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Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure for 1,3-Butadiene

Systematic Review Support Document for the Draft Risk Evaluation

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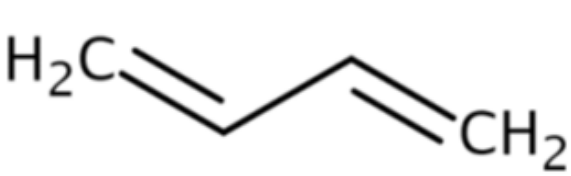

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This supplemental file contains information regarding the data extraction and quality evaluation results for data sources that were considered for the *Draft Risk Evaluation for 1,3-Butadiene* and that underwent systematic review. EPA conducted data extraction, and quality evaluation 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 used the TSCA systematic review process described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances* (also referred to as the '2021 Draft Systematic Review Protocol').

Data that met the RESO screening criteria during the full-text screening was extracted by three data types, general facility, occupational exposure, and environmental release, as explained in Section 6.2 of the 2021 Draft Systematic Review Protocol. Five different data quality evaluation forms were used depending on the data type and condition of use (COU), as explained in Appendix M of the 2021 Draft Systematic Review Protocol. All references with data points containing monitoring data (*e.g.*, measured occupational exposures) underwent data quality evaluation as described in Section M.6.1, using the monitoring data quality metrics. All references with data points containing environmental release data (*e.g.*, measured or calculated quantities of chemical release across facility fence line) underwent data quality evaluation as described in Section M.6.2, using the environmental release data quality metrics. All references with data points containing published models for environmental release or occupational exposure (*e.g.*, published models used to calculate occupational exposure or environmental releases) underwent data quality evaluation as described in Section M.6.3, using the published models for environmental release or occupational exposure quality metrics. All references with data points containing completed exposure or risk assessments (*e.g.*, completed exposure or risk assessments containing a broad range of data types) underwent data quality evaluation as described in Section M.6.4, using the completed exposure or risk assessments quality metrics. All references with data points containing reports for data or information other than exposure or release data (*e.g.*, process description) underwent data quality evaluation as described in Section M.6.5, using the reports for data or information other than exposure or release data quality metrics. The extracted data and their data quality evaluation are available in the tables below.

Additionally, each data type and condition of use is evaluated independently within a given study; therefore, each reference may have more than one overall quality determination (OQD) to reflect the quality of each outcome and the exposures and releases more appropriately as described by the study authors. No OQD is determined for each reference, as a whole, if it contains data from more than one evidence stream.

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HERO ID	Reference	Page
Occupational Exposure		
Monitoring Data		
2968277	Abdel-Rahman, S. Z., Ammenheuser, M. M., Omiecinski, C. J., Wickliffe, J. K., Rosenblatt, J. I., Ward, J. B. (2005). Variability in human sensitivity to 1,3-butadiene: influence of polymorphisms in the 5'-flanking region of the microsomal epoxide hydrolase gene (EPHX1). Toxicological Sciences 85(1):624-631.	**38**
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2959573	Ammenheuser, M. M., Bechtold, W. E., Abdel-Rahman, S. Z., Rosenblatt, J. I., Hastings-Smith, D. A., Ward, J. B. (2001). Assessment of 1,3-butadiene exposure in polymer production workers using HPRT mutations in lymphocytes as a biomarker. Environmental Health Perspectives 109(12):1249-1255.	**50**
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Study Citation:	Abdel-Rahman, S. Z., Ammenheuser, M. M., Omiecinski, C. J., Wickliffe, J. K., Rosenblatt, J. I., Ward, J. B. (2005). Variability in human sensitivity to 1,3-butadiene: influence of polymorphisms in the 5'-flanking region of the microsomal epoxide hydrolase gene (EPHX1). Toxicological Sciences 85(1):624-631.
HERO ID:	2968277
Conditions of Use:	Processing synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	high exposure group (16 workers) had BD exposures of 2244.2ppb with S.E.M. +/-749.1ppb... low exposure group (33 workers) had BD exposures of 18.4ppb with S.E.M. +/-5.5ppb; 16 workers in low exposure group had exposures below detection limit (2.5ppb)
Exposure duration:	12hr shifts with 28-day cycle of rotating shifts
Number of workers:	49 workers sampled

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SEM, and sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Abdel-Rahman, S. Z., Ammenheuser, M. M., Ward, J. B. (2001). Human sensitivity to 1,3-butadiene: role of microsomal epoxide hydrolase polymorphisms. Carcinogenesis 22(3):415-423.
HERO ID:	782889
Conditions of Use:	Synthetic rubber manufacturing, monomer used in polymerization

EXTRACTION

Parameter	**Data**
Worker activity description:	higher exposures in reactor, recovery, tank farm, laboratory, and polymerization areas
Personal sampling data:	Divided exposures into two groups: one with exposure >150 ppb, and one with exposure <150ppb... >150ppb group: 16 study subjects with mean exposure of 2244.2 ppb; <150ppb group: 33 study subjects with mean exposure of 18.4 ppb; Standard error of the mean given for each group
Exposure duration:	12 hr shift
Number of workers:	49 workers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data from more than 20 years ago.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (number of samples, mean, and SEM) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure level for each worker activity.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparison to similar studies and limits of detection, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Abdel-Rahman, S. Z., El-Zein, R. A., Ammenheuser, M. M., Yang, Z., Stock, T. H., Morandi, M., Ward, J. B. (2003). Variability in human sensitivity to 1,3-butadiene: Influence of the allelic variants of the microsomal epoxide hydrolase gene. Environmental and Molecular Mutagenesis 41(2):140-146.
HERO ID:	782890
Conditions of Use:	Synthetic rubber manufacturing, monomer used in polymerization

EXTRACTION

Parameter	**Data**
Worker activity description:	Higher exposures in reactor, recovery, tank farm, laboratory, and polymerization areas
Personal sampling data:	Divided exposures into two groups: one with exposure >150ppb, and one with exposure <150ppb... >150ppb group: 16 study subjects with mean exposure of 2244.2ppb; <150ppb group: 33 study subjects with mean exposure of 18.4ppb; Standard error of the mean given for each group
Exposure duration:	12hr shift with a 28-day cycle of rotating shifts
Comments:	Same information as HERO ID 782889 (duplicate)See table 1 for data.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (number of samples, mean, and SEM) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing results for each worker activity.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparison to similar studies and limits of detection, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Akerstrom, M., Almerud, P., Andersson, E. M., Strandberg, B., Sallsten, G. (2016). Personal exposure to benzene and 1,3-butadiene during petroleum refinery turnarounds and work in the oil harbour. International Archives of Occupational and Environmental Health 89(8):1289-1297.
HERO ID:	4140910
Conditions of Use:	Processing as intermediate in petroleum refineries

EXTRACTION

Parameter	**Data**
Worker activity description:	Tasks during initial shutdown phase of refinery turnaround; work tasks included spading, cleaning and steaming activities, drainage of benzene-containing petroleum products, and dismantling of equipment. Occupational groups included process technicians, contractors, and other refinery workers such as turnaround coordinators, maintenance workers and process engineers. (Page 2 of 9). Also monitored were jetty workers, sewage tanker drivers, and dock workers for sampling at the nearby oil harbour. The jetty workers worked by the ships during the entire work shift, coupling and uncoupling hoses to the ships and supervising the loading activities. Dockworkers alternated their work out on the jetty, helping the jetty workers, and in the dock, managing the pipe system in the tank park. Exposure measurements on the jetty workers and dockworkers were taken while they were loading petroleum products containing benzene. The sewage tanker drivers were providing a wide range of services, and measurements were taken at randomly chosen work shifts while working in the oil harbour or at the refineries. (Page 2-3 of 9)
Personal sampling data:	Table 1 on page 4, Table 2 on page 5, and Table 3 on page 7 show results. The tables provides number of samples, average, % over LOD, and additional variance and summary statistics for occupational exposure groups during turnarounds and among oil harbour workers. The average for all workers during turnaround at Refinery 1 was 14 ug/m3; average for full turnaround at Refinery 2 was 10 ug/m3 and 2.8 ug/m3 for partial turnaround. Overall average exposure for oil harbour workers was 2.9 ug/m3.Figure 2 on page 6 shows in scatter plot form the association between personal benzene and 1,3-butadiene exposure. Discussion of results within text on pages 5-8.
Exposure duration:	Work shifts were 8hr or 12hr (page 2 of 9). The actual measurement times (assuming they represent possible shift durations) are described here: ”91 full-shift measurements were taken during the shutdown phase of the three turnarounds (median measurement time 8.4–10.7 h, range 4.0–12.8 h), and 50 measurements were taken on jetty workers, dockworkers and sewage tanker drivers in the oil harbour (median measurementtime 8.0–10.8 h, range 6.5–14.0 h).” (Page 4 of 9).
Personal protective equipment:	Personal protective equipment (PPE), such as respiratory protection, was only used during a few measurements (<20 %), except during the last turnaround, where a campaign increased the use of PPEs to about 50 % of the measurements (page 4 of 9)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for petroleum refining, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (number of samples, % over LOD, average) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				

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Study Citation:	Akerstrom, M., Almerud, P., Andersson, E. M., Strandberg, B., Sallsten, G. (2016). Personal exposure to benzene and 1,3-butadiene during petroleum refinery turnarounds and work in the oil harbour. International Archives of Occupational and Environmental Health 89(8):1289-1297.
HERO ID:	4140910
Conditions of Use:	Processing as intermediate in petroleum refineries

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by worker occupation exposures and refinery differences.

Overall Quality Determination High

Study Citation:	Albertini, R. J. (2004). Mechanistic insights from biomarker studies: Somatic mutations and rodent/human comparisons following exposure to a potential carcinogen. IARC Scientific Publication No. 157 157:153-177.
HERO ID:	5585303
Conditions of Use:	Manufacturing, Processing as a monomer

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	Personal 8hr butadiene measurements on several occassions over 60-day period: mean butadiene exposure in monomer production workers was 0.291ppm; mean exposure for styrene-butadiene workers was 0.796ppm

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are IARC article, which includes OECD countries generally.
	Metric 3:	Applicability	High	Data are for manufacturing and processing as a monomer, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a central tendency value with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Albertini, R. J., Sram, J., Vacek, P. M., Lynch, J., Nicklas, J. A., Sittert, Van, N. J., Boogaard, P. J., Henderson, R. F., Swenberg, J. A., Tates, A. D., Ward, J. B., Jr, Wright, M. (2003). Biomarkers in Czech workers exposed to 1,3-butadiene: a transitional epidemiologic study. Research Reports (Health Effects Institute) (116):1-141; discussion 143-62.
HERO ID:	94288
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic rubber manufacturing
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	”Monomer group: 0.642 mg/m^3 Polymer group: 1.794 mg/m^3 Control group: 0.023 mg/m^3”
Exposure duration:	8 hr
Exposure frequency:	60 days
Number of workers:	83

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Research was conducted in many different countries, but worker data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old, but less than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution is fully characterized with many subgroups analyzed. Standard deviations, p-values, means, R2 values given. This sample is representative of the population.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Almost all metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainties are explained and put into context of the study.

Overall Quality Determination High

Study Citation:	Albertini, R. J., Sram, R. J., Vacek, P. M., Lynch, J., Rossner, P., Nicklas, J. A., McDonald, J. D., Boysen, G., Georgieva, N., Swenberg, J. A. (2007). Molecular epidemiological studies in 1,3-butadiene exposed Czech workers: female-male comparisons. Chemico-Biological Interactions 166(1-3):63-77.
HERO ID:	1329826
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	Table 2Exposed males: N=300, mean=0.808mg/m3, S.D.=1.663, median=0.241, range=0.004-12.583;Control males: N=249, mean=0.007 mg/m3, S.D.=0.012, median=0.004, range=0.004-0.157;Exposed females: N=230, mean=0.397 mg/m3, S.D.=1.094, median=0.056, range=0.004-9.793;Control females: N=260, mean=0.008 mg/m3, S.D.=0.015, median=0.004, range=0.004-0.219
Exposure duration:	8 hours
Number of workers:	Exposed Females = 23, Female Controls= 26, Exposed Males = 25, Male Controls = 30

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of butadiene as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making 10 visits to the testing site.

Overall Quality Determination High

Study Citation:	Albertini, R. J., Sram, R. J., Vacek, P. M., Lynch, J., Wright, M., Nicklas, J. A., Boogaard, P. J., Henderson, R. F., Swenberg, J. A., Tates, A. D., Ward, J. B. (2001). Biomarkers for assessing occupational exposures to 1,3-butadiene. Chemico-Biological Interactions 135-136:429-453.
HERO ID:	1328141
Conditions of Use:	Manufacturing and Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Monomer workers, polymer workers, and administrative controls
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Table 4 Descriptive statistics for individual butadiene exposure measurements on workers by groupMonomer production workers: n=217, mean=0.643 mg/m3, S.D.=2.056, Range=0.002-19.909, 50%=0.074, 90%=1.886 Polymerization workers: n=319, mean=1.760 mg/m3, S.D.=4.692, Range=0.002-39.030, 50%=0.293, 90%=4.344Controls (administration workers): n=28, mean=0.026 mg/m3, S.D.=0.030, Range=0.002-0.125, 50%=0.013, 90%=0.071
Exposure duration:	8 hours
Number of workers:	24 monomer workers, 34 polymer workers, and 25 administrative controls
Comments:	This reference is a summary of the more comprehensive report [17] R.J. Albertini, et al., 2000. Biomarker responses in butadiene exposed Czech workers: A transitional, epidemiological study. Final Report. Health Effects Institute, Cambridge MA. HERO ID: 94288

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
Metric 3:	Applicability	High	Data are for the use of butadiene in manufacturing and polymerization, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years and industry conditions that may be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges, standard deviations, medians) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making multiple visits to the testing site and taking many samples.

Overall Quality Determination Medium

Study Citation:	Albertini, R. J., Sram, R. J., Vacek, P. M., Nicklas, J. A., McDonald, J., Swenberg, J. A. (2006). Molecular epidemiologic studies in 1,3-butadiene-exposed Czech workers. Epidemiology 17(6):S25-S25.
HERO ID:	5651061
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in monomer production and polymerization departments.
Personal sampling data:	"Male Controls: 0.010 ppm Male Monomer production: 0.290 ppm Male Polymerization: 0.810 ppm Female Exposed: 0.180 ppm Female Controls: 0.0035 ppm Follow-up Male Exposed: 0.370 ppm Follow-Up Male Controls: 0.007 ppm"
Exposure duration:	8 hours
Number of workers:	25 male controls, 24 male monomer production, 34 male polymerization workers. 23 female exposed workers and 26 female controls. In follow up, 30 exposed males and 30 male controls.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from the Czech Republic, an OECD country.
Metric 3:	Applicability	High	Data are for monomer and polymer production, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Sample type and exposure provided, but missing physical form, exposure route, exposure frequency, engineering controls, and PPE.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by conducting a follow up study at a different time.

Overall Quality Determination Medium

Study Citation:	Almerud, P., Akerstrom, M., Andersson, E. M., Strandberg, B., Sallsten, G. (2017). Low personal exposure to benzene and 1,3-butadiene in the Swedish petroleum refinery industry. International Archives of Occupational and Environmental Health 90(7):713-724.
HERO ID:	4140671
Conditions of Use:	Processing as intermediate in petroleum refineries

EXTRACTION

Parameter	**Data**
Worker activity description:	Table 1 on page 3 of 12 describes the various tasks, which include outdoor process technicians in either process area or harbour and tank park, indoor process technicians, outdoor maintenance workers in either process area or harbour and tank park, indoor maintenance workers, lab workers, engineers, safety and emergency staff, inspectors, administrative personnel, railroad terminal workers.
Personal sampling data:	The 1,3-butadiene exposure was low, 5.4 and 1.8 µg/m3, in Refinery 1 and 2 (as defined in Table 3 on page 7 of 12) respectively (Page 6 of 12). The total variation was generally attributed to within-worker variability (page 1 of 12).Table 2 on page 6 and Table 3 on page 7 provide various data, including number of samples, average, % over LOD, 95% CI, maximum value, and additional variance and summary statistics for some occupational exposure groups; primarily outdoor process technicians ... data not shown for select occupational exposure groups where only a few samples were above LOD - included such groups as lab workers, engineers, inspectors, administration personnel, etc.
Exposure duration:	Full work shift of 8hr or 12hr (page 4 of 12). Median sampling time was 8hr during weekday and 12hr on weekend for Refinery 1, median sampling time was 7hr for Refinery 2 (page 5 of 12).
Number of workers:	Refinery 1: about 650 employees for annual capacity of 11million tonnes of petroleum products... Refinery 2: about 200 employees for annual cpacity of 4million tonnes of petroleum products (Page 2 of 12).
Personal protective equipment:	in general the use of personal protective equipment wasreported to be very low. (Page 10 of 12)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3: Applicability	High	Data are for processing in petroleum refineries, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (95% CI for data, variance statistics, number of samples, % below LOD, maximum).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by different worker exposures and differences between refineries.

Overall Quality Determination High

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Study Citation:	Almerud, P., Akerstrom, M., Andersson, E. M., Strandberg, B., Sallsten, G. (2017). Low personal exposure to benzene and 1,3-butadiene in the Swedish petroleum refinery industry. International Archives of Occupational and Environmental Health 90(7):713-724.
HERO ID:	4140671
Conditions of Use:	Processing as intermediate in petroleum refineries

		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Ammenheuser, M. M., Bechtold, W. E., Abdel-Rahman, S. Z., Rosenblatt, J. I., Hastings-Smith, D. A., Ward, J. B. (2001). Assessment of 1,3-butadiene exposure in polymer production workers using HPRT mutations in lymphocytes as a biomarker. Environmental Health Perspectives 109(12):1249-1255.
HERO ID:	2959573
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	"High Exposure Group: reactor, recovery, tank farm, and laboratory workers Low Exposure Group: blending, coagulation, baling, shipping, control room, and utility workers."
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	1.48+-0.37 ppm in high exposure group, and 0.15+-0.02 ppm in low exposure group.
Exposure duration:	8 hours
Exposure frequency:	20.9+-10.7 years for high-exposure group. 14.0+-12.2 years for low exposure group.
Number of workers:	49

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Well-described method by a national laboratory was used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Correlation factors, means, standard error, graphs, p-values, and subgroup statistics provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty discussed heavily in the last section of the paper.

Overall Quality Determination High

Study Citation:	Anderson, D., Hughes, J. A., Brinkworth, M. H., Peltonen, K., Sorsa, M. (1996). Levels of ras oncoproteins in human plasma from 1,3-butadiene-exposed workers and controls. Mutation Research 349(1):115-120.
HERO ID:	2960518
Conditions of Use:	Processing (Synthetic rubber, plastic, and resin manufacturing)

EXTRACTION

Parameter	**Data**
Area sampling data:	1.8+-2.8 ppm in plant, 0.07+-0.07 ppm in controls (pg. 2/6)
Exposure frequency:	15.3+-10.5 years (work history of subjects)
Number of workers:	23 (pg. 2/6)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Only a mean and range given for exposure concentrations, with no explanation of how it was obtained.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of theuncertainty in the exposure estimates.

Overall Quality Determination Medium

Study Citation:	Anttinen-Klemetti, T., Vaaranrinta, R., Mutanen, P., Peltonen, K. (2004). Personal exposure to 1,3-butadiene in a petrochemical plant, assessed by use of diffusive samplers. International Archives of Occupational and Environmental Health 77(4):288-292.
HERO ID:	5584146
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Loadin and unloading of vehicles, and repairing of process lines.
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Mean value of all samples was 0.169 ppm.
Exposure duration:	5-9 hours
Exposure frequency:	2-3 weeks
Number of workers:	30,000 workers in Europe and 50,000 workers in the USA.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges and means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling participants multiple times.

Overall Quality Determination High

Study Citation:	Anttinen-Klemetti, T., Vaaranrinta, R., Mutanen, P., Peltonen, K. (2006). Inhalation exposure to 1,3-butadiene and styrene in styrene–butadiene copolymer production. International Journal of Hygiene and Environmental Health 209(2):151-158.
HERO ID:	5675367
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers in production of purified butadiene monomer, production of various butadiene-based polymers and manufacture of rubber and plastic products
Exposure route:	inhalation
Personal sampling data:	”Plant 1: 0.068 ppm Plant 2: 0.125 ppm Plant 3: 0.302 ppm”
Exposure duration:	8 hours
Number of workers:	30,000 in Europe, 50,000 in the USA.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for polymerization for synthetic rubber, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 3 different sites and taking multiples samples per person.

Overall Quality Determination High

Study Citation:	ARCO, (1989). Air monitoring for organic compounds during processing of arco report on ethyl benzene, maleic anhydride and toluene with attachments and cover letter dated 022389 (sanitized). :#86-890000124S.
HERO ID:	2859370
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Organic chemical manufacturing
Worker activity description:	Exposure from the injection nozzle area and sonic welder area.
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	All samples below the LDL of 0.11 ppm.
Exposure duration:	40-44 mins

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Since all values were below detection limits, only a ”less-than” range was given for butadiene concentrations.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	Au, W. W., Bechtold, W. E., B, W.E., , J. R., Legator, M. S. (1995). Chromosome aberrations and response to gamma-ray challenge in lymphocytes of workers exposed to 1,3-butadiene. Mutation Research 334(2):125-130.
HERO ID:	5663108
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	”Exposed Areas: 3.5 ppm Controls: 0.03 ppm”
Exposure frequency:	Mean employment of 6.0 +- 9.6 years.
Number of workers:	10 exposed workers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, p-values, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different age groups and races of workers.

