concentrations from emissions data were presented with equations and model inputs, assumptions and uncertainties reported and described (page 8).
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The population at risk was characterized through census tract and city data, and temporality within the risk data was calculated for a 70-year lifetime. The range of dates for data used in emissions calculations was unclear.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	High	The complete assessment provides a discussion and evaluation of key uncertainties and gaps in the risk assessment. It appears that a Monte Carlo simulation was conducted and SD and percentiles for risk estimates were calculated.

Overall Quality Determination High

Study Citation:	Nazaroff, W. W., Singer, B. C. (2004). Inhalation of hazardous air pollutants from environmental tobacco smoke in US residences. Journal of Exposure Analysis and Environmental Epidemiology 14(S1):S71-S77.
HERO ID:	1476440

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The techniques used in the assessment of environmental tobacco smoke in US residences are scientifically sound.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to environmental tobacco smoke in US residences.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	High	References are available for all reported data.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Medium	Characterization of variability (ranges) was limited, and the discussion of uncertainties and limitations was brief.

Overall Quality Determination High

Study Citation:	Radian Corp, (1991). Letter from Exxon Chemical Inc to USEPA submitting information concerning the California Assembly Bill 25588, the toxic hot spots information and assessment act of 1987 w-attachments.
HERO ID:	1874145

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Some components of the modeling of ambient air concentrations were missing due to missing Appendices. Sample calculations for emissions by source data, used in calculating ambient air concentrations in Table 7, were presented in Appendix B-1 but the PDF is missing Appendix B. The ISCST and SHORTZ programs were used to predict air concentrations. It seems like details about the exposure assessment are cut off on page 6 of the PDF. Page 26 of the PDF gives details on the exposure assessment variables.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	Medium	The exposure likely represents the population and scenario of interest. Risks were described as calculated for both the occupational site and the neighborhood around the facility. Characterization of the surrounding neighborhood population was not presented.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Medium	The complete assessment provides a discussion of key uncertainties in the risk assessment. The study conducts probabilistic analysis to account for variability. No discussion of limitations was presented.

Overall Quality Determination Medium

Study Citation:	Envirologic Data, (1992). Assessment of risks from potential exposure to airbourne facility emissions under California AB 2588 for the Rohr Inc Facility Riverside, Calif (vol. 1) (final report) w-letter.
HERO ID:	4214360

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	A description of contaminant concentration modeling procedures, and the necessity for delineating uncertainties within models was reported, however an actual discussion of assumptions and limitations was lacking.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	Characterization of the geographic area with maps was provided for the site exposure sources, and details of the modeling of potential exposure was described. Modeling for the relevant residential populations was presented, however temporality was not directly discussed in detail.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	Statistical summary measures of variability for concentration data were lacking, and a robust discussion of limitations was also lacking.

Overall Quality Determination Low

Study Citation:	U.S. EPA, (2015). Technical support document, EPA's 2011 National-scale Air Toxics Assessment, 2011 NATA TSD.
HERO ID:	5113338

Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The methods applied in conducting NATA are consistent with the general risk assessment framework used throughout EPA.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The presented data is for the U.S., representing point, nonpoint, and mobile sources, although the inventory year is 2011.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	High	References were well documented.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	High	Uncertainty and variability were specifically discussed at length throughout the report. There is a robust discussion of how the NATA assessment should and should not be used.

Overall Quality Determination High

Study Citation: ENSR, (1991). AB 2588 health risk assessment for the Texaco Refinery Areas 1 and 2 Bakersfield, California.
HERO ID: 6338980

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The modeling (ISCST program) and methodology are described with calculations. However, some of the exposure assumptions and justifications are not fully explained.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	Low	The data may represent relevant exposure scenarios related to Texaco Inc. Bakersfield Refinery Areas 1 and 2 in Bakersfield, California. However, the lack of methodological details limits the validity of the assessment, and the assessment was conducted in 1962, 1963 and 1964.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	Critically Deficient	The reported inputs are only sparsely documented and explained.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Medium	Variability was characterized by modeling 3 different years. Uncertainties were discussed.

Overall Quality Determination Uninformative

Study Citation:	Luft Environmental Consulting, (1993). AB 2588 Health risk assessment for Texaco Refining and Marketing Inc.'s Bakersfield Plant-Areas 1 and 2 Reporting Year 1991.
HERO ID:	6570009

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The ISCST2 air dispersion model and the ACE 2588 risk model and inputs are described.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	Low	The data represents relevant human exposure scenarios related to the site (residential and occupational). However, the emissions data is from 1991 and the meteorological data used in modeling is from 1964.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	Low	Only some modeling inputs were explained.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Low	Variability was not characterized. Key uncertainties were not discussed.