Overall Quality Determination High

Study Citation:	Austin, C. C., Wang, D., Ecobichon, D. J., Dussault, G. (2001). Characterization of volatile organic compounds in smoke at municipal structural fires. Journal of Toxicology and Environmental Health, Part A: Current Issues 63(6):437-458.
HERO ID:	666418
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Worker activity description:	firefighters
Exposure route:	inhalation of combustion byproducts
Physical form:	Combustion product from municipal/structural fires
Area sampling data:	Mean concentration: 1.03ppm... SD: 1.49ppm... Range: 0.03-4.84ppm... Plot showing concentration for each sample is given in source
Comments:	firefighter exposures; unsure if in scope

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for firefighter exposures, which is similar to in-scope occupational scenarios pertaining to combustion byproducts.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by samples for different fires.

Overall Quality Determination High

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	”Site A: 0.01+-0.01 ppb Site B: 0.16+-0.39 ppb Site C: 0.01+-0.07 ppb Site D: 0.01+-0.04 ppb Site E: 0.01+-0.01 ppb”
Comments:	See Table 2 for the data.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling method is an approved EPA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	Low	Data are non-occupational and for ambient air near industrial facilities, which is similar to the in-scope occupational scenario of petrochemical manufacturing
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Exposure route and area concentrations provided but missing all other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by taking during four seasons and 5 sites.

Overall Quality Determination Medium

Study Citation:	Begemann, P., Srám, R. J., Neumann, H. G. (2001). Hemoglobin adducts of epoxybutene in workers occupationally exposed to 1,3-butadiene. Archives of Toxicology 74(11):680-687.
HERO ID:	2989653
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Monomer production unit and heat production units of a petrochemical plant (page 2 of 8).
Personal sampling data:	Table 1 on page 3 of 8 describes the results, which includes the median, range, mean and SD for the individuals in the exposed group, control group, smokers and nonsmokers in the exposed group, and smokers and nonsmokers in the control group. The mean ranged from 0.01 to 4.06 mg/m^3
Exposure duration:	8 hours per workshift (page 2 of 8)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, medians, ranges, standard deviations, and percentiles given. Subgroups are also analyzed to avoid confounding.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Multiple sources of uncertainty described in the conclusion.

Overall Quality Determination High

Study Citation:	Begemann, P., Upton, P. B., Ranasinghe, A., Swenberg, J. A., Soleo, L., Vimercati, L., Gelormini, A., Fustinoni, S., Zwirner-Baier, I., Neumann, H. G. (2001). Hemoglobin adducts as biomarkers of 1,3-butadiene in occupationally low exposed Italian workers and a few diesel-exposed miners. Chemico-Biological Interactions 135-136:675-678.
HERO ID:	1942870
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Monomer production, polymerization, and copolymerization production units at BD plant. (page 2 of 4)
Personal sampling data:	Average of 31 µg/m3 in plant workers. Range of 4-201 µg/m3. (Page 3 of 4).
Exposure duration:	8 hours/day (page 2 of 4)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Method is mentioned, but isn't described or elaborated on.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Report is around 20 years old.
	Metric 5:	Sample Size	High	Statistics fully characterized with ranges, means, p-values, and sample sizes.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Effects of smoking discussed on results, but no other uncertainty addressed.

Overall Quality Determination Medium

Study Citation:	Boogaard, P. J., Sittert, Van, N. J., Megens, H. J. (2001). Urinary metabolites and haemoglobin adducts as biomarkers of exposure to 1,3-butadiene: a basis for 1,3-butadiene cancer risk assessment. Chemico-Biological Interactions 135-136:695-701.
HERO ID:	5580311
Conditions of Use:	Processing (synthetic rubber and resin manufacturing)

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing, plastic and resin manufacturing
Worker activity description:	Loading of butadiene to ships and tankers, BD monomer production, SBR production.
Exposure route:	inhalation
Personal sampling data:	”Loading: <0.2-9.5 ppm, median of 0.5 ppm Monomer production: 0.02-1.6 ppm, median of 0.17 ppm SBR production: 0.02-4.2 ppm, median of 0.50 ppm” (pg. 4/7)
Exposure duration:	8 hours
Exposure frequency:	60 days
Number of workers:	44 in loading, 24 in BD monomer production, 34 in SBR production. (pg. 3/7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from The Netherlands and the Czech Republic, both OECD countries.
	Metric 3:	Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges and medians) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by using two sampling sites in different countries.

Overall Quality Determination Medium

Study Citation:	Boysen, G., Georgieva, N. I., Bordeerat, N. K., Sram, R. J., Vacek, P., Albertini, R. J., Swenberg, J. A. (2012). Formation of 1,2:3,4-diepoxybutane-specific hemoglobin adducts in 1,3-butadiene exposed workers. Toxicological Sciences 125(1):30-40.
HERO ID:	2570239
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Administrative workers (control group), monomer production workers, and polymer production workers (page 3 of 11).
Personal sampling data:	In control group, 0.023 mg/m3. In monomer production workers, 0.64 mg/m3. In polymerization workers, 1.79 mg/m3 (page 4 of 11, or table 1 on page 3 of 11). Additional discussion on pages 8-9 of 11
Exposure duration:	8 hour work shifts (page 3 of 11)
Exposure frequency:	10 separate occasions over 4 months (page 3 of 11)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is well-described and approved by accredited universities.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	High	Data is around 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, ratios, and ranges provided. ANOVA test was also conducted.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation in results was accounted for and explained clearly.

Overall Quality Determination High

Study Citation:	California Office of Environmental Health Hazard Assessment :: OEHHA (2014). Appendix D: Individual acute, 8-hour, and chronic reference exposure level summaries.
HERO ID:	5155603
Conditions of Use:	Processing for petrochemical refineries, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Estimated exposures around 20ppm in 1940s and 1950s with annual trend towards average 6% drop in BD concentrations each year... exposures in 11-plant Taiwan petrochem complex study showed only 15% of values over LOD with mean low conc of 7.7ppb and mean high conc of 10.5ppb... ambient concentrations in toll booth study for Baltimore tunnel in 2001 were 3ppb... 49 workers at SBR plant separated into high and low exposure groups (exposure measured by personal badge dosimeter); average high: 1.48ppm, low: 0.15ppm

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as an intermediate or reactant, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency and duration, specific worker tasks.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Carrieri, M., Bartolucci, G. B., Paci, E., Sacco, P., Pigini, D., Zaratin, L., Cottica, D., Scapellato, M. L., Tranfo, G. (2014). Validation of a radial diffusive sampler for measuring occupational exposure to 1,3-butadiene. Journal of Chromatography A 1353:114-120.
HERO ID:	2443282
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers employed in the production unit of a chemical plant in northern Italy where BD was used (page 2 of 7). In general, occupational exposure to BD occurs during its production, its use as a chemical feedstock in the manufacture of other chemicals, during the use of such chemicals, and in a wide variety of miscellaneous processes involving petroleum refining, secondary lead smelting and wastewater treatment (page 1 of 7).
Exposure route:	Inhalation is the main route of exposure (page 2 of 7)
Personal sampling data:	See table 3 on page 5 of 7 for the personal(active) sampling results, the mean of which was 0.060 mg/m^3, and a range of <0.010 to 1.340. See section 3.3 on page 4 of 7 for brief discussion.
Area sampling data:	See table 3 on page 5 of 7 for the area(diffusive) data, the mean of which is 0.0569 mg/m^3, and a range of <0.0002 to 1.2318. See section 3.3 on page 4 of 7 for brief discussion.
Exposure duration:	8 hours (page 3 of 7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved OSHA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for processing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing individual worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but, variability is not addressed.

Overall Quality Determination High

Study Citation:	Chan, C. C., Shie, R. H., Chang, T. Y., Tsai, D. H. (2006). Workers' exposures and potential health risks to air toxics in a petrochemical complex assessed by improved methodology. International Archives of Occupational and Environmental Health 79(2):135-142.
HERO ID:	170003
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	emissions from petrochemical plant activities
Exposure route:	inhalation
Area sampling data:	Low (NDs treated as 0): mean 7.7ppb, SD 37.3ppb... High (ND as LOD/sqrt2): mean 10.5ppb, SD 36.7ppb... Max conc detected 3,080ppb
Number of workers:	about 3,100 onsite workers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical refining, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max, mean, SD, and number of samples >LOD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Chang, C. P., Lin, T. C., Lin, Y. W., Hua, Y. C., Chu, W. M., Lin, T. Y., Lin, Y. W., Wu, J. D. (2016). Comparison between Thermal Desorption Tubes and Stainless Steel Canisters Used for Measuring Volatile Organic Compounds in Petrochemical Factories. Annals of Occupational Hygiene 60(3):348-360.
HERO ID:	3120430
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Petrochemical Manufacturing
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	8.12+-37.13 ppb taken by thermal desorption tubes, 6.38+-31.87 ppb taken by steel cannisters
Exposure duration:	6 hours
Exposure frequency:	6 months

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved EPA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple sites using two sampling methods.

Overall Quality Determination High

Study Citation:	Checkoway, H., Williams, T. M. (1982). A hematology survey of workers at a styrene-butadiene synthetic rubber manufacturing plant. American Industrial Hygiene Association Journal 43(3):164-169.
HERO ID:	73423
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic Rubber manufacturing
Worker activity description:	Tank Farm provides most of exposure
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	"Tank Farm Dept: 20.03ppm Reactor/Recovery Dept: 0.77ppm Solution Dept: 0.59ppm Shipping/Receiving Dept: 0.08ppm Storeroom Dept: 0.08ppm Factory Service Dept: 0.37ppm Maintenance Dept: 0.97ppm"
Number of workers:	163

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Data is well-characterized. Ranges, means, regression statistics, and p-values given for all categories of workers.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most crucial data included, but missing exposure frequency and exposure types.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is mentioned, but not spoken about in detail.

Overall Quality Determination — High

Study Citation:	Cheng, X., Zhang, T., Zhao, J., Zhou, J., Shao, H., Zhou, Z., Kong, F., Feng, N., Sun, Y., Shan, B., Xia, Z. (2013). The association between genetic damage in peripheral blood lymphocytes and polymorphisms of three glutathione S-transferases in Chinese workers exposed to 1,3-butadiene. Mutation Research 750(1-2):139-146.
HERO ID:	4685298
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic rubber manufacturing
Worker activity description:	pretreatment procedures (measuring, polymerization, condensation, recycle, tank unit) and after treatment procedures (drying, pressing, package unit, control office)
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	In exposed group (n=44): 2.40+-2.93 mg/m3, range of 0.06-12.41 mg/m3
Exposure duration:	8 hours
Exposure frequency:	At least one year of exposure
Number of workers:	56

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by using a control group, and finding statistics for different subgroups of workers to avoid confounding.

Overall Quality Determination High

Study Citation:	Cowles, S. R., Tsai, S. P., Snyder, P. J., Ross, C. E. (1994). Mortality, morbidity, and haematological results from a cohort of long-term workers involved in 1,3-butadiene monomer production. Occupational and Environmental Medicine 51(5):323-329.
HERO ID:	646900
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	employees involved in butadiene production, maintenance personnel in butadiene areas, laboratory staff, and shipping personnel involved in butadiene transfer and storage
Personal sampling data:	arithmetic means for each job area... operations: 0.7ppm... shipping: 10.4ppm... laboratory: 1.2ppm... maintenance: 1.69ppm... Total: 3.51ppm ; provides min and max range for each job area as well as sample size; spans 1979-1992 see table 8
Exposure frequency:	A minimum of five years of employment in jobs withpotential exposure to butadiene with averaged 7-6years.
Number of workers:	614 employees qualified for the mortality study, 438 of those were still employed during the period of the morbidity study

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range, number of samples, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at different job areas, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Davis, M. E., Blicharz, A. P., Hart, J. E., Laden, F., Garshick, E., Smith, T. J. (2007). Occupational Exposure to Volatile Organic Compounds and Aldehydes in the U.S. Trucking Industry. Environmental Science & Technology 41(20):7152-7158.
HERO ID:	1013846
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Worker activity description:	Truck drivers exposed to diesel exhaust
Exposure route:	Inhalation
Physical form:	vapor
Personal sampling data:	River exposures were 0.34 micrograms/m3 for non-smokers and 1.26 micrograms/m3 for smokers. Loading dock exposures were 0.75 micrograms/m3. Mechanic shop exposures were 0.30 micrograms/m3.
Area sampling data:	Mean background concentration of butadiene is 0.20 micrograms/m3.
Particle size characterization:	less than 1 micrometer in diameter
Comments:	See Table 2 for the sampling data and statistical analysis.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Method is completely described and looks equivalent to an approved method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data from USA.
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	High	Statistical distribution fully characterized. Subcategories were described and explained. Many applicable statistics were provided.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty and sources of error are described and put into context.

Overall Quality Determination High

Study Citation:	Dement, J. M., Hensley, L., Gitelman, A. (1997). Carcinogenicity of gasoline: A review of epidemiological evidence. Annals of the New York Academy of Sciences, vol. 837 837:53-76.
HERO ID:	85507
Conditions of Use:	Commercial Uses

EXTRACTION

Parameter	**Data**
Worker activity description:	Several studies have measured occupational exposures to gasoline vapors (as total hydrocarbons) and its constituents (e.g., benzene, 1,3 butadiene, MTBE) during various phases of gasoline distribution. The highest occupational gasoline exposures typically occur among bulk terminal operators, truck drivers, marine loading operators, and service station attendants according to the petroleum industry. (Page 4 of 24)
Physical form:	Vapor (page 4 of 24)
Personal sampling data:	Table 4 on page 5 of 24 displays the range and mean for personal exposures to 1,3 Butadiene associated with gasoline for both service station attendants (8 hour TWA) and self-service station (2 minute TWA). For service station attendants the mean was 0.3 mg/m3 with a range from ND - 1.1. A brief discussion of the table is also located on page 5. Table 7 on page 8 of 24 displays range and mean for personal exposures to 1,3 Butadiene associated with gasoline bulk loading. There are six means and six ranges displayed for road tanker loading and ship loading combined. The means ranged from 0.2 - 6.4 and the total range of data was between ND - 32.3. A brief discussion of the table is also located on page 8.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	IARC data was used, which comes from an accredited national research laboratory.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized, means and ranges provided and demographics of study subjects were given.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Report clearly documents sources of data, and explains how it was obtained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Potential bias, confounding, and variation causes are explained. Also, future work is recommended.

Overall Quality Determination High

Study Citation:	Dostal, M., Vacek, P., Albertini, R., Sram, R. J. (1999). Association of exposure to butadiene with distribution of T lymphocyte subsets in peripheral blood. Epidemiology 10(4):S84-S84.
HERO ID:	5715680
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Monomer workers, polymer workers, and administrative workers in a petrochemical plant (page 3 of 3)
Personal sampling data:	Exposure assessment by personal monitoring was done (no further detail included in this summary, page 3 of 3)
Number of workers:	24 monomer workers, 33 polymer workers, and 25 administrative workers (administrative workers were used as controls in the study) (page 3 of 3)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Du, Z., Mo, J., Zhang, Y. (2014). Risk assessment of population inhalation exposure to volatile organic compounds and carbonyls in urban China. Environment International 73:33-45.
HERO ID:	2536230
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Home: 0.5 +- 0.3 µg/m3 Office: 0.3 +- 0.1 µg/m3 Commute: 0.6 +- 0.3 µg/m3 Outdoor/other: 0.4 +- 0. µg/m3”. See Table 2
Exposure duration:	varies among studies included in report. See table 5.
Exposure frequency:	varies among studies included in report
Comments:	Estimated personal exposure levels for females and males (μg/m3). See table 5.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Method is state-regulated.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data is from an non-OECD country.
Metric 3:	Applicability	Low	Data is for a non-occupational scenario, but is similar in methods.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
Metric 5:	Sample Size	High	Many statistics provided to fully characterize data, like means, standard deviations, ratios, percentiles, and median values.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some metadata included, but some metadata varies between studies summarized in report.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	A sensitivity analysis was performed to quantify effects of uncertainty.

Overall Quality Determination — Medium

Study Citation:	EC, (2002). Summary risk assessment report for 1,3-butadiene.
HERO ID:	7348613
Conditions of Use:	Monomer and polymer production

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Gas
Personal sampling data:	Occupational exposure data obtained from companies across the EU indicate that the majority of personal 8-hour TWA airborne exposures to butadiene during monomer and polymer production are very low, generally below 5 ppm (8-hour TWA). Exposures inexcess of 10 ppm (8-hour TWA) are likely to be rare, and will arise as a result of unplanned releases.There is the potential for short-term exposures of the order of about 30 - 70 ppm (15-minute reference period) to occur during certain specific operations, particularly during sampling and loading/unloading operations.
Area sampling data:	In monomer production, 90% of exposures are below 1 ppm, with 70% of results in polymer production less than 1 ppm.
Exposure duration:	8 hour time weighted average, but no sample times provided.
Personal protective equipment:	Personal exposure in situations such as sampling and loading/unloading will be mitigated by the use of appropriate respiratory protective equipment.
Engineering control:	Where there is the potential for high exposure, EU industry indicates that exposures can be adequately controlled with LEV, changes in work practices or the wearing of appropriate respiratory protective equipment during specific operations.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified, but information may be available in the main report.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	Report from 20 years ago, but expected to be relevant.
Metric 5:	Sample Size	Low	No sample data provided in report. Unclear if data collected were area or personal breathing zone samples.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	8-hr TWA provided, but no additional metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	No discussion of variability or uncertainty of exposure measurements.

Overall Quality Determination Low

Study Citation: ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID: 5155560
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Worker activity description:	The largest industry sector where workers are exposed to butadiene are those involved with its manufacture and those in the working on polymer production plants (page 72 of 204). Detailed descriptions of various worker activity is described on page 73-74 and includes material sampling, filling road tankers and ships, periodic and unplanned maintenance, and fugative emissions.
Exposure route:	The main route of occupational exposure to 1,3-butadiene is by inhalation of the vapour. While the potential for oral and dermal exposure cannot be ruled out, this is considered to represent a very minor route of exposure, particularly if good occupational hygiene practice is assumed (page 162 and 169 or 204)
Physical form:	colourless gas at n.t.p. (page 18 and 162 of 204)
Personal sampling data:	To establish occupational exposure during the manufacture of butadiene monomer and polymers about 5,000 results were collated from various sources and presented in this risk assessment. These showed that over 90% of exposures were less than 5 ppm 8-hour TWA, with the majority of these less than 1 ppm 8-hour TWA. It was concluded that higher results, although on occasion significantly higher than 5 ppm, were as a result of one-off identifiable occurrences and not representative of an individuals workers routine exposure. (page 72 and 162 of 204) See page 74-81 for a summary of data from several facilities. See page 83-86 for a summary of occupational exposure findings in the risk assessment, including a table on page 84 that includes the 8-hour TWA exposure data (number of samples, ranges, and means in ppm among other information) used in this document.
Dermal exposure data:	nan
Personal protective equipment:	Where there is the potential for high exposure, EU industry indicates that exposures can be adequately controlled with LEV, changes in work practices or the wearing of appropriate respiratory protective equipment during specific operations. Personal exposure in situations such as sampling and loading/unloading will be mitigated by the use of appropriate respiratory protective equipment. (page 162 of 204)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	EU
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

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Study Citation: ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID: 5155560
Conditions of Use: Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Personal sampling data:	exposure to butadiene during the use of polymers at two rubber plants and found all results to be lower than the detection limit of 0.3 µg/sample. (page 72 of 204). See page 83-86 for a summary of occupational exposure findings in the risk assessment, including a table on page 84 that includes the 8-hour TWA exposure data (number of samples, ranges, and means in ppm among other information) used in this document.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	EU
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination High

Study Citation:	Fajen, J. (1988). Extent of exposure study: 1,3-butadiene polymer production industry.
HERO ID:	6558313
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Exposures ranged from less than 0.006ppm to 209.6ppm; the average exposure was less than 2ppm.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for polymerization in synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker activity, area sampling data, exposure duration and frequency, number of workers, PPE, and engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 17 different sites.

Overall Quality Determination High

Study Citation:	Fajen, J. M., Lunsford, R. A., Roberts, D. R. (1993). Industrial exposure to 1,3-butadiene in monomer, polymer and end-user industries. IARC Scientific Publication No. 127 127:3-13.
HERO ID:	5663322
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	"Technicians and operators in decontamination and maintenance of process equipment; sampling and analysis of samples for quality control; and loading and unloading of crude feed and butadiene product."
Exposure route:	Inhalation
Personal sampling data:	Monomer Industry: Lab technician: 1.06+-1.61 ppm Bomb voiding technician: 126+-215 ppm Control Technician: 0.45+-0.72 ppm Loading Technician: 11.60+-35.30 ppm Production Technician: 2.16+-6.38 ppm Storage Technician:0.44+-0.62 ppm Polymer Industry: Lab Technician: 3.09+-6.91 ppm Tank Farm Operators: 1.97+-5.01 ppm Front End: 1.80+-4.02 ppm Maintenance Technician: 1.84+-6.85 ppm Back End: 0.351+-1.07 ppm Other: 0.035+-0.032 ppm
Area sampling data:	Monomer Industry: Production Area: 0.57+-0.57 ppm Railcar Loading Area: 10.5+-18.4 ppm Trailer Loading Area: 0.57+-0.90 ppm Laboratory: 1.04+-1.92 ppm Tank Farm: 7.80+-10.4 ppm Polymer Industry: Barge Area: 0.474 ppm Tank Farm: 0.668+-0.670 ppm Laboratory: 3.02+-5.18 ppm Front End: 0.285+-0.486 ppm Back End: 0.009+-0.008 ppm
Number of workers:	9500 workers exposed in the USA.
Engineering control:	"1. Plants should consider converting to a closed-loop sampling system for obtaining cylinder samples for quality control, in order to lower the mean exposures of laboratory technicians and technicians working in process areas. 2. Leaking pumps can result in exposure of technicians in process areas. The release of butadiene from such equipment can be controlled by the use of dual mechanical seals. Plants should consider retro-fitting pumps that have single mechanical seals with the more effective dual mechanical seals. 3. Because magnetic gauges are known to limit the release of butadiene (and hence exposure of process technicians in the loading area) while rail cars are being loaded, plants should consider a program to convert to 100% magnetic gauges for monitoring rail-car filling operations. 4. As is evident from the monitoring results for laboratory technicians involved in voiding cylinders, workers assigned to this task may be exposed to butadiene. Consideration should be given to using a laboratory hood or a vacuum exhaust with an enclosure for cylinder voiding. Furthermore, workers should be trained in the proper conduct of tasks such as cylinder voiding and cylinder sampling. 5. The new NIOSH sampling and analytical method for butadiene is recommended in areas of potentially low exposure and where there is potential interference from other C4 compounds."
Comments:	See Table 1-3.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene monomer and polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges, percentiles) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.

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Study Citation:	Fajen, J. M., Lunsford, R. A., Roberts, D. R. (1993). Industrial exposure to 1,3-butadiene in monomer, polymer and end-user industries. IARC Scientific Publication No. 127 127:3-13.
HERO ID:	5663322
Conditions of Use:	Processing

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different plants and sampling the same workers multiple times.

Overall Quality Determination — High

Study Citation:	Fajen, J. M., Roberts, D. R., Ungers, L. J., Krishnan, E. R. (1990). Occupational exposure of workers to 1,3-butadiene. Environmental Health Perspectives 86(0):11-18.
HERO ID:	5663352
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	"Technicians and operators in decontamination and maintenance of process equipment; sampling and analysis of samples for quality control; and loading and unloading of crude feed and butadiene product."
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	In monomer production, laboratory technicians voiding sample cylinders and process technicians loading or unloading tank trucks or rail cars had geometric mean exposures of 7.46, 1.02, and 1.00 ppm, respectively. All other job titles experienced geometric mean exposures of less than 1 ppm. In polymer production, The six job categories that experience full-shift (personal) 1,3-butadiene exposures greater than 10 ppm (at least one sample) are the process technician in unloading, tank farm, purification, polymerization or reaction, laboratory technician, and maintenance technicians. These job categories had geometric mean exposures of 4.69, 0.270, 6.10, 0.062, 0.213, and 0.122 ppm, respectively.
Area sampling data:	In monomer production, area concentrations of 1,3-butadiene were also detected at levels well below the OSHA PEL of 1000 ppm. A review of the 123 area monomer results indicated that rail car terminals and tank storage farms had geometric mean concentrations of 1.96 and 2.12 ppm, respectively. Other work areas had geometric mean concentrations of less than 1 ppm. No full-shift area samples exceeded 100 ppm. In polymer production, Full-shift 1,3-butadiene concentrations in the work areas ranged from 0.006 to 9.08 ppm.
Exposure duration:	8 hours
Number of workers:	65,000 workers
Engineering control:	Leak prevention from pumps at 1,3-butadiene monomer and polymer facilities is accomplished through the use of various types of seals that isolate the interior of the pump from the atmosphere. During quality control sampling, the potential for worker exposure during sampling is greatly minimized by the use of closed-loop sampling techniques. Engineering controls in the laboratory may include dilution ventilation of the laboratory air, using laboratory hoods with adequate face velocities, and employing sample connections that minimize leakage and dead volume.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene monomer and polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges, percentiles) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.

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Study Citation:	Fajen, J. M., Roberts, D. R., Ungers, L. J., Krishnan, E. R. (1990). Occupational exposure of workers to 1,3-butadiene. Environmental Health Perspectives 86(0):11-18.
HERO ID:	5663352
Conditions of Use:	Processing

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different plants and sampling the same workers multiple times.

Overall Quality Determination — High

Study Citation:	Fajen, J., Ungers, L., Roberts, D. (1986). Occupational exposure of workers to 1,3-butadiene at monomer production plants.
HERO ID:	6558520
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Rail car process technicians, tank truck process technician, tank farm process technician, pump alley technician, control room technician, maintenance worker, laboratory analysis technician, laboratory cylinder voiding technician
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Arithmetic mean butadiene exposures according to job title were: rail car process technician 14.64 parts per million (ppm), tank truck process technician 2.65ppm, tank farm process technician 0.44ppm, pump alley technician 2.23ppm, control room technician 0.45ppm, maintenance worker 0.21ppm, laboratory analysis technician 1.06ppm, and laboratory cylinder voiding technician 125.32ppm.
Area sampling data:	Arithmetic mean exposures by work area were: rail tank terminal 11.03ppm, tank car terminal 0.57ppm, tank farm 7.80ppm, pump alley 0.50ppm, control room 2.13ppm, laboratory 1.14ppm, and ambient air 0.08ppm.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for monomers in polymer production, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL. More than 20 years old
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 7 work areas.

Overall Quality Determination High

Study Citation:	Fent, K. W., Musolin, K., Methner, M. (2013). Health hazard evaluation report: Evaluation of chemical exposures during fire fighter training exercises involving smoke simulant.
HERO ID:	2452610
Conditions of Use:	Commercial Use - Training Smoke

EXTRACTION

Parameter	**Data**
Worker activity description:	fire fighter trainers using a mineral oil-based smoke simulant used during training exercises (page 7 of 46)
Exposure route:	Inhalation (page 28 of 46)
Area sampling data:	See Figure 10 on page 22 of 46 for area sampling data from exercise 2 (1,3-butadiene values were below MCD). See Figure 12-14 on page 24-26 of 46 for area sampling data inside and outside the room, as well as different heights, in exercise 3-5 (values ranging between 5 and around 700 ug/m3).
Exposure duration:	the fire fighter trainers worked about 40 hours a week. In one incident they were exposed to a dense cloud of oil-based smoke simulant for at least 30 minutes during preparations for a training exercise (page 7 of 46) Each exercise lasted approximately 15 minutes with 10 minutes of smoke simulant and heat generation (page 10 of 46)
Exposure frequency:	conducted almost 100 training exercises every year (page 7 of 46)
Number of workers:	255 full-time fire fighters and 5 full-time fire fighter trainers. The number of fire fighter trainers on-site varied from two to five a day (page 7 of 46)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	United States
	Metric 3: Applicability	Medium	training smoke for firefighters is not a COU, but it is an occupational exposure scenario.
	Metric 4: Temporal Representativeness	Medium	Data is from early to mid 2012
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination High

Study Citation:	Fields, B. (1987). Diffusive sampling onto solid adsorbents for the analysis of benzene and 1,3-butadiene in air by gas chromatography. :85-88.
HERO ID:	5547387
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	A graph is included, in which exposures appear to range from 0-6 ppm.
Exposure duration:	8 hours
Number of workers:	186

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Fishbein, L. (1992). Exposure from occupational versus other sources. Scandinavian Journal of Work, Environment and Health 18(S1):5-16.
HERO ID:	200024
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Principal exposures occurring in consuming plants, terminal facilities, decon and maintenance of process equipment, and analysis of quality control samples
Exposure route:	inhalation
Area sampling data:	occupational settings 0.06-39ppm
Number of workers:	62,000 workers potentially exposed in United States

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for unknown occupational scenarios, though similar to in-scope occupational scenarios for manufacturing and processing.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing methods.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Fustinoni, S., Perbellini, L., Soleo, L., Manno, M., Foà, V. (2004). Biological monitoring in occupational exposure to low levels of 1,3-butadiene. Toxicology Letters 149(1-3):353-360.
HERO ID:	1328866
Conditions of Use:	Processing: Petrochemical manufacturing; Petroleum refineries

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in a petrochemical plant
Exposure route:	inhalation
Personal sampling data:	”Exposed workers: 11.5+-35.8 ug/m3 Controls: 0.9+-1.0 ug/m3”
Exposure duration:	8 hours
Exposure frequency:	7.2+-7.1 years
Number of workers:	42 exposed, 43 controls

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, medians, maximums) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making 3-4 visits to the testing site.

Overall Quality Determination High

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
Conditions of Use:	Processing (BD monomers and polymers)

EXTRACTION

Parameter	**Data**
Worker activity description:	10 workers in monomer production, 10 workers in co-polymerization, 10 workers in rubber polymerization, 10 administrative clerks
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	”Clerks: ND; Butadiene exposed workers: 55+- 53 µg/m3; Nonsmokers: 50+- 51 µg/m3; Smokers: 61+-57 µg/m3; Nonsmoking clerks: ND; Nonsmoking BD exposed workers: 50+-51 µg/m3; Smoking BD exposed workers: 61+-57 µg/m3”See Table 2, pg. 4/10
Exposure duration:	8 hours/day
Exposure frequency:	average of 11.7 +- 8.33 years of exposure among subjects
Number of workers:	40 (10 clerks and 30 workers, see Table 1 pg. 2/10)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	High	Statistical distribution fully characterized, with subgroups of sample population analyzed and compared. Many statistics like P-values, R2 values, means, medians, ranges, and regression provided.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is mentioned briefly in the conclusion.

Overall Quality Determination High

Study Citation:	Gabriel, S., Steinhausen, M., Gelder, Van, R. (2013). Identification of work-related exposure to carcinogenic substances in Germany. WIT Transactions on Ecology and the Environment 174(18):85-102.
HERO ID:	3420213
Conditions of Use:	Domestic manufacturing, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	listed most frequent working areas as those near extruders, mouldings, plastic welding, and laboratory
Personal sampling data:	of 257 measured values, only one was above the analytical quantification limit; quantification limit around 1 mg/m3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to approved OSHA/NIOSH methods (ISO method).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	Medium	Data are for generic industrial scenarios, which include the in-scope occupational scenarios of domestic and synthetic rubber manufacturing.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Goodrich, J. D., DeWees, W. G., Segall, R. R. (1989). Sampling and analysis of butadiene at a synthetic rubber plant.
HERO ID:	5699391
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	Samples range from 13-3480 ppmv, however outliers are observed in this range. See table 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for laboratory calibration of sampling equipment in a rubber plant, which is similar to the in-scope occupational scenario of synthetic rubber manufacturing.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, variances) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by explaining outliers and calculating variances.

Overall Quality Determination Medium

Study Citation:	Guirguis, S. S., Cohen, M. B., Rajhans, G. S. (1984). A review of health risks in acrylonitrile industry. Giornale Italiano di Medicina del Lavoro 6(3-4):87-93.
HERO ID:	1008191
Conditions of Use:	Processing (synthetic rubber manufacturing, resin manufacturing)

EXTRACTION

Parameter	**Data**
Worker activity description:	Reactors and sample taking
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	up to 1000 ppm in reactor and sample taking processes
Number of workers:	660
Engineering control:	Local ventilation, top-unloading of tank cars, sealing process vessels, double seals, permit systems, alarm systems, infrared analyzers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Data on subgroups and departments given also.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Almost all metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty mentioned in the conclusion, but not in depth.

Overall Quality Determination High

Study Citation:	Hall, T. A., Esmen, N. A., Jones, E. P., Basara, H., Phillips, M. L., Marsh, G. M., Youk, A. O., Buchanich, J. M., Leonard, R. C. (2007). Chemical process based reconstruction of exposures for an epidemiological study: III. Analysis of industrial hygiene samples. Chemico-Biological Interactions 166(1-3):277-284.
HERO ID:	625243
Conditions of Use:	Processing as an intermediate

EXTRACTION

Parameter	**Data**
Worker activity description:	chemical operators and mechanics in either monomer or polymer areas
Exposure route:	reactant in chloroprene monomer production
Personal sampling data:	Only chloroprene exposure information; provide mean, GM, GSD, maximum, and number of samples for each year at each facility: Mean for Louisville facility ranged from 0.7 to 3ppm in monomer areas from 1975-1990... Mean for Pontchartrain facility ranged from 0.09 to 1.41ppm in monomer areas from 1976-1992

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for processing chloroprene in production, which is similar to the in-scope occupational scenario processing butadiene as reactant in chloroprene production.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, GM, GSD, and number of samples for each year) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by years collected and both sites present in the United States.

Overall Quality Determination Medium

Study Citation:	Hallberg, L. M., Bechtold, W. E., Grady, J., Legator, M. S., Au, W. W. (1997). Abnormal DNA Repair Activities in Lymphocytes of Workers Exposed to 1,3-Butadiene. Mutation Research 383(3):213-221.
HERO ID:	2961678
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	2.4+-1.8 ppm for exposed workers, ND for control group
Number of workers:	43

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling method is very well-described and seems equivalent to a NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Demographics of sample group was disclosed, and means and standard deviation was given for butadiene exposure.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation is discussed and shown in statistics.

Overall Quality Determination High

Study Citation:	Hansen, J. (2000). Elevated risk for male breast cancer after occupational exposure to gasoline and vehicular combustion products. American Journal of Industrial Medicine 37(4):349-352.
HERO ID:	94367
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Worker activity description:	Employees of service stations, vehicle maintenance locations, wholesale gasoline shops, and car repair shops who are exposed to butadiene through vehicle emissions.
Exposure route:	inhalation
Physical form:	vapor
Exposure frequency:	At least three months of employment.
Number of workers:	230

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Medium	Sampling method is described, but analytical methods aren't specified.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from an OECD country.
	Metric 3: Applicability	Low	Butadiene is mentioned, but is grouped with other hydrocarbons and has no individual data in the report.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5: Sample Size	High	Statistical distribution fully characterized. Includes p-values, confidence intervals, & means.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Most metadata included, but missing a few categories.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty briefly mentioned in the conclusion of report.

Overall Quality Determination Medium

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., Committee, H.H. (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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Worker activity description:	non-occupational personal exposure
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Total personal exposure: 0.14 +- 5.2 4µg/m3
Area sampling data:	Home: 0.12+- 4.37 µg/m3 Workplace: 0.05 +- 2.85 µg/m3 Street: 0.04+-6.06 µg/m3 Transport Vehicles: 0.13 +- 3.62 µg/m3 Transport Stations: 0.09+- 3.06 µg/m3 Pubs/Restaurants: 0.70 +- 12.18 µg/m3 Other indoor: 0.05 +- 8.81 µg/m3
Exposure duration:	12 hours in home, 8 hours in workplace
Exposure frequency:	lifetime
Number of workers:	100

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is completely described and looks equivalent to an approved method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	Low	Data is for a non-occupational scenario, but is similar in methods.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Many statistics are provided, subgroups are broken down and explained, and correlations and ratios are talked about in detail.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Almost all metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty and variation is mentioned in the report, and the statistics characterize it as well.

Overall Quality Determination High

Study Citation:	Hayes, R. B., Xi, L., Bechtold, W. E., Rothman, N., Yao, M., Henderson, R., Zhange, L., Smith, M. T., Zhang, D., Wiemels, J., Dosemeci, M., Yin, S., O'Neil, J. P. (1996). hprt mutation frequency among workers exposed to 1,3-butadiene in China. Toxicology 113(1-3):100-105.
HERO ID:	5544872
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Process analysts, who sample butadiene production process lines, and process operators, who do routine process control, minor maintenance, and major repairs.
Exposure route:	inhalation
Personal sampling data:	"Analysts at polymer facility: 1.0 ppm Analysts at dimethyl formamide facility: 3.5 ppm Process operators, routine work: 1.1 ppm Process operators, pump repair: 45 ppm"
Exposure duration:	6 hours
Exposure frequency:	"Exposed Males: 8.6+-6.1 years Exposed Females: 6.5+-5.5 years"
Number of workers:	65000
Comments:	See Table 2Study population sample size is smaller and different from the size of 65k people potentially exposed to BD.Personal air samples were available for 40 exposed subjects, among whom 20 had measurements taken on two separate days. (page 4 of pdf)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation, sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by providing data for different subgroups of the sample.

Overall Quality Determination Medium

Study Citation:	Hayes, R. B., Zhang, L., Swenberg, J. A., Yin, S. N., Xi, L., Wiencke, J., Bechtold, W. E., Yao, M., Rothman, N., Haas, R., O'Neill, J. P., Wiemels, J., Dosemeci, M., Li, G., Smith, M. T. (2001). Markers for carcinogenicity among butadiene-polymer workers in China. Chemico-Biological Interactions 135-136:455-464.
HERO ID:	5552863
Conditions of Use:	Processing (synthetic rubber)

EXTRACTION

Parameter	**Data**
Life cycle description:	Polymer production for synthetic rubber manufacturing (see fig 1)
Worker activity description:	Three groups of workers with high potential exposure were identified for study (1) DMF process analysts sampled process lines and analyzed the products by gas chromatography at the DMF unit; (2) polymer process analysts carried out these tasks at the recovery and polymerization units; and, (3) operators at the recovery facility who carried out routine minor maintenance and, as needed, major repair operations (pg. 3/10)
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	"DMF analysts: median butadiene (ppm)=54, range=0-3090 ppm Polymerization analysts: median=6.5ppm, range=0–1078 ppm Recovery operators: median=7.0ppm, range=0– 12 000ppm" (pg. 5/10)
Exposure duration:	6 hour shift (pg. 3/10)
Exposure frequency:	"Exposed Males: 8.6+-6.1 years Exposed Females: 6.5+-5.5 years" (pg. 3/10)
Number of workers:	50000 in the US and 30000 in Europe (pg. 2/10)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for polymer production for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sections of the plant, and taking multiple samples.

Overall Quality Determination High

Study Citation:	Hayes, R. B., Zhang, L., Yin, S., Swenberg, J. A., Xi, L., Wiencke, J., Bechtold, W. E., Yao, M., Rothman, N., Haas, R., O'Neill, J. P., Zhang, D., Wiemels, J., Dosemeci, M., Li, G., Smith, M. T. (2000). Genotoxic markers among butadiene polymer workers in China. Carcinogenesis 21(1):55-62.
HERO ID:	5586518
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	DMF process analysts sample process lines and analyze the product by GC in the DMF unit. Polymer process analysts carry out these tasks in the recovery and polymerization units. A third group of workers were process operators at the recovery facility who do minor routine maintenance.
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	"Polymer analysts: 1.0 ppm median DMF analysts: 3.5 ppm median Recovery analysts: 1.1 ppm median Recovery operators: 45 ppm median"
Exposure duration:	6 hours
Number of workers:	65,000 US workers annually.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for polymers used in plastics and rubbers, and in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, ranges, means, standard deviations, and P-values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different locations and worker activities in the plant.

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
Conditions of Use:	Consumer Uses

EXTRACTION

Parameter	**Data**
Worker activity description:	cigarette smoke in the workplace
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	0.57 micrograms/m^3 in non-smoking workplaces, 1.18 micrograms/m^3 in smoking workplaces. Table 5
Exposure duration:	nan
Number of workers:	104
Comments:	See page 163 (document) for participants/workers information.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIST guidelines were followed.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	Medium	Report is similar to an occupational scenario, but very vague in what occupations are included.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Samples are fully characterized with a full range of statistics for each chemical analyzed.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most metadata included, but missing a few categories.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability shown in statistics, but not explained.

Overall Quality Determination Medium

Study Citation:	Heikkilä, P., Riala, R., Hämeilä, M., Nykyri, E., Pfäffli, P. (2002). Occupational exposure to bitumen during road paving. AIHA Journal 63(2):156-165.
HERO ID:	1942700
Conditions of Use:	Use in road paving (see comments)

EXTRACTION

Parameter	**Data**
Life cycle description:	Asphalt Emulsion Coating
Worker activity description:	Paving machine operator, screed operator, rakerman, roller driver, technicians, traffic controllers, adhesive sprayer, surface dressing worker, mastic paver, heating machine operator, foreman, lorry driver
Exposure route:	Inhalation, Dermal
Physical form:	Vapor
Personal sampling data:	Butadiene was below the detection limit of 0.1 mg/m3
Exposure duration:	0.5-4 hours
Comments:	It is not clear how many workers could be exposed to paving mixtures that actually contain BD, one quote states ”Bitumen road paving is an extensive industry involving nearly 300,000 workers in the United States.”QC note: COU was originally listed as ”Consumer Uses” and changed to ”Use in road paving”, not sure which COU this best falls into. BD only appears to be added to the paving mixture some of the time for a specific purpose that is not clear.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Study is from Finland an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data was collected in 1992-1996
	Metric 5:	Sample Size	High	Distribution of samples is characterized well with statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.