Overall Quality Determination Low

Study Citation:	URS Corporation, (2015). Revised Strategic Toxic Air Reduction (STAR) environmental acceptability demonstration for 2013 and 2014.
HERO ID:	11273429

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The modelling methodology is detailed and clearly explained.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	Medium	The exposure scenario is not clearly described, raising uncertainty in the affected population characteristics.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	Critically Deficient	References are sparce and not clearly documented. This makes the manuscript unacceptable.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Medium	Variability was not characterized. Uncertainties were briefly discussed.

Overall Quality Determination Uninformative

Study Citation:	AECOM, (2017). Strategic Toxic Air Reduction (STAR) environmental acceptability demonstration.
HERO ID:	11273446

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The study reports detailed information for the modeling approach and calculations.
Domain 2: Representative				
	Metric 2:	Exposure Scenario	High	The study evaluates fugitive releases from a rubber company and the possible exposure to the general population.
Domain 3: Accessibility/Clarity				
	Metric 3:	Documentation of References	High	The study only reference one previous report for the same site. The model setups and inputs are also reported.
Domain 4: Variability and Uncertainty				
	Metric 4:	Variability and Uncertainty	Low	The study does not report limitations, uncertainty or variability.

Overall Quality Determination High

Study Citation:	Serrano-Trespalacios, P. I., Ryan, L., Spengler, J. D. (2004). Ambient, indoor and personal exposure relationships of volatile organic compounds in Mexico City metropolitan area. Journal of Exposure Analysis and Environmental Epidemiology 14 Suppl 1(S1):S118-S132.
HERO ID:	56224

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	Critically Deficient	Model not explained in detail, only that it was built on a cited model. No equations provided
	Metric 2:	Model Evaluation	Medium	Modeled GM concentrations compared to measured GM concentrations.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Medium	Indoor/home exposure is relevant but concentrations/study based in Mexico City.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	Low	No user guide or documentation provided.
	Metric 5:	Model Inputs and Defaults	Critically Deficient	Besides the sampled concentrations, the inputs to the model are very briefly described if at all.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	Low	Model output GM concentrations for indoor, outdoor, and personal air; some discussion of limitation and uncertainty.

Overall Quality Determination — Uninformative

Study Citation:	Luecken, D. J., Hutzell, W. T., Gipson, G. L. (2006). Development and analysis of air quality modeling simulations for hazardous air pollutants. Atmospheric Environment 40(26):5087-5096.
HERO ID:	125794

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	A modified Version 4.4 of the community multi-scale air quality (CMAQ) modeling system was used to simulate ambient air concentrations in the US. Equations were not provided, but a general description of the publicly-available EPA model were included, with reference citations.
	Metric 2:	Model Evaluation	High	The model has undergone evaluation, including comparison with monitoring data..EPA: The CMAQ model is a US Government-developed model, thus the scoring of high. Though this paper presents a modified Version 4.4 of CMAQ for this application, it provides a quantitative comparison of model results with monitoring data for the formaldehyde and 1,3-butadiene.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Low	2001 US meteorological data from the Penn State/NCAR Mesoscale Model (MM5) emissions data from the 1999 National Emissions Inventory (NEI) were used as inputs.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	Documentation of the CMAQ modeling system and other intermediate models and inputs are widely available. References are provided in the study.
	Metric 5:	Model Inputs and Defaults	High	Key model inputs such as meteorological data from MM5 and emissions data from NEI are described. All equations and inputs are not detailed in the study, but additional information is likely available in the references.EPA: Key model inputs are described in detail, including initial and boundary conditions, meteorology and emissions. Modifications for the chemical mechanisms for the inputs are described in detail as well. Though model equations are not detailed explicitly in the study, this study scored as high given the level of detail for the model inputs and referenced literature for CMAQ.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	High	The study characterizes variability between modeled and observed concentrations with discussion of uncertainties, limitations and data gaps.

Overall Quality Determination High

Study Citation: Suzuki, N., Murasawa, K., Sakurai, T., Nansai, K., Matsuhashi, K., Moriguchi, Y., Tanabe, K., Nakasugi, O., Morita, M. (2004). Geo-referenced multimedia environmental fate model (G-CIEMS): Model formulation and comparison to the generic model and monitoring approaches. Science of the Total Environment 38(21):5682-5693.

HERO ID: 198786

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	Model equation provided with additional detail in SI. Exposure-Weighted Averaged Concentrations equation provided.
	Metric 2:	Model Evaluation	Medium	Authors evaluate georeferenced model by comparison to generic model and monitoring data.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Medium	Less representative of current exposure; 2004 publication date.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	Companion reference (Mackay 2001) for fugacity model is publicly available. Model description in paper is thorough.
	Metric 5:	Model Inputs and Defaults	High	Key model inputs are well-described.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	Medium	Model covers spatial and temporal variability. Some discussion of uncertainty in emission estimation and atmospheric reaction mechanisms.

Overall Quality Determination High

Study Citation:	Yu, H., Stuart, A. (2016). Exposure and inequality for select urban air pollutants in the Tampa Bay area. Science of the Total Environment 551:474-483.
HERO ID:	3276086

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	The basic approach for estimating emissions was described in a secondary reference (Yu and Stuart 2013) and extended to chemicals and scenarios in the current paper. Widely-accepted models such as the CALPUFF dispersion model and Community Modeling and Analysis System (CMAQ) transport model were also incorporated to estimate ambient concentrations. Equations and theory were described and referenced.
	Metric 2:	Model Evaluation	High	Model evaluation included comparison of modeled and measured concentrations. Model performance statistics from comparison with the previous version of the secondary emissions model were also presented.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Low	The paper was published in 2016 but the estimation period was 2002.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	The model was documented in the data source and references.QC: Agree with high score, CalPuff and CMAQ also have detailed documentation that is publicly available.
	Metric 5:	Model Inputs and Defaults	High	Key model inputs are identified, referenced and described.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	High	Variability is characterized in Figure S2 as error bars. Uncertainties, limitations and data gaps were described.

Overall Quality Determination High

Study Citation:	Gallego, E., Roca, F. J., Perales, J. F., Guardino, X., Gadea, E., Garrote, P. (2016). Impact of formaldehyde and VOCs from waste treatment plants upon the ambient air nearby an urban area (Spain). Science of the Total Environment 568:369-380.
HERO ID:	3449325

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	Critically Deficient	The model equation is not given and only two out of three possible inputs are directly given. The output values cannot be reproduced.
	Metric 2:	Model Evaluation	Medium	The paper states that the accuracy of TAPM was checked for two US tracer experiments, for several annual US dispersion datasets and dispersion throughout Australia, though other studies are cited little context or detail is given regarding this evaluation/validation.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Medium	Sampling conducted between 2014 and 2015 in Barcelona, Spain, thus the medium metric score.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	The version used is not given, though documentation on The Air Pollution Model v3 is publicly available on CSIROs website. Little documentation or detail provided within the paper itself, though additional may be available in the cited sources.
	Metric 5:	Model Inputs and Defaults	Low	Model inputs and defaults used in TAPM are not presented in detail, thus the concerns regarding reproducibility.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	Medium	There is limited discussion of variability and uncertainty related to emission factors, but both the average measured concentration and the standard deviation were used in the calculation

Overall Quality Determination — Uninformative

Study Citation:	Radian Engineering, (1997). General Electric Engine Services Test Cell Complex - AB 2588 air toxic ”hot spots” 1991 health risk assessment, with cover letter dated 10/21/1997. 980000062:#86-980000062.
HERO ID:	5665035

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	Use of Industrial Source Complex Short Term (ISCST3) model (version 96113) for dispersion modeling also widely accepted and scientifically sound (EPA).
	Metric 2:	Model Evaluation	Medium	There is limited discussion of model evaluation however it can be inferred based on the cited references that some model evaluation and validation has been conducted.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	Low	This study was published in 1997. The tested items are not consistent with when current or recent exposures are expected.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	The model documentation for ACE2588 is easily accessible online and there is detailed information in the current document and provided appendices.
	Metric 5:	Model Inputs and Defaults	Medium	Model inputs are described in section 3.2.2 however the exact inputs and defaults are only available online via their references.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	Low	The model uncertainty is not extensively discussed and there is no statistical characterization of variability. The study also states that using local meteorological data from 1981 will result in a conservative estimate without justification or sensitivity analysis.