Overall Quality Determination High

Study Citation:	Heseltine, E., Peltonen, K., Sorsa, M., Vainio, H. (1993). Assessment of the health hazards of 1,3-butadiene and styrene. Meeting report. Journal of Occupational Medicine 35(11):1089-1095.
HERO ID:	200013
Conditions of Use:	Manufacturing, Processing, Commercial Use

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	Monomer industry: mean 5.9ppm, GM 0.5ppm... Polymer industry: mean 1.1ppm, GM 0.1ppm (occasional peaks exceeded 200ppm for both polymer and monomer industries)... Not detected in samples taken from end-user industries

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and polymer production, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average and geometric mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Himmelstein, M. W., Acquavella, J. F., Recio, L., Medinsky, M. A., Bond, J. A. (1997). Toxicology and epidemiology of 1,3-butadiene. Critical Reviews in Toxicology 27(1):1-108.
HERO ID:	7418
Conditions of Use:	Manufacturing and Processing (Polymerization)

EXTRACTION

Parameter	**Data**
Worker activity description:	Loading/unloading, transfer, and recovery of butadiene monomer, lab sampling, and production and maintenance activities
Exposure route:	Inhalation
Physical form:	vapor
Personal sampling data:	>10 ppm for both monomer and polymerization facilities (page 6) nd-495 ppm (based on various sampling years, plant types, and job category (see Table 3)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	OSHA Data
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Low	Data not well characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	No metadata but does provide data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	No variability or uncertainty discussed.

Overall Quality Determination Medium

Study Citation:	IARC, (2012). Chemical agents and related occupations: A review of human carcinogens.
HERO ID:	1104286
Conditions of Use:	Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Current exposure estimates in North America and western Europe generally below 2mg/m3 (pg. 328/628) ; Table 4.1, pg. 572/628: workers in butadiene production plant had 8hr PBZ sample exposures of 3.5 +- 7.25 ppm
Area sampling data:	Table 4.1, pg. 572/628: 0.30 +- 0.59, 0.21 +- 0.21, and 0.12 +- 0.27 ppm for high, intermediate, and low exposure areas
Number of workers:	52,000 workers in the United States in 1981-1983 OES (pg. 328/628) From Table 1.1, pg. 328/628: 1990-1993 based on CAREX database EU workers exposed in Top 10 industries: 8300 in manufacture of industrial chemicals; 7100 in manufacture of rubber products; 7000 in manufacture of plastic products not elsewhere classified, 2200 in petrol refineries; 1600 in construction; 1300 manufacture of other chem products; 700 education services; 700 manufacture transport equip; 600 in wholesale/reatil trade and restaurants and hotels; 500 in manufacture of machinery (TOTAL is 31,600 EU workers)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from IARC, which includes OECD countries.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	IARC, (1986). 1,3-Butadiene. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, vol. 39 :155-179.
HERO ID:	1161949
Conditions of Use:	Processing: Manufacturing synthetic rubber and plastics

EXTRACTION

Parameter	**Data**
Worker activity description:	Tank car loaders/unloaders, vessel cleaners, reactor operators, stripping-column operators, coagulation operators, dryer operators, baler and packing operators, warehouse men, lab analysts, maintenance men, foremen and leadmen, and waste treatment workers.
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	Table of occupational exposure measurements in the Polymer Plants and in the rubber and plastic industry are included in the report in Table 2 and Table 3 on page 8 and page 9 of the PDF. Table 2 depicts the number of personal occupational exposure measured for each work category for specific PPM ranges. Table 3 depicts concentration for various job classifications.
Area sampling data:	Tables of occupational exposure measurements in the rubber and plastic industry are included in the report in Table 3 on page 9 of the PDF. Concentrations ranged from ND- 88 mg/m^3.
Exposure duration:	8 hours/day

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for polymerization and synthetic rubber and resin production.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges, averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different job descriptions at different sites.

Overall Quality Determination High

Study Citation:	IARC, (1986). General remarks on the substances considered. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, vol. 39 39:33-36.
HERO ID:	5658496
Conditions of Use:	Manuacturing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor from volatile monomers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Only exposure route provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	Jones, R. M., Dell, L., Torres, C., Simmons, C. E., Poole, J., Boelter, F. W., Harper, P. (2015). Exposure Reconstruction and Risk Analysis for Six Semiconductor Workers With Lymphohematopoietic Cancers. Journal of Occupational and Environmental Medicine 57(6):649-658.
HERO ID:	3420798
Conditions of Use:	Commercial use

EXTRACTION

Parameter	**Data**
Personal sampling data:	monitoring at semiconductor facilities did not identify detectable concentrations (LOD between 0.04 to 0.05ppm as 8hr TWA)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	Medium	Data are for industrial-related OES in manufacturing, which may be similar to the in-scope occupational scenario for commercial uses of butadiene.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Worker activity description:	Ambient air in homes, department stores, libraries, restaurants, pubs, coach and train stations, cinemas, perfume shops, heavily trafficked roadside locations, and inside buses, trains, and automobiles.
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	”All Homes: 1.1+-1.9 ug/m3 Offices: 0.3+-0.2 ug/m3 Restaurants: 1.5+-0.8 ug/m3 Pubs: 3.0+-2.0 ug/m3 Department stores: 0.6+-0.4 ug/m3 Cinemas: 0.6+-0.3 ug/m3 Perfume shops: 0.9+-0.1 ug/m3 Libraries: 0.4+-0.2 ug/m3 Labs: 0.2+-0.1 ug/m3 Train stations: 2.2+-1.7 ug/m3 Coach stations: 0.9+-0.7 ug/m3 Along roads:1.8+-0.9 ug/m3 Inside cars: 7.9+-4.7 ug/m3 Inside trains: 1.0+-0.6 ug/m3 Inside buses:1.7+-0.9 ug/m3 Outdoor homes: 0.3+-0.2 ug/m3 Non-smoking homes: 0.5+-0.3 ug/m3 Smoking homes: 1.7+-2.5 ug/m3”
Exposure duration:	nan
Exposure frequency:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data is from the United Kingdom, an OECD country.
Metric 3:	Applicability	Low	Data are non-occupational and for ambient air, which is similar to the in-scope occupational scenario for workers who perform tasks in these environments.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, standard deviations, maximums, ratios) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by collecting samples at 15 locations.

Overall Quality Determination Medium

Study Citation:	Krishnan, E., Ungers, L., Morelli-Schroth, P., Fajen, J. (1987). Extent of exposure study: 1,3-butadiene monomer production industry.
HERO ID:	6558315
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	quality control sampling activities, laboratory analysis, pump maintenance and seal changing activities, process area pump alleys, control room operations, tank farm operations, and transportation vehicle loading activities.
Exposure route:	inhalation
Personal sampling data:	Control Room Tech: 0.09+-8.01 ppm Process Area Tech: 0.64+-4.30 ppm Rail Car Loading Tech: 1.00+-8.46 ppm Tank Truck Loading Tech: 1.02+-9.38 ppm Lab Tech: 0.40+-4.36 ppm Cylinder Voiding Lab Tech: 7.46+-33.58 ppm Maintenance Tech: 0.21 ppm Tank Farm Tech: 0.20+-4.75 ppm
Area sampling data:	Pump Alley: 0.31+-2.98 ppm Control Room: 2.13 ppm Rail Car Terminal: 1.77+-9.36 ppm Tank Truck Terminal: 0.24+-4.01 ppm Lab: 0.21+-6.14 ppm Tank Farm: 2.12+-8.36 ppm Ambient Air: 0.04+-3.14 ppm
Exposure duration:	8 hour and 12 hour rotating shifts
Number of workers:	815 at Plant A, 330 at Plant B, 3200 at Plant C, and 7000 at Plant D
Personal protective equipment:	The safety program requires that hard hats and safety glasses be worn in the process areas. Rubber gloves are required for QC sampling, and laboratory personnel must wear both gloves and protective aprons during chemical handling operations. Scott Air-Packs and Norton 7500 half-face organic vapor respirators are available for emergency use. Showers and a central clothing! changing area is provided. Smoking is prohibited in the production area because of the explosion hazard of 1,3-butadiene.
Engineering control:	”A. Leak prevention from pumps at 1,3-butadiene monomer facilities is accomplished through the use of various types of seals which isolate the interior of the pump from the atmosphere. B. A QC program typically requires workers to perform three major tasks: 1) collection of 1,3-butadiene samples using sampling cylinders or ””bombs””, 2) laboratory analysis of the samples, and 3) purging/cleaning of the sampling cylinders. Each task has individual controls associated with it. C. The transportation of crude C4 feedstock and 1,3- butadiene product to and from the monomer production facilities is accomplished using four transfer methods: pipelines, rail tank cars, tank trucks, and marine vessels. Of these methods, only pipeline transfer (which is a totally enclosed system) represents a situation where no exposure to or release of 1,3-butadiene occurs.”

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			

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Study Citation:	Krishnan, E., Ungers, L., Morelli-Schroth, P., Fajen, J. (1987). Extent of exposure study: 1,3-butadiene monomer production industry.
HERO ID:	6558315
Conditions of Use:	Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling various job areas at 4 different plants.

Overall Quality Determination — High

Study Citation:	Lee, N., Lee, B. K., Jeong, S., Yi, G. Y., Shin, J. (2012). Work environments and exposure to hazardous substances in Korean tire manufacturing. Safety and Health at Work 3(2):130-139.
HERO ID:	1641552
Conditions of Use:	Processing (rubber tire manufacture)

EXTRACTION

Parameter	**Data**
Worker activity description:	Compounding, extrusion, curing, and production management.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Table 6, pg. 5/10: No butadiene detected with LOD of ??? μg/sample (The text at the top of pg. 5 says the LOD is 0.15 but the footnote below Table 6 says 0.53)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Korea, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data was collected in 2007.
	Metric 5:	Sample Size	High	Statistics are fully characterized with means, ranges, and regression values.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.

Overall Quality Determination High

Study Citation:	Legator, M. S. (1996). Underestimating risk for three important human carcinogens: Vinyl chloride, benzene, and butadiene. Journal of Clean Technology and Environmental Sciences 5(3):199-205.
HERO ID:	5643588
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	This report cites a study in which workers were exposed to 1-3 ppm of butadiene.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for ”occupational exposure” but don’t specify an industry or workplace.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Exposure route and sampling concentrations provided but missing all other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty and variability of the correlation between animal and human data are discussed, but uncertainty and variability of the occupational measurements aren’t addressed.

Overall Quality Determination Medium

Study Citation:	Legator, M. S., Au, W. W., Ammenheuser, M., Ward, J. B. (1993). Elevated somatic cell mutant frequencies and altered DNA repair responses in nonsmoking workers exposed to 1,3-butadiene. IARC Scientific Publication No. 127 127:253-263.
HERO ID:	2966425
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Workers exposed to levels of 1-3ppm
Area sampling data:	long-term area samples indicated exposures in production areas at or below 1ppm... several samples that raised the average were in enclosed spaces such as chromatograph rooms... Exposure levels in control room area average 0.03ppm
Number of workers:	1990 study estimated about 65,000 workers potentially exposed to 1,3-BD... this study looked at exposures for 10 production and non-production area workers at BD plant

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency or specific worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Lemen, R. A., Meinhardt, T. J., Crandall, M. S., Fajen, J. M., Brown, D. P. (1990). Environmental epidemiologic investigations in the styrene-butadiene rubber production industry. Environmental Health Perspectives 86(0):103-106.
HERO ID:	200000
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	Plant A: mean 1.24ppm, SD 1.20ppm, range 0.11-4.17ppm... Plant B: mean 13.50ppm, SD 29.90ppm, range 0.34-174ppm

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and synthetic rubber production, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range, mean, SD, and number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Lovreglio, P., Bukvic, N., Fustinoni, S., Ballini, A., Drago, I., Foà, V., Guanti, G., Soleo, L. (2006). Lack of genotoxic effect in workers exposed to very low doses of 1,3-butadiene. Archives of Toxicology 80(6):378-381.
HERO ID:	2965136
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Petrochemical plant workers and administrative personnel as controls.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	”Control group: 0.8+-1.1 µg/m3 Exposed workers: 6.4+-14.0 µg/m3 Non-smokers: 2.0+-4.2 µg/m3 Smokers: 7.7+-18.0 µg/m3”
Exposure duration:	8 hours
Number of workers:	53
Comments:	See Table 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is approved by a health and safety executive
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, medians, ranges, standard deviations, and p-values given.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Issues with the study and potential confounding discussed in conclusion.

Overall Quality Determination — High

Study Citation:	Lovreglio, P., Bukvic, N., Fustinoni, S., Ballini, A., Drago, I., Foà, V., Guanti, G., Soleo, L. (2003). 613 Chromosomal aberration (CA) and sister chromatid exchange (SCE) frequencies in workers exposed to very low doses of 1,3-butadiene. Toxicology Letters 144:s164-s165.
HERO ID:	5571917
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers at a butadiene production and polymerization plant
Personal sampling data:	”Exposed workers: 0.18- 69.03 µg/m3 Control group: 0.05- 3.8 µg/m3”
Number of workers:	27

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for polymerization processes, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing physical form, exposure route, number of samples, exposure duration and frequency, engineering controls, PPE, and particle size.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Lynch, J. (2001). Occupational exposure to butadiene, isoprene and chloroprene. Chemico-Biological Interactions 135-136:207-214.
HERO ID:	5571990
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	"Czech BD plant: Control group: 0.012 ppm Monomer production: 0.292 ppm Polymer production: 0.800 ppm NIOSH Data: Reactor group: 4 ppm Finishing group: 0.5 ppm Laboratory group: 7 ppm"
Number of workers:	325
Engineering control:	"-Dry connectors are used on hoses for transfer operations from tank cars and tank trucks. -Double mechanical pump seals and improved valve packings have been installed. -Reactors, towers and drums can now be cleaned with high-pressure water systems mostly eliminating the need for workers to enter the vessels. -improved process control has reduced fouling and unwanted polymerization so that vessels are cleaned less frequently, and there is less frequent filter changing -A better level of control on draw-off from drums reduces the amount of monomer released. -better sampling techniques such as closed loop sampling reduce the exposure of laboratory technicians and general releases in the plant. -better polymer stripping results in less monomer in latex, finishing and in fouled towers and less exposure for users."
Comments:	See page 210 for workers info.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for polymerization for synthetic rubber, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, maximum, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker description, particle size, exposure duration and frequency, number of workers, and PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by pulling data from various reports to supplement data, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Ma, H., Wood, T. G., Ammenheuser, M. M., Rosenblatt, J. I., Ward, J. B. (2000). Molecular analysis of hprt mutant lymphocytes from 1, 3-butadiene-exposed workers. Environmental and Molecular Mutagenesis 36(1):59-71.
HERO ID:	2989204
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation (page 1 of 13)
Physical form:	colorless, flammable gas (page 1 of 13)
Personal sampling data:	12 workers had exposure above 0.25 ppm and ranged from 0.25-20.80 ppm (page 3 of 13).
Exposure duration:	8 hours/day, 5 days/week (page 3 of 13).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Method is described fully and approved by a university.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data is from USA.
	Metric 3: Applicability	Medium	Report discusses occupational exposure briefly, but the majority of the report focuses on gene mutations and biology.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5: Sample Size	Medium	Only a range is provided for exposure concentrations of butadiene.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Some metadata provided.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty not addressed in terms of butadiene exposure.

Overall Quality Determination Medium

Study Citation:	MAK-Commission, (2012). 1,3-Butadiene [MAK value documentation, 2001]. :51-70.
HERO ID:	9493518
Conditions of Use:	Synthetic Rubber Production

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Gas
Personal sampling data:	In the 1940s the exposure levels averaged about 6 ml/m3; in the subsequent decades they were continually reduced (1950–1959: 5 ml/m3; 1960–1969: 3 ml/m3; 1970–1979: 2 ml/m3; 1980–1989: 1 ml/m3; after 1990: 0.8 ml/m3). For certain workplaces average levels of 29 ml/m3 with peak values up to 10000 ml/m3 were given (Macaluso et al. 1996).In another factory in which styrene-butadiene synthetic rubber was produced, the incidence of HPRT mutations was increased in the lymphocytes of smokers and non-smokers exposed to butadiene levels between 0.25 and 1 ml/m3 (Ward et al. 1996).
Number of workers:	The mortality of 15649 men who had been employed for at least one year in one of eight factories producing synthetic rubber was investigated. 75% of the employees were exposed to1,3-butadiene.
Comments:	Exposure data is cited from another source.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified in report. Details may be provided in the referenced monitoring study.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected over 20 years ago.
	Metric 5:	Sample Size	Low	Average values given with no sample statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Worker activity details, exposure durations, exposure frequency, and other critical metadata are not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	MAK-Commission, (2012). 1,3-Butadiene [MAK value documentation, 2001]. :51-70.
HERO ID:	9493518
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Gas
Personal sampling data:	The authors make no statement as to the absolute exposure levels. In the publication, however, relative levels of exposure are given. As basis the time from 1986–1994 was used. For the period before 1986 the following factors were given: 1977–1985: exposure factor 2; 1960–1976: factor 4; 1946–1959: factor 8; before 1946: factor 10 and higher. (Divine and Hartmann, 1996)
Comments:	Exposure data is cited from another source.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified in report. Details may be provided in the referenced monitoring study.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected over 20 years ago.
	Metric 5:	Sample Size	Low	Average values given with no sample statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Worker activity details, exposure durations, exposure frequency, and other critical metadata are not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	MAK-Commission, (2012). 1,3-Butadiene [MAK value documentation, 2001]. :51-70.
HERO ID:	9493518
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Gas
Personal sampling data:	The average 1,3-butadiene concentration in the factory was given as 3.5 ml/m3; however, most persons were exposed to 1 ml/m3. The actual exposure levels for the persons who were examined are unclear. 23 male workers who had been employed in another factory for 15.3 ± 10.5 years and were on average 37.8 years old (controls 38.1 years). The assayed exposure levels were 1.8 ± 2.8 ml/m3 (43% of the values were below 1 ml/m3). [Sorsa 1996]
Comments:	Exposure data is cited from another source.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified in report. Details may be provided in the referenced monitoring study.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected over 20 years ago.
	Metric 5:	Sample Size	Low	Average values given with no sample statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Worker activity details, exposure durations, exposure frequency, and other critical metadata are not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	Matanoski, G., Francis, M., Correa-Villasenor, A., Elliot, X., Santos-Burgoa, C., Schwartz, L. (1993). Cancer epidemiology among styrene-butadiene rubber workers. IARC Scientific Publication, No. 127 Assessment of Health Hazards(127):363-374.
HERO ID:	51500
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	average, SD, and range given for each sampling study; overall average: 7.96ppm overall SD: 53.96ppm

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD, number of samples, range, and geometric mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Meinhardt, T. J., Lemen, R. A., Crandall, M. S., Young, R. J. (1984). Mortality and industrial hygiene study of styrene-butadiene rubber workers. NIOSH Collaborative Workshop:57-86.
HERO ID:	2971454
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	Mean concentrations of butadiene at two sites were 1.24 and 13.50ppm.
Exposure frequency:	at least 6 months of employment
Number of workers:	2756

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 2 separate facilities.

Overall Quality Determination High

Study Citation:	Meinhardt, T. J., Young, R. J., Hartle, R. W. (1978). Epidemiologic investigations of styrene-butadiene rubber production and reinforced plastics production. Scandinavian Journal of Work, Environment and Health 4 Suppl 2:240-246.
HERO ID:	2975722
Conditions of Use:	Processing synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Job classification given for each exposure
Personal sampling data:	Summary table of employees' 8hr TWAs from April 1977 based on job classification; provides range, mean, median, number of samples, and TWA; mean for each job classification given below: Tech services personnel - 19.85ppm... Production foreman - 1.16ppm... Head production operator - 15.50ppm... Production operator - 3.30ppm... Operator helper - 0.79ppm... Pipefitter - 0.74ppm... Electrician - 0.22ppm... Maintenance/mechanic - 3.15ppm... Carpenter - 7.80ppm... Common laborer - 1.52ppm... Instrument man - 58.62ppm
Comments:	See Table 3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old. Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (number of samples, min, max, mean, median, TWA) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Melnick, R. L., Shackelford, C. C., Huff, J. (1993). Carcinogenicity of 1,3-butadiene. Environmental Health Perspectives 100(0):227-236.
HERO ID:	646923
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Highest exposures from industrial hygiene survey were in operations involving decontamination and maintenance of process equipment, sampling and analyzing quality control samples, and loading or unloading tank trucks or rail cars.
Personal sampling data:	industrial hygiene survey showed exposures generally less than 10ppm; several maximum 8hr TWAs and short-term exposures were between 10 and 150ppm, with one sample as high as 374ppm
Number of workers:	5,200 workers potentially exposed to BD in the United States, based on NOES (Note: typo in source showed ”52,00” and assumed misplacement of comma)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Musak, L., Soucek, P., Vodickova, L., Naccarati, A., Halasova, E., Polakova, V., Slyskova, J., Susova, S., Buchancova, J., Smerhovsky, Z., Sedikova, J., Klimentova, G., Osina, O., Hemminki, K., Vodicka, P. (2008). Chromosomal aberrations in tire plant workers and interaction with polymorphisms of biotransformation and DNA repair genes. Mutation Research: Fundamental and Molecular Mechanisms of Mutagenesis 641(1-2):36-42.
HERO ID:	628501
Conditions of Use:	Commercial rubber tire manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	mixing operation department, pressing department, inner tube press operation department; occupations as calenders, extruder operators, dump and knead workers, confectioners, and inner tube repairers
Personal sampling data:	mean+/-SD... Mixing operation dep: 2.6+/-0.2 mg/m3... Pressing dep: 2.3+/-2.2 mg/m3 ... Inner tube press operation dep: values ranged from 0.1 to 1.2 mg/m3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Slovak Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for rubber tire manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and/or ranges for each department) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure length or frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1993). NTP technical report on the toxicology and carcinogenesis studies of 1,3-butadiene (CAS no. 106-99-0) in B6C3F1 mice (inhalation studies).
HERO ID:	5160111
Conditions of Use:	Domestic manufacturing, Processing as a reactant

EXTRACTION

Parameter	**Data**
Worker activity description:	operations involving decontaminating and maintaining process equipment, sampling and analyzing QC samples, loading/unloading tank trucks or rail cars (pg. 16/389)
Personal sampling data:	less than 10ppm in most process areas; frequently between 10 to 150ppm for maximum 8hr-TWA; one 8hr-TWA was 374 ppm (pg. 16/389)
Number of workers:	52,000 workers exposed annually based on 1990 study (pg. 16/389)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1999). NTP report on carcinogens background document for 1,3-butadiene.
HERO ID:	5160135
Conditions of Use:	Manufacturing, Processing, Commercial uses

EXTRACTION

Parameter	**Data**
Worker activity description:	tank farm operator, maintenance technician, lab technician, process technician (pg. 11/143)
Personal sampling data:	Swedish petrochemical plant: average 5.06 +/- 8.41ppm for handling BD containers....Arithmetic mean exposure for personal full-shift exposure in polymer plants was 1.14ppm (1993) (pg. 11/143)
Area sampling data:	NIOSH studies personal or area full-shift: 5 job areas with potentially higher exposure including maintenance tech (0.026-94.38mg/m3), loading (0.17-273mg/m3), tank farm (0.02-52.8mg/m3), process (<0.011-76.78mg/m3), and laboratory (<0.0132-822.8mg/m3). (pg. 11/143)
Number of workers:	NIOSH study estimated 51,971 workers for 1981-1983 (Table 2-1, pg. 12/143 gives full breakdown by industry)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, number of samples.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fifteenth edition: 1,3-butadiene.
HERO ID:	5160138
Conditions of Use:	Manufacturing, Processing, Commercial uses

EXTRACTION

Parameter	**Data**
Personal sampling data:	In most cases, 8hr TWAs for butadiene are less than 10ppm for monomer, polymer and end-use plants NIOSH HHEs at six facilities found air concentrations ranging from 0.06 to 39ppm; gives range of samples <1ppm, 1-2ppm, 2-10ppm, and >10ppm
Number of workers:	52,000 workers exposed annually based on 1990 study; does not include workers exposed to butadiene polymers and copolymers similar study in 1972-1974 showed 66,000 to 70,000 workers
Comments:	See page 2.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, number of samples.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Neumann, H. G., Albrecht, O., Dorp, van, C., Zwirner-Baier, I. (1995). Macromolecular adducts caused by environmental chemicals. Clinical Chemistry 41(12 Pt 2):1835-1840.
HERO ID:	4264907
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	An exposed group and one control group of individuals from a BD production plant (page 2 of 6)
Area sampling data:	external exposures averaging 1 ppm (page 2 of 6)
Number of workers:	43 (from figure 2 on page 2 of 6)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for BD monomer and polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by using two control groups and discussing potential causes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.
HERO ID:	1976942
Conditions of Use:	Manufacturing and processing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Environmental sampling conducted at the time of the study characterized the most likely chemical exposures to be1,3-butadiene, styrene, and benzene . Average exposure concentrations of 1,3-butadiene in the two facilities were 1.24 ppm (range, 0 .11-4 . 17 ppm) and 13.5 ppm (range , 0 . 34-174 ppm).
Number of workers:	Approximately 65,000 workers (Table 2) are potentially exposed to 1,3-butadiene as estimated from data compiled from the National Institute for Occupational Safety and Health (NIOSH) National Occupational Hazard Survey (NOHS) [5]. Table 2 breaks down the number of workers into SIC codes.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the US
	Metric 3:	Applicability	High	The data are for manufacturing and processing, which is in scope
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old, but it is unknown when the PEL was last updated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	No metadata is provided beyond the implication that it is personal breathing zone.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	NIOSH, (1988). The determination of 1,3-butadiene in workplace air: Reevaluation of NIOSH method S91 and development of NIOSH method 1024.
HERO ID:	2075005
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	In NIOSH Method 1024,air volumes up to 25 L may be sampled, permitting quantitation of full-shift exposures ranging from 0.4 to 10 ppm. The range may be extended up to 100 ppm by diluting desorbed samples.
Area sampling data:	In NIOSH Method S91, a lower quantitation limit of 3.4 ppm was indicated.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for detection methods of butadiene in the butadiene monomer industry, which is similar to monomers used in polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, efficiencies, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparing two measurement methods.

Overall Quality Determination High

Study Citation:	NIOSH, (1984). Current intelligence bulletin 41, 1,3-butadiene.
HERO ID:	62350
Conditions of Use:	Processing as a reactant, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	See Table 2 for a list of various industries in which workers are exposed, the biggest being chemical and allied production, rubber and plastics products, and miscellaneous business services (page 8 of 22)
Personal sampling data:	According to a NIOSH survey of six facilities the range of reported exposures was 0.06 ppm and 39 ppm. See document for the types of facilities in this study, which included mostly rubber and plastic product manufacturing (page 8 of 22). In another study of two SRB production facilities in the US the average exposure concentrations was 1.24 ppm (with range of 0.11-4.17 ppm) and 13.5 ppm (range of 0.34-174 ppm) (page 11 of 22).
Number of workers:	65,000 workers are potentially exposed to 1,3-butadiene. See table 2 for a breakdown of workers exposed by industry. (page 8 of 22)
Comments:	Data from cited HHEs and peer-reviewed articles, which [6-11]: 6307493/2971532, 1009699, HHE 77-114-529, 1317911, 6307491/ 1009700, HHE 79-36-656, 62365.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	In the US
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1981). In-depth industrial hygiene composite report on exposure to styrene and butadiene at two styrene-butadiene rubber processing plants.
HERO ID:	6580285
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Operators, electricians, foremen, carpenters, cleaners, janitors, laboratory workers, machinists, lift truck drivers, maintenance workers, mechanics, welders, utility workers.
Exposure route:	inhalation
Personal sampling data:	In Plant B, fifty of the 103 personal sample "A" tubes analyzed for BD were found to have detectable levels. Sixty-six percent of these samples indicated atmospheric concentrations less than 2.0 ppm. Thirteen samples indicated concentrations between 2.0 and 50.0 ppm, and four ranged between 50.0 and 175.0 ppm. The two high samples were numbers 1 "A" and 196 "A" indicating 144.55 and 174.14 ppm respectively.
Area sampling data:	In Plant A, full-shift TWA's for BD ranged between less than 0.10 ppm and 4.82 ppm. Of the 57 TWA's, 39 were less than 1.00 ppm, 11 ranged from 1.00 to 1.99 ppm, 5 ranged from 2.0 to 3.99 ppm, while 2 were above 4.0 ppm
Number of workers:	Facility A employed 650 workers, 200 of whom were in management, and facility B employed 475, with 115 of these in management.
Comments:	See Table 5 and 111-3 of Appendix III

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided)
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by taking different types of samples at two plants.

Overall Quality Determination High

Study Citation:	NIOSH, (1973). Health hazard evaluation: Gates Rubber Company.
HERO ID:	8689109
Conditions of Use:	Synthetic rubber manufacturing (braided hose)

EXTRACTION

Parameter	**Data**
Worker activity description:	Exposure to the employees would result from vaporization of chemicals coming from the fibers that have been pre-treated. The chemical containers, where the fibers pass through and are coated with the numerous formulations, are closed and are located on the floor. Any exposure coming from the tanks or from the treated fibers would have been collected on the breathing zone samples of the workers involved, since these workers have to replenish the supply of-solutions in the chemical containers.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	All measurements for butadiene are ND.
Area sampling data:	All measurements for butadiene are ND.
Number of workers:	The braided hose department employing approximately 70 peopleoccupies three floors of a brick building with wooden floors.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical method are expected to be aligned with NIOSH guidance (NIOSH HHE 72-86-38).
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data collected over 20 years ago.
	Metric 5: Sample Size	High	Discrete sampling data provided, all ND.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Sampling data provided (all ND), but no additional metadata was provided.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	OEHHA, (2013). 1,3-Butadiene reference exposure levels.
HERO ID:	5099113
Conditions of Use:	Processing for petrochemical refineries, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Estimated exposures around 20ppm in 1940s and 1950s with annual trend towards average 6% drop in BD concentrations each year... exposures in 11-plant Taiwan petrochem complex study showed only 15% of values over LOD with mean low conc of 7.7ppb and mean high conc of 10.5ppb... ambient concentrations in toll booth study for Baltimore tunnel in 2001 were 3ppb... 49 workers at SBR plant separated into high and low exposure groups (exposure measured by personal badge dosimeter); average high: 1.48ppm, low: 0.15ppm

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as an intermediate or reactant, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency and duration, specific worker tasks.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ogawa, M., Oyama, T., Isse, T., Yamaguchi, T., Murakami, T., Endo, Y., , K. T. (2006). Hemoglobin adducts as a marker of exposure to chemical substances, especially PRTR class I designated chemical substances. Journal of Occupational Health 48(5):314-328.
HERO ID:	597196
Conditions of Use:	Domestic manufacturing, polymer processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	1,3-BD production: 11.2 mg/m3... Maintenance and lab workers: <1.2 mg/m3... workers in 1,3-BD monomer production: 0.44 mg/m3... workers in 1,3-BD monomer production, polymerization, and copolymerization units: 4-201 ug/m3... workers in 1,3-BD polymer production: 2ppm (6h TWA)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene monomer processing and production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided; referenced in studies highlighted.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different exposure to smokers non-occupationally, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Osterman-Golkar, S. M., Bond, J. A., Ward, J. B., Jr, Legator, M. S. (1993). Use of haemoglobin adducts for biomonitoring exposure to 1,3-butadiene. IARC Scientific Publication No. 127 127:127-134.
HERO ID:	2973385
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Chemical production plant where significant exposures to butadiene had been clearly documented (page 2 of 8).
Area sampling data:	Time-weighted average 8-h area samples showed a mean value of about 3.5 ppm, although most samples contained less than 1 ppm . Most of the samples with higher levels were collected in areas not frequented by workers, suggesting that the average exposure of workers to butadiene was less than 3.5 ppm. An environmental sampling survey indicated that exposure to butadiene in the central control area was about 0.03 ppm (page 3 of 8)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from IARC, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Osterman-Golkar, S., Peltonen, K., Anttinen-Klemetti, T., Landin, H. H., Zorcec, V., Sorsa, M. (1996). Haemoglobin adducts as biomarkers of occupational exposure to 1,3-butadiene. Mutagenesis 11(2):145-149.
HERO ID:	2970680
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers handling butadiene containers (sampling and voiding); maintenance and lab workers (page 3 of 5)
Personal sampling data:	bomb voiding and sampling activities (19 samples) had a mean of 11.2mg/m3 and a range of of up to 55.0mg/m3. FOr maintenance and lab activities (8 samples) the mean was 0.6mg/m3 and a range of up to 1.2mg/m3. The table also shows the SD, SE, and median. (See table I on page 3 of 5).
Area sampling data:	area sampling (19 samples) had a mean of 5.3mg/m3 and a range of 0.8 to 16.9mg/m3. The table also shows SD, SE and median (Table I, page 3 of 5). Concentration in central control area of around 0.03ppm (page 3 of 5).
Exposure duration:	sampled over full shift (page 2 of 5)
Number of workers:	10 workers in plant worker group; 7 workers in lab and maintenance worker group; (and 10 additional control) (page 2 of 5).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean, SD, number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by different worker activities/areas.

Overall Quality Determination — High

Study Citation:	Peltonen, K., Vaaranrinta, R. (1995). Sampling and analysis of 1, 3-butadiene in air by gas chromatography on a porous-layer open-tubular fused-silica column. Journal of Chromatography A 710(1):237-241.
HERO ID:	5553767
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing
Exposure route:	Inhalation
Physical form:	Gas
Area sampling data:	From Figure 4, range of a field study was between 0-40ppm
Exposure duration:	6-8 hours
Number of workers:	9500 workers in the US, 50000 worldwide.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing number of samples, number of sites, measurement method, worker activity, sampling location, exposure frequency, particle size, engineering controls, and PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Penn, A., Snyder, C. A. (2010). 6.27 - 1,3-butadiene and cardiovascular disease. :513-521.
HERO ID:	5697247
Conditions of Use:	Processing as a monomer, Unknown

EXTRACTION

Parameter	**Data**
Personal sampling data:	Study undertaken on Czech chemical workers in 2003 showed 8hr TWA of 0.180ppm for female workers and 0.370ppm for male workers; individual 8hr maxes were 4.45ppm for females and 5.70ppm for males... Finnish study reported in 2006 assessed 28 workers in styrene-BD copolymer production facility and only 21/885 samples exceeded 1ppm; used personal air monitors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic and Finland, OECD countries.
	Metric 3:	Applicability	High	Data are for chemical processing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max, mean, number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by exposure differences among males and females, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Peterkova, K., Peltonen, K., Sram, R. (1996). Damage of DNA after occupational exposure to 1 3-butadiene by the comet assay. Mutation Research 360(3):246.
HERO ID:	5663728
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Median of exposure for the control group was 6.5 × 10^-3 ppm (range 4.5 × 10 ^-3 to 0.16) and for the exposed subjects 0.35 ppm (range 3.3 x 10^-3 to 21).
Area sampling data:	Ambient air concentration of 1,3-BD at working place was lower than 0.5 ppm
Number of workers:	19 exposed, 19 controls

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by running an ANOVA test, and using a control group.

Overall Quality Determination Medium

Study Citation:	Pfäffli, P., Säämänen, A. (1993). The occupational scene of styrene. IARC Scientific Publications No. 127 (127):15-26.
HERO ID:	1151166
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	filling, opening, cleaning and maintenance operations
Exposure route:	inhalation
Area sampling data:	”Plant 1: TWA 10.3 ppm, range 0.2-58.6 ppm Plant 2: TWA 1.2 ppm, range 0.1-4.2 ppm Plant 3: TWA 13.5 ppm, range 0.3-174 ppm”
Exposure duration:	8 hours/day

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by providing statistics for different applications of butadiene. Uncertainty isn’t addressed.

Overall Quality Determination Medium

Study Citation:	Primavera, A., Fustinoni, S., Biroccio, A., Ballerini, S., Urbani, A., Bernardini, S., Federici, G., Capucci, E., Manno, M., Bello, Lo, M. (2008). Glutathione transferases and glutathionylated hemoglobin in workers exposed to low doses of 1,3-butadiene. Cancer Epidemiology Biomarkers and Prevention 17(11):3004-3012.
HERO ID:	5705080
Conditions of Use:	Domestic manufacturing, Processing as a monomer

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in production departments of petrochemical plant; involved in synthesis of BD monomer and production of SBR, cis-polyBD rubber, styrene-BD latex, and polyBD latex... Besides regular sampling and circuit inspections each hour, primarily remained in control centers
Personal sampling data:	Exposure levels for BD-exposed and non-exposed workers given as mean, standard deviation, median, number of samples, and range;Data distribution shown as box and whisker plotTable 2. Airborne BD levels in the three groups of subjects under studyStatistics, Foresters, Workers not exposed to BD, BD-exposed workers;Airborne BD (ug/m3)Valid n, 24, 43, 42;Mean (SD), 0.3 (0.3), 0.9 (1.0), 11.5 (35.8);Median (min-max), 0.1 (<0.1-1.0), 0.4 (<0.1-3.8), 1.5 (0.1-220.7);
Exposure duration:	8hr work shift

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3: Applicability	High	Data are for manufacturing and processing as a monomer, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (median, number of samples, min, max, mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Sample type and exposure type provided but missing identification of workers with various plant processes.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparison between BD exposed and non-exposed workers at the petrochemical plant as well as with rural workers (foresters).

Overall Quality Determination Medium

Study Citation:	Primavera, A., Fustinoni, S., Biroccio, A., Ballerini, S., Urbani, A., Bernardini, S., Federici, G., Capucci, E., Manno, M., Bello, M. L. (2008). Glutathione transferases and glutathionyl haemoglobin as biomarkers of oxidative stress in subjects exposed to low doses of 1,3-butadiene in a petrochemical plant. Toxicology Letters 180:S26-S27.
HERO ID:	5691944
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Median BD exposure was 1.5, 0.4, and 0.1 µg/m3 in BD-exposed workers, non BD-exposed workers, and controls.
Number of workers:	42 BD-exposed and 43 no BD-exposed workers of a petrochemical plant, using 82 forest guards as controls were investigated measuring personal exposure to airborne BD,

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from the Italy, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (medians) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Monitoring data indicate personal exposure, but no other metadata
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Riservato, M., Rolla, A., Davoli, E. (2004). An isotopic dilution approach for 1,3-butadiene tailpipe emissions and ambient air monitoring. Rapid Communications in Mass Spectrometry 18(4):399-404.
HERO ID:	1942367
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Physical form:	gas
Area sampling data:	A weekly average concentration of butadiene in ambient air from vehicle exhaust was 0.53ug/m3.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of fuels and related products, but also include ambient air samples.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided)
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Only area samples provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the description of the sampling and analysis method. Variability is addressed by sampling multiple vehicles and ambient air.

Overall Quality Determination — High

Study Citation:	Roper, C. P., Jr (1976). Health Hazard Evaluation Determination, Report No. 74-120-260, Goodyear Tire and Rubber Company, Gadsden, Alabama.
HERO ID:	1009699
Conditions of Use:	Processing, processing as a reactant, synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	It was suspected that some butadiene might be liberated from the nitrile rubber (page 5 of 16)
Personal sampling data:	See Table 4 on page 14 of 16. Concentration values include 1.8 and 2.1 ppm.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling done by NIOSH
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	from United States
	Metric 3:	Applicability	High	in scope, rubber manufacturing
	Metric 4:	Temporal Representativeness	Low	from 1976
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

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
Conditions of Use:	Commercial Use (fuels)

EXTRACTION

Parameter	**Data**
Worker activity description:	gasoline service station workers and temple workers
Exposure route:	inhalation
Physical form:	gas/smoke (from incense)
Personal sampling data:	Temple workers: 11.29+-1.48 ug/m3 Temple controls: 0.04+-0.004 ug/m3
Area sampling data:	Gasoline service stations, area: 0.006+-0.003 ug/m3
Exposure duration:	8 hours
Number of workers:	62 service station & petroleum workers, 40 temple workers
Comments:	The Temple workers are exposed to incense smoke, not sure if that is in scope or not?

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Thailand, a non-OECD country.
	Metric 3:	Applicability	High	Data are for butadiene exposure from fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, standard deviations, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling at multiple sites. Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Saborit, D., J.M., 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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Worker activity description:	non-occupational personal exposure
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	average concentration of 0.4 +- 0.7 µg/m3 of butadiene for all groups. Max concentration recorded was 6.3 µg/m3.
Exposure duration:	24 hours
Exposure frequency:	lifetime
Number of workers:	100

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Report mentions that three methods were used for analysis but doesn't specify what they are.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	Low	This data is from a non-occupational scenario, but can be compared to a scenario in scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	A wide range of statistics were run for the study.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Almost all metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Possible causes for variations in data explained.

Overall Quality Determination Medium

Study Citation:	Sangaraju, D., Boldry, E. J., Patel, Y. M., Walker, V., Stepanov, I., Stram, D., Hatsukami, D., Tretyakova, N. (2017). Isotope Dilution nanoLC/ESI+-HRMS3 Quantitation of Urinary N7-(1-Hydroxy-3-buten-2-yl) Guanine Adducts in Humans and Their Use as Biomarkers of Exposure to 1,3-Butadiene. Chemical Research in Toxicology 30(2):678-688.
HERO ID:	4694854
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Exposure route:	Inhalation
Physical form:	Vapor
Exposure duration:	8 hours
Exposure frequency:	4 months
Number of workers:	51

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are focus on biological and genotoxic effects of butadiene to exposed workers, which is similar to the in-scope occupational scenario of domestic manufacturing.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics (pertaining to butadiene occupational exposure).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but exposure concentration, number of samples, measurement method, number of sites, sampling location, worker activity, particle size, engineering controls, and PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed (with respect to butadiene occupational exposure).