Overall Quality Determination Medium

Study Citation:	KEC, (2007). Re-submittal of modeling of LMAPCD Category 1 Toxic Air Contaminants.
HERO ID:	11273428

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	ISC3ST is a model recognized by EPA as an alternative Air Quality Dispersion Modeling.
	Metric 2:	Model Evaluation	Low	The document does not mention if the model has undergone evaluation, but it is suspected.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	High	The model evaluates emission rates for both industrial and non-industrial receptors from the American Synthetic Rubber Company in 2007.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	The model and documentation (user guide, documentation manual) are publicly available.
	Metric 5:	Model Inputs and Defaults	High	Source inputs and control parameters are reported in the text.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	Medium	The study has limited characterization of variability of the industrial and non industrial receptors.

Overall Quality Determination High

Study Citation:	E. Rex Consulting,, LLC, (2019). American Chemistry Council Olefins Panel: 1,3-Butadiene air modeling report.
HERO ID:	11273458

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Mathematical Equations	High	The NATA hybrid model is widely accepted from a trusted authoritative source and is used by EPA.
	Metric 2:	Model Evaluation	High	The study reports NATA model performance compared with monitoring data obtained from the Texas Air Monitoring Information System and the national network for air toxics.
Domain 2: Representative				
	Metric 3:	Exposure Scenario	High	The model represents ambient air concentrations form 2015 in the Houston Ship Channel region and the Jefferson County, TX, both areas with similar industrial sources.
Domain 3: Accessibility/Clarity				
	Metric 4:	Model and Model Documentation Availability	High	The model and documentation are publicly available.
	Metric 5:	Model Inputs and Defaults	High	Emissions inputs are reported in page 2.
Domain 4: Variability and Uncertainty				
	Metric 6:	Variability and Uncertainty	High	Variability is accounted for different locations modeled but the uncertainty is mentioned in the text.

Overall Quality Determination High

Table 89: Glossary of Select Terms for Data Evaluation

Term	Definition
ABS	Acrylonitrile Butadiene Styrene copolymer
ACC	American Chemistry Council
ACGIH	American Conference of Governmental Industrial Hygienists
AEGL	Acute Exposure Guideline Level
ATSDR	Agency for Toxic Substances and Disease Registry
BCF	Bioconcentration factor
CAA	Clean Air Act
CASRN	Chemical Abstracts Service Registry Number
CBI	Confidential Business Information
CCL	Contaminant Candidate List
CDR	Chemical Data Reporting
CEPA	Canadian Environmental Protection Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COU	Condition of Use
CSCL	Chemical Substances Control Law
DMR	Discharge Monitoring Report
ECB	European Chemicals Bureau
ECHA	European Chemicals Agency
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Emission Scenario Document
GACT	Generally Available Control Technology
ECEL	Existing Chemical Exposure Limit
ERG	Eastern Research Group
EU	European Union
EV	Exposure Value
GS	Generic Scenario
HAP	Hazardous Air Pollutant
HEC	Human Equivalent Concentration
IMAP	Inventory Multi-Tiered Assessment and Prioritization
IUR	Inhalation Unit Risk
IRIS	Integrated Risk Information System
ISHA	Industrial Safety and Health Act
KOC	Organic Carbon: Water Partition Coefficient
KOW	Octanol: Water partition Coefficient
LCD	Life Cycle Diagram
MACT	Maximum Achievable Control Technology

Continued on next page . . .

Table 89 . . . continued from previous page

Term	Definition
MOA	Mode of Action
MOE	Margin of Exposure
NAICS	North American Industry Classification System
NEI	National Emissions Inventory
NICNAS	National Industrial Chemicals Notification and Assessment Scheme (Australia)
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priorities List
NPRI	National Pollutant Release Inventory
NTP	National Toxicology Program
OCSPP	Office of Chemical Safety and Pollution Prevention
OECD	Organisation for Economic Co-operation and Development
OES	Occupational Exposure Scenario
ONU	Occupational Non-User
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PECO	Populations, Exposures, Comparators, and Outcomes
PESS	Potentially Exposed or Susceptible Subpopulations
POD	Point of Departure
POTW	Publicly Owned Treatment Works
PV	Production Volume
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (European Union)
SARA	Superfund Amendments and Reauthorization Act
SBR	Styrene-Butadiene Rubber
SDS	Safety Data Sheet
SDWA	Safe Drinking Water Act
SRC	Syracuse Research Corporation
STEL	Short-term Exposure Limit
TSCA	Toxic Substances Control Act
TLV	Threshold Limit Value
TRI	Toxics Release Inventory
TWA	Time-weighted Average
UCMR	Unregulated Contaminants Monitoring Rule
UF	Uncertainty Factor
VOC	Volatile Organic Compound
WWT	Waste Water Treatment