Overall Quality Determination Medium

Study Citation:	Santos-Burgoa, C., Eden-Wynter, R. A., Riojas-Rodriguez, H., Matanoski, G. M. (1997). Living in a chemical world: health impact of 1,3-butadiene carcinogenesis. Annals of the New York Academy of Sciences 837:176-188.
HERO ID:	49714
Conditions of Use:	Manufacturing, Processing, Use

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing, Monomer used in polymerization process, Plastic and Rubber products (tires)
Worker activity description:	Describes exposure sources: final product of ethanol/acetaldehyde, olefin cracking, entire polymer production process, polymerized or trapped in bubbles in rubber in polymer user studies
Exposure route:	inhalation
Personal sampling data:	Given as concentration range for various sources (from other studies) Monomer: 0-142ppm Polymer: 0.03-374ppm
Number of workers:	Monomer: 5,000 Polymer: 52,000

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for general manufacturing, processing, and use occupational scenarios, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata (potentially included in source documents).
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Sapkota, A., Williams, D., Buckley, T. J. (2005). Tollbooth workers and mobile source-related hazardous air pollutants: How protective is the indoor environment?. Environmental Science & Technology 39(9):2936-2943.
HERO ID:	86402
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Worker activity description:	Tollbooth workers, exposure from motor vehicle emissions in the Baltimore Harbor Tunnel.
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Outdoor: 19.8 micrograms/m^3 during morning shift, 14.9 micrograms/m^3 during afternoon shift, 4.9 micrograms/m^3 during night shift Indoor: 6.7 micrograms/m^3 during morning shift, 3.2 micrograms/m^3 during afternoon shift, 2.4 micrograms/m^3 during night shift
Exposure duration:	8hr/day
Number of workers:	292
Engineering control:	Pressure control ventilation systems are equipped in 55% of tollbooths in Maryland. This accounts for the decrease in indoor concentrations.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Method is completely described and looks equivalent to an approved method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data from USA.
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old, but less than 20 years old.
Metric 5:	Sample Size	High	Samples are fully characterized with a full range of statistics like percentile values, p values, linear regressions, and standard deviations.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Almost all metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability explained and shown through analytic method, and provides limited discussion of theuncertainty

Overall Quality Determination High

Study Citation:	Sasol, (2021). Industrial hygiene risk assessment (January 21, 2021).
HERO ID:	11272631
Conditions of Use:	Reactant in the production of Butadiene via ethane cracking

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Monitoring data for Ethane Cracking Process Unit provided which I assume is area source as details for personal sampling is not provided:n=12Max concentration= 0.04Mean = 0.036Median = 0.036GM = 0.036assume the units are ppm
Exposure duration:	work shift duration 12 hrs
Number of workers:	13-16
Personal protective equipment:	noted that respiratory protection is not required.
Engineering control:	Safe design, process controls, and general ventilation

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	unknown methodology; but this appears to be part of their permit requirements
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Ethane Cracking
	Metric 4:	Temporal Representativeness	High	January 2021
	Metric 5:	Sample Size	High	Provided max, mean, median, GM, LCL95 and UCL95
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	no details were provided
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	LCL95 and UCL95 percentiles were provided to assess variance and uncertainty.

Overall Quality Determination High

Study Citation:	Sasol, (2021). Industrial hygiene risk assessment (January 26, 2021).
HERO ID:	11272632
Conditions of Use:	Disposal - offside water system

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	assume this is area sample as details typically included of for personal sampling is not provided. n=13Max = 0.039Mean = 0.035Median = 0.035GM = 0.035assume this is PPM
Exposure duration:	Work shift duration 12 hours
Number of workers:	17-20
Personal protective equipment:	noted that respiratory protection was not required
Engineering control:	Safe design, process controls and general ventilation

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	Low	No details were provided of the sampling or analytic methodology used, but this monitoring may be part of their permit.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	USA
	Metric 3: Applicability	High	Water treatment
	Metric 4: Temporal Representativeness	High	January 2021
	Metric 5: Sample Size	High	ProvidedMaxMeanMedianGMLCL95UCL95
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Only work shift hours provided
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	LCL95 and UCL95 percentiles were included which can be used to quantify variance and uncertainty.

Overall Quality Determination High

Study Citation:	Sasol, (2021). Industrial hygiene risk assessment (June 9, 2021).
HERO ID:	11272633
Conditions of Use:	processing reactant - Ethylene unit

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Assume that sampling was area as details typically included with personal sampling were not providedN=22Max = 0.041Mean = 0.036Median = 0.035GM = 0.036Assume these are PPM
Exposure duration:	12 hour work shift duration
Number of workers:	13-16
Personal protective equipment:	Noted that respiratory protection was not required
Engineering control:	Safe design, process controls and general ventilation

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Low	No details about the sampling or analytic methods used were provided
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	USA
Metric 3:	Applicability	High	Ethylene Unit
Metric 4:	Temporal Representativeness	High	June 2021
Metric 5:	Sample Size	High	ProvidedNMaxMeanMedianGMLCL95 UCL95
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Other than Work Shift duration, no other data were provided
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	LCL95 and UCL95 percentiles were provided to quantify variance and uncertainty.

Overall Quality Determination High

Study Citation:	Sasol, (2021). Industrial hygiene risk assessment (June 9, 2021 - B).
HERO ID:	11272634
Conditions of Use:	Processing reactant - QA product activities

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	assuming this is area sampling for their quality control lab as additional details related to personal sampling was not provided:n=7Max = 0.04Mean = 0.036Median = 0.035GM = 0.036assume the units are ppm
Exposure duration:	12 hour work shift
Number of workers:	more than 20
Personal protective equipment:	noted that respiratory protection is not required
Engineering control:	Safe design, general ventilation, local exhaust, lab fume hoods

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling and analytic methods not provided but it appears that this monitoring is required under their permit.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Quality control lab
	Metric 4:	Temporal Representativeness	High	June 2021
	Metric 5:	Sample Size	High	includes:MaxMeanMedianGMLCL95UCL95
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	only shift length (12 hrs) was provided
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	LCL95 and UCL95 percentiles were provided to assess variance and uncertainty.

Overall Quality Determination High

Study Citation:	Sasol, (2021). Industrial hygiene risk assessment (June 9, 2021 - D).
HERO ID:	11272635
Conditions of Use:	Processing reactant - ethylene steam unit

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Area sampling data:	Assumed area source as did not include details typically provided for personal sampling:n= 11Max = 0.096Mean = 0.046Median = 0.036GM 0.043assume units are ppm
Exposure duration:	12 hour work shift
Number of workers:	9-12
Personal protective equipment:	Noted respiratory protection not required
Engineering control:	Safe Design, process controls, and general ventilation

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	sampling and analytic methods not provided, but monitoring requirement seems to be part of their permit.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	High	Ethylene Steam unit
	Metric 4:	Temporal Representativeness	High	June 2021
	Metric 5:	Sample Size	High	included:NMaxMeanMedianGMLCL95UCL95
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	only work shift duration was provided
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	included LCL95 and UCL95 percentiles to quantify variance and uncertainty.

Overall Quality Determination High

Study Citation:	Sathiakumar, N., Delzell, E., Cheng, H., Lynch, J., Sparks, W., Macaluso, M. (2007). Validation of 1,3-butadiene exposure estimates for workers at a synthetic rubber plant. Chemico-Biological Interactions 166(1-3):29-43.
HERO ID:	4142022
Conditions of Use:	Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Tank farm operators, reactor operators, recovery operators (each is a job in the polymerization area of the plant); also finishing operator, coagulation operator, dryer operator, baler operator, etc. (Page 4 of 15)
Personal sampling data:	Table 3 on page 7-8 of 15, for each job title, provides number of measurements, range of years when samples were taken, range of measurement values, mean, std dev, and median.Table 4 on page 9 of 15 also provides overview of sample results for each year 1977-1991. Table 5 on page 9 shows the mean (standard deviation, S.D.) and medians of measurements and estimates, by job category. In this table the total overall mean value of BD measurements was stated to be 5.2ppmSeveral other tables describing characteristics of the data, along with text description, are found throughout the study.
Number of workers:	Several epidemiologic investigations have evaluated the mortality experience of workers in the North American synthetic rubber industry One study included over 17,000 men potentially exposed to 1,3-butadiene (BD) and other chemicals at eight synthetic rubber plants. (page 2 of 15)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is nearly fully characterized (range of years sampled, number of samples taken, range of values, mean, median, standard deviation).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by change over years, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Scarselli, A., Corfiati, M., Marzi, Di, D., Iavicoli, S. (2017). Appraisal of levels and patterns of occupational exposure to 1,3-butadiene. Scandinavian Journal of Work, Environment and Health 43(5):494-503.
HERO ID:	4140715
Conditions of Use:	Domestic Manufacturing, Processing, Commercial use

EXTRACTION

Parameter	**Data**
Worker activity description:	Multiple including, but not limited to, extraction of crude petroleum and natural gas, chemists, building structure cleaners, manufacture of rubber and plastic products, motor vehicle mechanics and fitters, etc.... category identified as most at risk was molding activities among plastic product machine operators
Physical form:	colorless gas
Personal sampling data:	Comprehensive table splitting into different occupational groups and giving number of samples, arithmetic and geometric mean, arithmetic and geometric standard deviation, median, and interquartile range for each occupational group... overall mean exposure to 1,3-BD was 0.12 mg/m3; StDev: 0.37 mg/m3; IQR: 0.007-0.097 mg/m3
Number of workers:	OSHA estimate in 1980s was 52,000 US workers exposed to 1,3-BD
Comments:	Labeled as Personal Sampling data, but includes both Personal and Area data mixed together.Table 1. Distribution of mean levels of 1,3-butadiene exposure with variability metrics by activity sector and occupational group.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for various in-scope occupational scenarios including processing and commercial use.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (number of samples, arithmetic and geometric mean, arithmetic and geometric standard deviation, median, and interquartile range).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by changes over time and various worker groups.

Overall Quality Determination Medium

Study Citation: Shimek, M., J.A. (2010). Occupational chemical exposure assessment in a brain cancer case-control study.
HERO ID: 5718484
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Worker activity description:	See page 184-221 for tables that list jobs with possible 1,3-butadiene exposure (1,3-butadiene is number 11 on these tables)
Exposure route:	inhalation (page 51 of 299)
Physical form:	gas (page 50 of 299)
Area sampling data:	2.7 ppm average between all exposed study participants (page 52 of 299, see page 52 for a summary of an IH survey of 1,3-butadiene in the mid-80s)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for a wide variety of jobs, but all are within scope in terms of occupational exposure.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling people in a large variety of occupations.

Overall Quality Determination High

Study Citation: Simonds, M. A. (1993). Evaluation of the role of fixed beam open path Fourier transform infrared spectroscopy in air monitoring strategies.
HERO ID: 5700365
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Worker activity description:	Exposure source is a filter process building adjacent to an acrylonitrile, 1,3-butadiene, and styrene (ABS) polymer process building
Exposure route:	inhalation
Area sampling data:	22 runs were performed, concentrations of butadiene ranged from 0.07-0.40 ppm
Personal protective equipment:	Respirators were required in the area where sampling occurred.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for a laboratory technique to monitor air conditions, which is applied to the occupational scenario of butadiene polymer processing.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges and graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology, but variability isn't addressed.

Overall Quality Determination Medium

Study Citation:	Sittert, Van, N. J. (2000). Biomarkers of Exposure to 1,3-Butadiene as a Basis for Cancer Risk Assessment. Toxicological Sciences 56(1):189-202.
HERO ID:	1327875
Conditions of Use:	Processing: Manufacturing synthetic rubber and plastics

EXTRACTION

Parameter	**Data**
Worker activity description:	SBR plant workers.
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	Manufacture of SBR: 0.82 ppm
Exposure duration:	8 hours
Exposure frequency:	60 days
Number of workers:	58 exposed workers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from OECD countries.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges, medians) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making multiple visits to the testing site and including control group.

Overall Quality Determination Medium

Study Citation:	Sittert, Van, N. J. (2000). Biomarkers of Exposure to 1,3-Butadiene as a Basis for Cancer Risk Assessment. Toxicological Sciences 56(1):189-202.
HERO ID:	1327875
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Loading of BD in ships and rail tankers, monomer production workers.
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	Truck Loading: 0.95 ppm Ship Loading: 3.7 ppm Manufacture of BD Monomer: 0.29 ppm
Exposure duration:	8 hours
Number of workers:	44 workers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from OECD countries.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges, medians) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most associated metadata, including sample types, exposure types, sample durations, exposure durations, worker activities, but not exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making multiple visits to the testing site and including different activities.

Overall Quality Determination Medium

Study Citation:	Sittert, Van, N. J., Vliet, Van, N., E.W. (1994). Monitoring occupational exposure to some industrial chemicals by determining hemoglobin adducts. Clinical Chemistry 40(7):1472-1475.
HERO ID:	2971178
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	BD section of naphtha cracker (page 3 of 4)
Personal sampling data:	personal air sampling showed exposures mostly <1ppm for 8-hr TWAs (page 3 of 4)
Number of workers:	26 workers (page 3 of 4)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Netherlands, an OECD country.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Sjöström, M., Julander, A., Strandberg, B., Lewné, M., Bigert, C. (2019). Airborne and Dermal Exposure to Polycyclic Aromatic Hydrocarbons, Volatile Organic Compounds, and Particles among Firefighters and Police Investigators. Annals of Work Exposures and Health 63(5):533-545.
HERO ID:	5789545
Conditions of Use:	Various Commercial and Industrial Uses

EXTRACTION

Parameter	**Data**
Worker activity description:	Firefighters during training and emergency fires, and police forensic investigators during the aftermath of live fire events (page 3 of 13)
Exposure route:	inhalation & dermal (page 2 of 13)
Physical form:	In a typical firefighting scenario, PAHs will be present in both the gaseous and particulate phases (page 2 of 13)
Personal sampling data:	Firefighters during training: 2.69+-2.32 µg/m3 Firefighters during live fires: 23.6+-3.78 µg/m3 Police forensic investigators: 9.68+-3.97 µg/m3 (Table 2 on page 6 of 13). Also see Figure 1 on page 7 of 13 for visual of the data and statistics. Also see discussion from pages 6-7 of 13. the highest 1,3-butadiene exposures clearly occurred during car fires (data not shown). The highest mean exposures to 1,3-butadiene was 24 µg m–3 (2% of the respective Swedish OELs). (page 9 of 13)
Dermal exposure data:	Dermal exposure data
Personal protective equipment:	Personal protective equipment varied but typically included a disposable overall, respiratory protection (of various designs and types), and gloves (of varying material). (page 3 of 13)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
Metric 3:	Applicability	High	Data are for butadiene emissions to air due to material catching fire with respect to firefighters, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges, p-values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling three groups of workers at 5 different sites.

Overall Quality Determination High

Study Citation:	Smith, T. J., Davis, M. E., Hart, J. E., Blicharz, A., Laden, F., Garshick, E., Committee, H.H. (2012). Potential air toxics hot spots in truck terminals and cabs. Research Reports (Health Effects Institute) (172):5-82.
HERO ID:	1787892
Conditions of Use:	Vehicle emissions

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Worker activity description:	Truck drivers, loading-dock workers, and mechanics in truck terminals. Exposure is from tailpipe emissions.
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Table 7, pg. 87/117:0.15 +-0.36 µg/m3 upwind of truck terminal. 0.14 +-0.19 µg/m3 downwind of truck terminal. Table 8, pg. 88/117:0.2 +- 0.45 µg/m3 in yard (upwind). 0.75 +-0.57 µg/m3 in dock. 0.30 +-0.28 µg/m3 in shop.
Comments:	Table 11, pg 91/117 contains a comparison with other locations from other studies (list of studies provided in footnote)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	High	Many statistics provided that fully characterize the data. Regression statistics, p-values, R2 values, means, ratios, medians, standard deviations and correlation factors given. Statistics given on all subgroups.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Critical metadata provided, but missing some categories.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty addressed using both statistics and descriptions in the text.

Overall Quality Determination High

Study Citation:	Sorsa, M., Autio, K., Demopoulos, N. A., Järventaus, H., Rössner, P., Srám, R. J., Stephanou, G., Vlachodimitropoulos, D. (1994). Human cytogenetic biomonitoring of occupational exposure to 1,3-butadiene. Mutation Research 309(2):321-326.
HERO ID:	2966150
Conditions of Use:	Manufacture (and subsequent polymer production)

EXTRACTION

Parameter	**Data**
Worker activity description:	general; workers in butadiene manufacturing unit, involved with work on butadiene production or polymer production
Area sampling data:	Plant A (monomer facility): ambient levels less than 3ppm ; ambient levels were 1-3ppm with 72% of samples being below 1ppm ... Plant B (polymer facility): ambient levels generally below 10ppm; mean 1.8 +/- 2.8ppm with 43% of 42 total measurements below 1ppm (in text on pg. 2/6)
Number of workers:	50,000 workers estimated to be potentially exposed to 1,3-BD in United States based on 1992 IARC report

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic and Portugal, OECD countries.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency or worker tasks.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Sorsa, M., Osterman-Golkar, S., Peltonen, K., Saarikoski, S. T., Sram, R. (1996). Assessment of exposure to butadiene in the process industry. Toxicology 113(1-3):77-83.
HERO ID:	5621392
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in the butadiene production industry,
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	In Plant A, 70% of worker samples were below 0.2 ppm. In Plant B, 50% of the samples were between 0.2-2.0 ppm. About 10% of samples exceeded 10 ppm, and some very high exposures over 500 ppm were detected. (pg. 3/7)
Area sampling data:	In Plant C, 70% of samples were below 0.2ppm. In Plant A, 60% of samples were below 2 ppm. In Plant B, almost 45% of the samples exceeded 10 ppm. (pg. 3/7)
Number of workers:	106

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites.

Overall Quality Determination Medium

Study Citation:	Sorsa, M., Osterman-Golkar, S., Sasiadek, M., Peltonen, K. (1991). Genetic toxicology and biological monitoring of exposure to 1,3-butadiene. Mutation Research: Environmental Mutagenesis and Related Subjects 252(2):172.
HERO ID:	5694018
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Exposure of workers may only occur during sample taking or repair and service jobs.
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	In a few cases during sample taking occasional peak concentrations of up to 300 ppm were measured on personal monitors.
Area sampling data:	The ambient concentrations measured were generally below 1 ppm.
Personal protective equipment:	Workers were using protective clothing and respirators.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the U.K., an OECD country,
	Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution characterized by a range with uncertain statistics.. No information on number of samples
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Very little metadata included
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Sorsa, M., Peltonen, K., Anderson, D., Demopoulos, N. A., Neumann, H. G., Osterman-Golkar, S. (1996). Assessment of environmental and occupational exposures to butadiene as a model for risk estimation of petrochemical emissions. Mutagenesis 11(1):9-17. [Mutagenesis].
HERO ID:	5665158
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	manufacturing operators,
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Pg. 4/9: "Four samplings were performed at three different BDmanufacturing plants (Plant A, Sines, Plant B, Kralupy II andPlant C, Porvoo)...The full-shift personal monitoring samples from the breathingzone area of the workers taking part in the study showed70% of the samples to be <0.2 p.p.m. in Plant A and the BDmanufacturing plant in Plant C (Ahlberg et al., 1992). In PlantB the concentrations of BD in personal samples were fairlysimilar in both samplings (I and II). The typical range measuredwas between 0.2 and 2.0 p.p.m. (-50% of samples). About10% of the samples exceeded 10 p.p.m. However, some veryhigh exposures were detected (>500 p.p.m.) at both sampling times. The results are summarized in Figure 3." Pg. 8/9: "In Plant B, where exposure levels were increased dueto annual maintenance of the plant (sampling I)...(discussion related to biomonitoring)"Pg. 7/9: "Occupational exposure to BD is highest in the chemicalproduction industry (Fajen et al, 1993). Measurements performedwithin this project indicated exposure levels mainly<1 p.p.m. (2.2 mg/mA) and seldom exceeding 3 p.p.m. (6.7mg/nr) in three European BD production facilities. However,high peak exposures may occur during repair, maintenance,cylinder sampling and bomb voiding. Short-term exposureswere measured as exceeding 10 and even 100 p.p.m."
Area sampling data:	Pg. 4/9: "The ambient levels inthese operations varied greatly, but the lowest BD levels inarea samples were detected in the manufacturing processindustry in Plant C (70% of samples <0.2 p.p.m.). Slightlyhigher values were measured in Plant A (60% of samples <2p.p.m.). The highest area concentrations of BD were detectedin Plant B (sampling I), where almost 45% of the area samplesexceeded 10 p.p.m. (Figure 2)."
Exposure duration:	8 hours

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Portugal, Czech Republic, Finland, and Spain, OECD countries.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation, standard error, ranges, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites in different countries.

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Study Citation:	Sorsa, M., Peltonen, K., Anderson, D., Demopoulos, N. A., Neumann, H. G., Osterman-Golkar, S. (1996). Assessment of environmental and occupational exposures to butadiene as a model for risk estimation of petrochemical emissions. Mutagenesis 11(1):9-17. [Mutagenesis].
HERO ID:	5665158
Conditions of Use:	Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	Sorsa, M., Peltonen, K., Anderson, D., Demopoulos, N. A., Neumann, H. G., Osterman-Golkar, S. (1996). Assessment of environmental and occupational exposures to butadiene as a model for risk estimation of petrochemical emissions. Mutagenesis 11(1):9-17. [Mutagenesis].
HERO ID:	5665158
Conditions of Use:	Processing as a Reactant: Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	polymerization operators
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	Pg. 4/9: "The main exposure source of BD in styrene-butadienepolymerization units are leaks from large containers and,because they are indoors, the exposure levels may be higherthan in BD manufacturing. The main exposure level wasbetween 5 and 10 p.p.m. and almost 40% of the samplesexceeded 10 p.p.m. The results are shown in Figure 4 forPlant B, sampling II, and Plant D, a recently renovated plantin Finland."

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Portugal, Czech Republic, Finland, and Spain, OECD countries.
	Metric 3:	Applicability	High	COU
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation, standard error, ranges, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Minimal meta data
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variability addressed by sampling at different sites in different countries.

Overall Quality Determination Medium

Study Citation:	Sorsa, M., Peltonen, K., Anderson, D., Demopoulos, N. A., Neumann, H. G., Osterman-Golkar, S. (1996). Assessment of environmental and occupational exposures to butadiene as a model for risk estimation of petrochemical emissions. Mutagenesis 11(1):9-17. [Mutagenesis].
HERO ID:	5665158
Conditions of Use:	Commercial Use: Fuels and Related Products

EXTRACTION

Parameter	**Data**
Personal sampling data:	Pg. 3/9: "Ten full-shift personal samples (passive monitors) werecollected from ten Spanish petrol filling station attendants inBarcelona, Spain. The samples revealed only a very lowexposure to BD (mean 0.015, SD ± 0.014, SE ± 0.004p.p.m.). The highest and lowest amounts of BD detected were0.05 and 0 p.p.m. respectively. This very low exposure of thefilling station attendants is most probably due to the presenceof BD in automobile exhausts, rather than BD in petrol. However, the BD concentration in Spanish petrol was notdetermined in this study."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Method well described
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	OECD countries
	Metric 3: Applicability	High	COU
	Metric 4: Temporal Representativeness	Low	More than 20 years old.
	Metric 5: Sample Size	Medium	A range of values is reported.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Some meta data reported
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty discussed in terms of source of exposure

Overall Quality Determination Medium

Study Citation:	Sram, R. J., Beskid, O., Binkova, B., Rossner, P., Smerhovsky, Z. (2004). Cytogenetic analysis using fluorescence in situ hybridization (FISH) to evaluate occupational exposure to carcinogens. Toxicology Letters 149(1-3):335-344.
HERO ID:	89080
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Petrochemical manufacturing
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	”Monomer group: 0.642 mg/m^3 Polymer group: 1.794 mg/m^3 Control group: 0.023 mg/m^3”
Exposure duration:	8 hr
Exposure frequency:	10 measurements taken over a 60 day period
Number of workers:	82

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is completely described and looks equivalent to an approved method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old, but less than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution is fully characterized with many subgroups analyzed. Standard deviations, p-values, means, R2 values given.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Almost all metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty addressed and it is explained how it could affect the results.

Overall Quality Determination High

Study Citation:	Sram, R. J., Binkova, B. (2000). Molecular Epidemiology Studies on Occupational and Environmental Exposure to Mutagens and Carcinogens, 1997-1999. Environmental Health Perspectives 108(Suppl 1):57.
HERO ID:	1327829
Conditions of Use:	Processing: Monomer used in polymerization process in plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in monomer production unit
Exposure route:	inhalation
Personal sampling data:	0.53 mg/m3 with a maximum of 5 mg/m3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene monomer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The data were collected more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orspecific worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed with respect to butadiene.

Overall Quality Determination Low

Study Citation:	Strandberg, B., Bergemalm-Rynell, K., Sallsten, G. (2014). Evaluation of three types of passive samplers for measuring 1,3-butadiene and benzene at workplaces. Environmental Science: Processes & Impacts 16(5):1008-1014.
HERO ID:	2443442
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	"Sampling site F1, 4h: 1.1 ug/m3 Sampling site F1, 8h: 3.9 ug/m3 Sampling site F2, 4h: 1.3 ug/m3 Sampling site F2, 8h: 2.7 ug/m3 Sampling site F3, 4h: 13 ug/m3 Sampling site F3, 8h: 14 ug/m3 Sampling site F4, 4h: 50 ug/m3 Sampling site F4, 8h: 33 ug/m3"
Exposure duration:	4 or 8 hours

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by taking samples at different locations around the refinery.

Overall Quality Determination High

Study Citation:	Tan, H., Wang, Q., Wang, A., Ye, Y., Feng, N., Feng, X., Lu, L., Au, W., Zheng, Y., Xia, Z. (2010). Influence of GSTs, CYP2E1 and mEH polymorphisms on 1, 3-butadiene-induced micronucleus frequency in Chinese workers. Toxicology and Applied Pharmacology 247(3):198-203.
HERO ID:	2583451
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Production for synthetic rubber and resin manufacturing
Worker activity description:	Butadiene production plants, product storage area, waste water facilities and administrative offices.
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	At Polybutadiene Latex Plant, storage area had concentrations of 182.53 mg/m3. Operation area had concentrations of 1989.99 mg/m3. Vibrating screen area had concentration of 153.35 mg/m3. Median concentration for plant was 4.48 mg/m3.
Exposure duration:	2 hours/day, 5 days/week
Exposure frequency:	at least one year of exposure
Number of workers:	166

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Peer reviewed journal. Sampling conducted by local CDC (in China).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from an non-OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Medians, ranges, geometric means, p-values, frequency ratios, and a Poisson regression included.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is briefly mentioned at the end of the report.

Overall Quality Determination High

Study Citation:	Tates, A. D., Dam, Van, F. J., Zwart, De, F. A., Darroudi, F., Natarajan, A. T., Rossner, P., Peterkova, K., Peltonen, K., Demopoulos, N. A., Stephanou, G., Vlachodimitropoulos, D., R, Sram, J. L. (1996). Biological effect monitoring in industrial workers from the Czech Republic exposed to low levels of butadiene. Toxicology 113(1-3):91-99.
HERO ID:	2962228
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Monomer and polymer production
Personal sampling data:	Exposure ranged from 0.012-19.77 ppm. Mean exposure was 1.76+-4.20 ppm.
Exposure duration:	8 hours
Number of workers:	38

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling method mentioned, but not explained in detail to assess whether it is acceptable to a NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, standard deviations, and subgroup demographics provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Some metadata provided, but missing many fields.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty discussed in terms of similarity to other studies.

Overall Quality Determination Medium

Study Citation:	Texaco Chem Co, (2000). SAF studies, surveys and reports on employees exposure to anol, tert-butyl alcohol, 1,3-butadiene, methyl tert-butyl ether and total other hydrocarbons with cover letter dated 091586.
HERO ID:	1579736
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Life cycle description:	Petrochemical Manufacturing
Worker activity description:	Industrial hygiene sampling was conducted at the Methyl Tertiary Butyl Ether (MTBE) unit at the Neches Chemical West Plant on March 2 and 3, 1986. Samples were collected to determine employee exposure to methanol, tertiary butyl alcohol (TBA) , 1,3-butadiene (Bd), methyl tertiary butyl ether (MTBE) and total other hydrocarbons (TOHC). The sampling results are summarized on Tables I through IV. This sampling project was conducted during a test and inspection of the MTBE unit...These samples were collected on maintenance and operations personnel. The source of these exposures is likely the result of butadiene released when the feedstock (butanes and butylenes) lines were blinded. Varying small percentages of butadiene are found in the feedstock, and this is the only source of butadiene in this unit. There is a raffinate stream from the butadiene unit used in the MTBE unit, but it is treated through a Bd hydrogenation process which is 100% efficient. A survey of the MTBE unit is planned for evaluating exposures during routine operations. This upcoming survey would dispel any thought that these butadiene levels result from proximity to the butadiene unit.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	The butadiene samples ranged from less than 0.05 ppm to 9.27 ppm, seven samples were above 1.0ppmPipefitter, MTBE Unit, 86-03-01, 643 min, 9.27 ppm TWAPipefitter, MTBE Unit, 86-03-02, 696 min, 5.24 ppm TWAPipefitter, MTBE Unit, 86-03-02, 692 min, < 0.10 ppm TWAHDDP, Type, MTBE Unit, 86-03-02, 509 min, 0.23 ppm TWAHDDP, Type, MTBE Unit, 86-03-02, 511 min, < 0.05 ppm TWAOperator Type, MTBE Unit, 86-03-02, 456 min, 0.37 ppm TWAOperator Type, MTBE Unit, 86-03-02, 460 min, 0.05 ppm TWABoilermaker, MTBE Unit, 86-03-02, 631 min, < 0.12 ppm TWAOperator Type, MTBE Unit, 86-03-02, 450 min, 0.10 ppm TWAOperator Type, MTBE Unit, 86-03-02, 396 min, < 0.10 ppm TWABoilermaker, MTBE Unit, 86-03-02, 634 min, < 0.10 ppm TWABoilermaker, MTBE Unit, 86-03-02, 619 min, 0.28 ppm TWAPipefitter, MTBE Unit, 86-03-02, 480 min, 0.16 ppm TWAHDDP, Type, MTBE Unit, 86-03-01, 510 min, 0.62 ppm TWAHDDP, Type, MTBE Unit, 86-03-01, 510 min, 0.34 ppm TWAOperator Type, MTBE Unit, 86-03-01, 457 min, 0.88 ppm TWAOperator Type, MTBE Unit, 86-03-01, 448 min, 1.53 ppm TWAPipefitter, MTBE Unit, 86-03-01, 649 min, 1.04 ppm TWAPipefitter, MTBE Unit, 86-03-01, 645 min, 1.59 ppm TWAOperator Type, MTBE Unit, 86-03-01, 451 min, 1.20 ppm TWAOperator Type, MTBE Unit, 86-03-01, 453 min, 1.34 ppm TWA
Personal protective equipment:	Respiratory protection was not worn during the shutdown. The sampling results indicate a need for organic vapor respirators to be worn when breaking into and blinding lines. This recommendation has been made previously and should be adhered to in any teat and inspection situation.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	The sampling method is described and the analysis was conducted at an accredited industrial hygiene laboratory.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution is fully characterized. Individual sample results for each worker were provided in detail.
Domain 3: Accessibility/ Clarity				

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Study Citation: Texaco Chem Co, (2000). SAF studies, surveys and reports on employees exposure to anol, tert-butyl alcohol, 1,3-butadiene, methyl tert-butyl ether and total other hydrocarbons with cover letter dated 091586.
HERO ID: 1579736
Conditions of Use: Processing as a reactant

		EVALUATION		
Domain	Metric		Rating	Comments
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.

Overall Quality Determination — High

Study Citation:	Texaco Chem Co, (1986). SAF studies, surveys and reports on employees exposure to butadiene, methanol, tertiary-butyl alcohol, and other hydrocarbons with cover letter dated 091586.
HERO ID:	1579737
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Various activities including welding are conducted inside reactor tower 4D14, in the MTBE unit. (page 2 of 6)
Area sampling data:	Two butadiene samples were taken with adjusted concentrations of 0.18ppm and 0.11ppm. (See the Table on page 4 of 6)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling method is described and is conducted at a reputable national laboratory.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution is fully characterized. Individual sample results for each worker were provided in detail.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination High

Study Citation:	Texaco Chem Co, (2000). Industrial hygiene survey for methyl tertiary-butyl ether and 1,3-butadiene at the MTBE unit with cover letter dated 111386.
HERO ID:	5664501
Conditions of Use:	Processing as a Reactant: Petrochemical Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	head operator (stays with unit being monitored for entire work shift) and a roving operator (works with all units on plant) (page 2 of 9)
Exposure route:	Sampling done in MTBE unit. The feedstock to this unit does contain varying small percentages of butadiene. Fugitive emissions from pumps and piping handling the stream in question may be the cause of exposure. Proximity to acetylene unit (in which butadiene is produced in small amounts) and butadiene unit may be contributing factors as well (page 2 of 9)
Personal sampling data:	0.17, 3.08, 0.46, and 1.14 ppm. (page 2 of 9) See pages 5 and 7 for table of butadiene monitoring results.
Area sampling data:	two samples taken at a butanes and butylenes feed pump had results less than 0.06 ppm. Four other samples, taken at valves and filters, had results ranging from 0.19 ppm to 0.47 ppm. Emissions could be from these locations or just general background level in the unit. (page 3 of 9) See pages 5 and 7 for table of butadiene monitoring results.
Number of workers:	2 (page 2 of 9)
Comments:	1,3-butadiene may be an impurity in the feedstock of the MTBE production process.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology only briefly described on page 3
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	In the US
Metric 3:	Applicability	High	chemical manufacturing plant
Metric 4:	Temporal Representativeness	Low	from 1986
Metric 5:	Sample Size	Medium	A range of values is reported.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination High

Study Citation:	Texaco Chem Co, (1992). Initial submission: Letter from Texaco Chem Co to USEPA regarding a study in mutation and human exposure to butadiene with cover letter dated 110292 and attachments.
HERO ID:	5665270
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Worker activity description:	Higher exposure level workers were process operators or rovers in butadiene production areas. Lower exposure level workers were in Central Control area for production units, Steam Power and Water Plant with its control area. (pg 22)
Exposure route:	Inhalation (pg 22) More information on the exposure route is described in page 22-3
Personal sampling data:	Both area and personal samples were collected. Some personal samples were collected for 15-20 minute intervals. (pg 22) Unsure if results are included.
Area sampling data:	3.5+/-7.5 ppm in high exposure areas, 0.03+/-0.03 ppm in low exposure areas (greater detail included in table 2 pg 41)
Number of workers:	Approximately 65,000 U.S. workers are engaged in jobs in which there is some level of exposure to butadiene (pg 13) The study describes 20 workers at a butadiene production plant (pg 21)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 35 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data was only area data and only included the mean and SD of each of the three work areas. Individual data points are not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.

Overall Quality Determination High

Study Citation:	Texaco Chem Co, (1993). Support: mutation and human exposure to butadiene with cover letter dated 121692.
HERO ID:	5665287
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	”North Unit: 3.18+-7.13 ppm South Unit: 3.89+-7.60 ppm Central Control: 0.03+-0.03 ppm”
Exposure duration:	8 hours
Exposure frequency:	”High Exposed Group: 3.8 years Low Exposed Group: 3.4 years”
Number of workers:	65,000

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites within the plant.

Overall Quality Determination High

Study Citation:	Texaco Inc, (1986). SAF studies, surveys and reports on methanol, tert-butanol, 1,3-butadiene, methyl tert-butyl ether, and total other hydrocarbons with cover letters dated 091586 and 020687.
HERO ID:	1579711
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Petrochemical Manufacturing
Worker activity description:	Maintenance and operations personnel exposed. Butadiene is released when the feedstock (butanes and butylenes) lines were blinded.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Butadiene samples ranged from 0.05ppm to 9.27 ppm. Seven samples were above 1.0ppm
Exposure duration:	8 or 12 hours, depending on shift.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling method is described and is conducted at a reputable national laboratory.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution is fully characterized. Individual sample results for each worker were provided in detail.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Sources of variability were mentioned and future recommendations included to minimize error.

Overall Quality Determination High

Study Citation:	Texaco Inc, (1987). Industrial hygiene survey for methyl tertiary butyl ether (MTBE) and 1,3-butadiene (BD) at the MTBE unit with cover letters dated 111386 and 020687.
HERO ID:	5790926
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	roving operators at an MTBE production unit
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	four measurements taken for personal sampling: 0.17, 3.08, 0.46, and 1.14 ppm
Area sampling data:	Feed pump: 0.06 ppm Valves and filter areas: 0.19- 0.47 ppm
Exposure duration:	8 hours/day

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for organic chemical production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling on three different days at multiple locations, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	ToxStrategies, (2021). Analysis of 1,3-butadiene industrial hygiene data.
HERO ID:	9356965
Conditions of Use:	Manufacturing and Processing as a Reactant conditions of use

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading and transferring 1,3-butadiene to and from storage containers to process vessels (This task is associated with the unloading and loading of product which involves opening of storage vessels, hose connections to truck tankers, rail cars or cargo vessels and pumping of pressurized liquid 1,3-BD. Workers in the job group Infrastructure/ Transportation operations perform this task.)Handling, transporting and disposing of waste containing 1,3-butadiene. (This task is associated with potential contact of facility waste streams containing 1,3-BD including disposing of analytical samples, loading of recycled oil, operations conducted at the onsite waste-water treatment plant.)Cleaning and maintaining equipment (This task involves disassembly and re-assembly of process equipment (e.g. valves, pumps, and analyzers), tank cleaning, line purging, filter removal and cleaning, etc. Workers in the job groups Onsite Operations and Maintenance may perform this task.)Sampling chemicals, formulations, or products containing 1,3-butadiene for quality control (This task involves collection of process stream samples and analysis for 1,3-BD. For gaseous samples, workers connect pressurized cylinders that have ports to allow the sample to flow in and also to allow excess gas to vent to safe location. Workers in many job groups may perform this task although most of the air samples are associated with workersin the Laboratory Technician and Onsite Operations job groups.)Performing other work activities in or near areas where 1,3-butadiene is used (Most of the short-term or task samples were assignable to one of the four task categories described above. However, some samples were collected on workers that performed a variety of miscellaneous tasks that do not fall into the other categories identified by EPA. The tasks included air monitoring with direct reading instruments for VOCs during various maintenance activities (typically by EHS personnel) and routine visual onspections of operating areas.)Specifics were provided:Instrument and Electrical-Workers in the Instrument and Electrical job group are responsible for the set up and maintenance of various electrical equipment including analyzers and various instruments throughout the facility.Laboratory Technician-Workers in the Laboratory Technician job group are responsible for sample collection and chemical analysis of process and product samples for the facility and conduct their work in laboratories.Machinery & Specialist Mechanical Group-Workers in the Machinery & Specialists Mechanical job group are skilled workers such asmillwrights, boilermakers, pipefitters and welders who work throughout the manufacturing and processing facilities. In general, these workers perform activities in equipment that has been cleared and cleaned, especially because of the hazards associated with the heat/sparks generated during hot work such as welding and grinding. Exposures are typically associated with the brief activities involved in opening process equipment prior to maintenance activities.Maintenance-Workers in the Maintenance job group are responsible for a variety of preventative maintenance activities on process equipment, as well as addressing malfunctions. Some of the tasks performed by workers in this job group include connecting and disconnecting lines, and draining, clearing and venting equipment.Operations Onsite-Workers in the Operations Onsite job group are responsible for operations of manufacturing and processing equipment throughout the facilities. These workers may beindoors inside of control rooms where they monitor chemical feeds, process temperatures, vessel pressure, etc. or outdoors where the process equipment is located to where they may collect process samples, drain/vent/clear process equipment and prepare it for maintenance. Additionally, workers in this job group may also assist the IH team in conducting air monitoring to establish the restricted areas.Safety, Health and Environment (SHE)-Workers in the Safety, Health and Environment (SHE) job group are responsible forassuring safety, health and environmental protection protocols are being followed in all areas of the facility. Workers in this job group may include industrial hygienists who conduct exposure assessments of workers in the various job groups, LDAR technicians, environmental engineers and safety technicians. The SHE workers may be indoors inside of offices or in various control rooms or outdoors where the process equipment is located to monitor other workers or processes.Occupational Non-Users-Workers in the Occupational Non-Users (ONU) job group are supervisory personnel associated with all of the worker job groups. In the Manufacturing and Processing as aReactant conditions of use, administrative type employees (e.g. accountants, salespersons, etc.) do not access the operational parts of a facility.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Full Shift Personal Air Concentrations (ppm) - Kaplan Meier StatisticsInfrastructure/DistributionOperations KM Mean=0.12 SE=0.038 95th percent tile=0.450Instrument and Electrical KM Mean=0.068 SE=0.033 95th percent tile=0.160Laboratory Technician KM Mean=0.063 SE= 0.016 95th percent tile=0.246Machinery and Specialists Group KM Mean=0.087 SE=0.023 95th percent tile=0.280Maintenance KM Mean=0.109 SE=0.010 95th percent tile=0.240Operations Onsite KM Mean=0.074 SE=0.016 95th percent tile=0.190Safety Health and Engineering KM Mean=0.158 SE=0.036 95th percent tile=0.364Missing Job Group Designation KM Mean=0.024 SE=0.004 95th percent tile=0.037Occupational Non-User KM Mean=0.012 SE=0.001 95th percent tile=0.033Additional details are provided in the report appendix
Exposure duration:	Routine: 5 days per week, 15-239 min/taskMaintenance shutdown: 2 weeks/5 years, 15-239 min/task
Exposure frequency:	Routine: 5 days per weekMaintenance shutdown: 2 weeks/5 years

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Study Citation: ToxStrategies, (2021). Analysis of 1,3-butadiene industrial hygiene data.
HERO ID: 9356965
Conditions of Use: Manufacturing and Processing as a Reactant conditions of use

EVALUATION			
Domain	Metric	Rating	Comments
Personal protective equipment:	1,3-BD Air Concentration (ppm)Unloading and TransferSupplied air <0.118 - 89Full Face APR <0.06 - 36Half Face APR <0.05 – 2.2Handling and Transporting WasteFull Face APR <0.25 - <3.7Half Face APR <0.08 - < 0.1Cleaning and Maintaining EquipmentSupplied Air <0.15 - 120Full Face APR <0.02 - 110Half Face APR <0.04 - <0.7No respirator <0.4 - <0.7Sampling and Analysis Supplied Air <0.52Full Face APR <0.06 - 12Half Face APR <0.09 - 7.3No respirator <0.02 - 4.8Performing Other WorkSupplied Air 0.27 - 4.7Full Face APR <0.24 - <0.42Half Face APR <0.2 -< 0.3No respirator <0.39 - <0.67		

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	There were two methods used: NIOSH 1024 and OSHA 56. Both methods involve collection of an air sample using personal airsampling pumps, which draw air through a solid sorbent tube, followed by desorption using a solvent and analysis using gas chromatography (GC) coupled with flame ionization detection (FID). Passive sampling badges that do not require an air pump (e.g. 3M 3520, 3530) are also used to collect personal air samples and demonstrated to meet OSHA's accuracy requirements. The NIOSH method has a stated working range of 0.02 to 100 ppm(0.04 to 220 mg/m³) and the OSHA method has a lower limit of quantification of 155 ppb (0.343 mg/m3).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The NAICS codes for which the data are represented are:324110 – Petroleum refineries325110 – Petrochemical manufacturing325199 – Other organic chemical manufacturing325210 – Resin and synthetic rubber manufacturing325211 – Plastic and resin manufacturing325991 – Custom compounding of purchased resins325998 – All other chemical product and preparation manufacturing
	Metric 4:	Temporal Representativeness	High	All of the Consortium data were collected during theyears of 2010 -2019 and therefore directly applicable to EPA's risk evaluation.
	Metric 5:	Sample Size	High	The Consortium dataset is large; containing 5, 676 full-shift personal samples (workers and ONUs) and 1,051 short term and task level samples (workers).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	The Consortium data have been aggregated by job group, task,exposure frequency and duration. Additionally, 'meta data' including respiratory protection that is used in accordance with the requirements of the OSHA butadiene standard, and PPE to prevent skin contact with liquids containing low concentrations ofbutadiene are provided.
Domain 4: Variability and Uncertainty				

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Study Citation: ToxStrategies, (2021). Analysis of 1,3-butadiene industrial hygiene data.
HERO ID: 9356965
Conditions of Use: Manufacturing and Processing as a Reactant conditions of use

			EVALUATION	
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	High	The variability and uncertainty associated with the Consortium data are provided via full data distributions and summary statistics for the aggregated data sets. Overall, the dataset is highly censored (i.e., low detection frequency), but the limits of detection are sufficiently low to characterize potential exposure with respect to the OSHA PEL (8 hr TWA and STEL). The data at the high-end tail of the distributions represent jobs and tasks where engineering controls are not sufficient to reduce exposures and therefore OSHA mandated PPE is used.

Overall Quality Determination High

Study Citation:	Tsai, S. P., Ahmed, F. S., Ransdell, J. D., Wendt, J. K., Donnelly, R. P. (2005). A hematology surveillance study of petrochemical workers exposed to 1,3 butadiene. Journal of Occupational and Environmental Hygiene 2(10):508-515.
HERO ID:	2988431
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers in operating and maintenance jobs who regularly work in BD production and handling areas (page 3 of 9).
Personal sampling data:	See Table IV on page 7 of 9. Table provides averaged 8hr, 10hr, and 12hr together TWAs and short term exposure information at each complex for group 1979-1996 and group 1997-2003. Provided are sample numbers, arithmetic mean and StD; geometric mean and StD; 1%, 5%, median, 95%, and 99% exposures. Deer Park TWA average 1979-1996 was 5.70ppm, Deer Park TWA average 1997-2003 was 0.15ppm, Norco TWA average 1979-1996 was 4.21ppm, Norco TWA average 1997-2003 was 0.26ppm. See page 6 of 9 for additional discussion on table IV. Elevated levels in the tank farm area around 20ppm (Page 8 of 9).
Number of workers:	1800 people employed at Deer Park complex of which ~55% are employed in the refinery and 45% in the chemical plant; approximately 1400 employees at the Norco complex, about half work at the refinery and half at the chemical plant (page 3 of 9).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Sample distribution characterized by limited statistics (min, max, mean, etc) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency and description of tasks related to exposures.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by different sites and temporal changes.

Overall Quality Determination High

Study Citation:	Tsai, S. P., Wendt, J. K., Ransdell, J. D. (2001). A mortality, morbidity, and hematology study of petrochemical employees potentially exposed to 1,3-butadiene monomer. Chemico-Biological Interactions 135-136:555-567.
HERO ID:	2959630
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	employees involved in butadiene production, maintenance personnel in butadiene areas, butadiene lab staff, and shipping personnel involved in butadiene transfer/storage (page 3 of 13)
Personal sampling data:	From 1979-1992, 2.6 ppm butadiene exposure for employees in shipping areas, the highest predicted exposure. Additional exposure data from other areas during this timeframe and from 1993-1998 can be found in Table 5 on page 9, with discussion on the table from page 7-8.
Exposure frequency:	at least 5 years of employment in one or more jobs withpotential exposure to butadiene (page 3 of 13)
Number of workers:	614 (page 2 of 13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is well-described and seems equivalent to a commonly used method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, ranges, p-values, and confidence intervals given.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Some metadata provided, but missing exposure duration and routes of exposure.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Limitations of the study were described with recommendations on how to improve in the future.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1984). Assessment of occupational exposure data on 1,3-butadiene in plants producing synthetic rubbers, plastics, and resins.
HERO ID:	10476131
Conditions of Use:	Plastic material and resin manufacturing; Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Table 1 and 2: Tank Car Loader/Unloader, Vessel Cleaner, Charge Solution Makeup, Reactor Operators, Stripping Column Operators, Coagulation Operators, Dryer Operators, Baler and Packaging Ops., Warehousemen, Lab Analysts, Maintenance, Foreman, Waste Treatment.Table 4: Reactor Operator, Tank Farm, Recovery Operator, Coagulation Op., Blend Operator, Maintenance, Baler Operator, Dryer Operator, Lab Technician. Table 5: Reactor operator, Tank farm, Recovery operator, Coagulation op., Maintenance, Baler, Dryer Operator, Pumphouse Operator, Lab Analyst, Lab Technician, LaborersTable 6: Tank farm operator, Recovery Operator, Machinist Latex Area, Reactor Operator, Liquid Latex Operator, Blend Tank Operator, CoagulatorTable 7: Melter, dye preparer, tenter operator, injection pressmen, treat room operator, press operator, painter, millman extruding, extruder helper, press operator eemco, mill drop operator, welder assembler, wire belt, injection molder, reactor operator, stripper operator, coagulation operatorTable 8: Tank Farm, Reactor Receiving, Solution, Shipping Receiving, Store room, Factory Service, MaintenanceTable 10: Process Technicians, Tank Truck Operators, Tank Car Operators, Product Handlers, Laboratory TechniciansTable 13: Tank car loader/unloader, Vessel Cleaners, Reactor Operator, Stripper Operator, Coagulation Op., Baler/Packager, Warehousemen, Lab Analysts, Maintenance, Foremen, Waste treatmentTable 14: Tank Car load/unload, Vessel Cleaner, Reactor Operators, Stripper Operators, Coagulation Operators, Baler/Packager, Lab Analysts, Maintenance/Engineers
Exposure route:	Inhalation, Dermal
Physical form:	Liquid, Vapor

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Study Citation: U.S. EPA, (1984). Assessment of occupational exposure data on 1,3-butadiene in plants producing synthetic rubbers, plastics, and resins.
HERO ID: 10476131
Conditions of Use: Plastic material and resin manufacturing; Synthetic rubber manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Personal sampling data:			Table 1: Butadiene Exposure Data Summary of 11 North American Polymer Plants (1976-1981) IISRPThe 3766 data points ranged from nearly zero ppm (nondetectable) to the OSHA limit of 1000 ppm. Table 2: Butadiene Exposure Data Summary of 8 North American Polymer Plants (1978-1984) IISRPThe 1983 IISRP update of the earlier survey contained 1672 data points. The data points ranged from nearly zero ppm to 1000 ppm. Table 4 and 5: NIOSH performed an industrial hygiene survey of two neighboring styrene-butadiene rubber facilities during 1976 and 1977 (NIOSH, 1981a). Of the 57 measurements, 39 were less than 1.0 ppm, and 11 ranged from 1.0 to 1.99 ppm, 5 samples were between 2.0 and 3.99 ppm and the last 2 samples were above 4.0 ppm. In the second plant only 50 of 103 samples were found to have detectable amounts of butadiene. Thirty three samples with detectable amounts of butadiene were below 2.0 ppm, 13 samples were between 2.0 and 50 ppm, and four samples were between 50 and 175 ppm.Table 6: In a 1976 survey of the American Synthetic Rubber Corporation in Louisville, Kentucky (NIOSH, 1978a), NIOSH, using its previously mentioned method, reported butadiene exposures that ranged from less than 0.34 to 11.47 ppm. Table 7: OSHA has monitored nine facilities between June 1, 1979 and March 31, 1984 for compliance with the OSHA butadiene standard. These data were tabulated in the OSHA National Inspection Summary Report dated June 11, 1984 (OSHA, 1984). Nine different sites and 20 workers were monitored. All 20 samples were at least two orders of magnitude below the OSHA standard with 18 samples below the level of detection. Table 8: Checkoway and Williams reported in the ”Journal of the American Industrial Hygiene Association” that mean exposure levels were less than 1.0 ppm for all departments at an SBR facility they surveyed except for the tank farm operators whose average exposure was 20 ppm with a range of 0.14 to 53.37 ppm. Table 9: NIOSH also performed Health Hazard Evaluation reports on seven rubber and plastic products companies. These companies were Gates Rubber Company (NIOSH, 1973), Metamora Products Company (NIOSH, 1981b), Standard Products Co. (NIOSH, 1978b), Bell Helmets, Inc. (NIOSH, 1980), Piper Aircraft Corp. (NIOSH, 1979), Goodyear Tire and Rubber Company (NIOSH, 1976), and Firestone Synthetic Rubber Company (NIOSH, 1977). (See Table 9). Butadiene was not detected at the Gates Rubber Company where all 14 samples were taken for less than 10 minutes; the Standard Products Company, where 10 samples were taken with a duration of 3-7 1/2 hours; and at the Metamora Products Corp. of Elkland, Pa. At the Bell Helmets facility in Norwalk, California, the highest of the 15 area and personal samples was approximately 2 ppm. At the Piper Aircraft Corp. facility in Vero Beach, Florida, two personal and two area samples were collected in the work areas performing molding, finishing, and subassembly operations with ABS plastics. The two personal samples contained 0.7 and 0.8 ppm. In 1976, NIOSH collected two samples at the Goodyear Tire and Rubber Company Plant in Gadsden, Alabama. The personal sample contained 2.1 ppm. This company runs the rubber sleeve stock on one shift per week basis. In 1977, NIOSH conducted a survey at the Firestone Synthetic Rubber Company facility in Akron, Ohio using their P&C AM 127 method with workup by NIOSH S-91 multicomponent analysis. The average of the 70 personal samples was.2.52 ppm. The highest exposures were experienced by workers in the compressor house, 19 ppm and 26 ppm, and workers in the pump house, 39 ppm and 46 ppm.Table 10: Shell stated in a submission that a maximum of 450 workers who are employed in 90 different job functions could have in their opinion any exposure to butadiene in both its production and use (Howard Kusnetz, 1984). Of these 90 job functions only 5 are mentioned with exposure levels. During production, process technicians have exposures from less then 1 ppm to 6 ppm with a geometric mean of 1.2 ppm. The tank truck operators have experienced exposures in the range of less than 1 ppm to 55 ppm with a geometric mean of 4.3 ppm. The tank car operators, workers who pump butadiene into railroad cars, have experienced exposures up to 142 ppm with a geometric mean of 8.3 ppm. During use of butadiene to make a rubber product at the Marrietta, Ohio plant, both process technicians and laboratory technicians have experienced an arithmetic average exposure of less than 1 ppm. No range of the exposures was given. The level of detection was stated by Shell to be 1 ppm. Table 11: The data from 117 samples ranged from 0.00 ppm to 173.48 ppm. The arithmetic average exposure of the data is about 10.36 ppm TWA. Table 12: Butadiene Exposure Data from the URW Survey at the Goodyear Tire and Rubber Company3 personal0.01 - 0.0230 personal0.01 - 234 personal0.007 - 0.01412 area & personalnone detected-0.054 personal0.81 - 1.03Table 13: Uniroyal, at their Painesville Nitrile Rubber Plant, took 699 personal monitoring samples over the period 1982-1983. (See Table 13). The method, mentioned above, was used to monitor workers whose job titles are: tank car loaders, vessel cleaners, maintenance crafts, reactor, coagulation, and stripper operators, lab analysts, process engineers, and foremen. The tank car loaders experienced an exposure that ranged from O ppm to 98.36 ppm. The average (arithmetic) of the 61 samples was 3.76 ppm. The vessel cleaners, shift repair helpers (131 samples) and the maintenance crafts (59 samples) had exposures up to 55.37 and 19.40 ppm respectively. The average for these similar jobs was 1.63 ppm and 1.86 ppm. The reactor, coagulation, and stripper operators all had exposures under 16 ppm with the exception of one reactor operator who experienced a 53.61 ppm exposure. The average for each group of operators was: reactor operator (62 samples) 2.79 ppm, coagulation operators (111 samples) 0.40 ppm, and stripper operators (62 sampl s) 1.33 ppm.The foremen, process engineers, and laboratory analysts all had exposures under 10 ppm (9.77 ppm was the highest exposure found). The average of this group’s exposure was 0.80 ppm for 93 samples. Nothing was mentioned about the duration of exposure, frequency of the exposures, number of workers, worker activities, personal protective equipment used, and the existing controls.Table 14: Uniroyal also submitted data from the same plant covering the years 1980 through 1983. (See Table 14). In this survey the tank car loaders and unloaders experienced exposures to butadiene up to 98.36 ppm with an arithmetic mean of 3.16 ppm and a geometric mean of 0.34 ppm. Other worker categories such as reactor operators, coagulation operators, maintenance workers, vessel cleaners, and foremen and engineers all experienced some exposures to butadiene that ranged up to 93 ppm. However, the arithmetic mean of any job was less than 5 ppm.

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Study Citation: U.S. EPA, (1984). Assessment of occupational exposure data on 1,3-butadiene in plants producing synthetic rubbers, plastics, and resins.
HERO ID: 10476131
Conditions of Use: Plastic material and resin manufacturing; Synthetic rubber manufacturing

EVALUATION			
Domain	Metric	Rating	Comments
Area sampling data:	Table 9: NIOSH also performed Health Hazard Evaluation reports on seven rubber and plastic products companies. These companies were Gates Rubber Company (NIOSH, 1973), Metamora Products Company (NIOSH, 1981b), Standard Products Co. (NIOSH, 1978b), Bell Helmets, Inc. (NIOSH, 1980), Piper Aircraft Corp. (NIOSH, 1979), Goodyear Tire and Rubber Company (NIOSH, 1976), and Firestone Synthetic Rubber Company (NIOSH, 1977). (See Table 9). Butadiene was not detected at the Gates Rubber Company where all 14 samples were taken for less than 10 minutes; the Standard Products Company, where 10 samples were taken with a duration of 3-7 1/2 hours; and at the Metamora Products Corp. of Elkland, Pa. At the Bell Helmets facility in Norwalk, California, the highest of the 15 area and personal samples was approximately 2 ppm. At the Piper Aircraft Corp. facility in Vero Beach, Florida, two personal and two area samples were collected in the work areas performing molding, finishing, and subassembly operations with ABS plastics. The two area samples contained less than 1.0 and 1.3 ppm. In 1976, NIOSH collected two samples at the Goodyear Tire and Rubber Company Plant in Gadsden, Alabama. Analysis of the area sample showed a butadiene concentration of 1.8 ppm. This company runs the rubber sleeve stock on one shift per week basis. Table 12: Butadiene Exposure Data from the URW Survey at the Goodyear Tire and Rubber Company14 area<0.01 - 4212 area & personalnone detected-0.05		
Dermal exposure data:	Dermal exposure data		
Exposure duration:	Hours per day can vary from 1 to 8. (Table 15)		
Exposure frequency:	Exposure Frequency can vary from 30 to 240 days/yr. (Table 15)		
Number of workers:	Number of Workers can vary from 100-2000 for different job categories.		

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Some studies use approved OSHA or NIOSH methods, others use methods not mentioned.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is from 1984.
	Metric 5:	Sample Size	Medium	Individual data points not provided but range and mean provided for most studies.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.

Overall Quality Determination High

Study Citation:	UAB, (1995). Support: a follow-up study of synthetic rubber workers (cohort mortality study of male employees of 8 styrene-butadiene rubber plants), with cover letter dated 10/24/95.
HERO ID:	5554378
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	production, maintenance, labor, laboratories and other operations
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	The median cumulative time-weighted average BD exposure was 36.4 ppm-yrs for leukemia decedents, about twice as high as that of all decedents (19.0 ppm-years) and three times higher than that of all subjects (11.3 ppm-years).
Exposure duration:	nan
Exposure frequency:	nan
Number of workers:	15649

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Sample type and exposure type provided but missing number of samples, sampling method, particle size, engineering controls, and PPE.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling sites more than once, and sampling different sites.

Overall Quality Determination High

Study Citation:	UAB, (1995). Initial submission: Letter from intl inst syn rubber prod to USEPA RE prelim results in cohort mortality study of employees of 8 styrene butadiene rubber plants, dated 05/19/95.
HERO ID:	5665016
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Jobs include: administration, service, shipping, engineering, maintenance, utilities, butadiene production, polyethylene unit, rubber production.
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	”Plant 1: 0.7 ppm Plant 2: 0.7 ppm Plant 4: 1.3 ppm Plant 5: 1.7 ppm Plant 7: 1.3 ppm Plant 8: 1.1 ppm”
Exposure duration:	8 hrs
Exposure frequency:	average of 7.8 years of experience, but at least one year for all participants
Number of workers:	17,964

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study, and where further research needs to be done. Variability addressed by sampling multiple plants and age groups.

Overall Quality Determination High

Study Citation: UAB, (2004). Validation of 1,3-butadiene exposure estimates for workers at a synthetic rubber plant.
HERO ID: 6544135
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Worker activity description:	A complete table of jobs that were sampled is included in the report (Table A in Appendix A, pages 55-62 of 98).
Personal sampling data:	The mean BD concentration was 5.2 parts per million (ppm) (page 18 and 50 of 98) . The mean value over all years of measured BD concentrations varied by job, from 0.08 ppm for job 731 (petrochemicals, production, minimal exposure) to 46.7 ppm for job 813 (SBR tank farm operator) (page 17 of 98). A full table of exposure data for each job description is given in Tables 3 and 4 on pages 47-49 of 98.
Exposure duration:	Table B3 on page 68 of 98 implies both 12 hour and 8 hour shifts.
Number of workers:	754 (only employees who participated in the study, page 17 and 45 of 98)
Engineering control:	The report states that exposure controls were established, but doesn't go into detail (page 24 of 98)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S., and one site in Canada.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, ranges, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by taking samples from different job classifications at different plants.

Overall Quality Determination High

Study Citation:	Unwin, J., Coldwell, M. R., Keen, C., Mcalinden, J. J. (2013). Airborne emissions of carcinogens and respiratory sensitizers during thermal processing of plastics. Annals of Occupational Hygiene 57(3):399-406.
HERO ID:	1477715
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	vacuum-forming of ABS sheet; caravan panel and roof box manufacture (see Table 2)
Physical form:	fumes from processing ABS at 160-180deg Celsius
Area sampling data:	Did not detect significant levels over background
Engineering control:	General ventilation in ABS processing facilities; temperature control in process

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as a monomer, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure durations.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.

Overall Quality Determination Medium

Study Citation:	USTMA, (2020). Comment regarding 1,3-butadiene, submitted by U.S. Tire Manufacturers Association (USTMA), dated 05/26/2020.
HERO ID:	8802198
Conditions of Use:	Processing – incorporation into article: Other: Polymer in: Rubber and plastic product manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	Pg. 6/24: "It should be noted that the tire manufacturers have conducted objective evaluations of potential exposures in accordance with the OSHA butadiene standard and based on the very low residual amount of 1,3- butadiene in the synthetic polymers that are used in making a tire, most member companies determined that there is no potential for worker exposure in their factories "above the OSHA action level or STEL under the expected conditions of processing, use, or handling that will cause the greatest possible release or in any plausible accident," and therefore have not conducted air sampling. However, three companies provided quantitative exposure monitoring data that represent full-shift worker exposures in various operations associated with tire manufacturing during the time period of1998 – 2018. See attachment A.""...across all three companies, the detection frequency was 36%. No air concentrations of butadiene were measured in excess of the OSHA PEL or action level. There are 87 air samples associated with workers and various operations associated with tire manufacturing including mixing, milling, curing, block cutting, and machine operation (e.g. cutters, conveyers, and chippers). The median (50th percentile) air concentration was 0.09 ppm and the 95th percentile was 0.29 ppm."
Area sampling data:	Pg. 6/24: "There are 9 area air samples thatwere collected in various operational areas including maintenance, reprocessing, calendaring and rubber mixing, which can be used to characterize ONU exposures. The butadiene air concentrations inthese areas were not detectable with reported detection limits ranging from <0.019 to <0.05 ppm."
Dermal exposure data:	nan
Exposure duration:	Attachment A contains data associated with 87 personal and area samples taken at sites associated with 3 companies. The sampling duration is reported as 8hrs., App 8hrs., 12 hrs. and full shift.
Number of workers:	Pg. 1/24: The 13 companies who produce tires in the U.S. and are members of the U.S. Tire Manufacturers Association (USTMA) "support more than a quarter million tire manufacturing U.S. jobs."
Personal protective equipment:	Pg. 7/24: "the standard PPE requirements in mainoperational areas of the factory (i.e., raw materials weighing and transfer, rubber mixing, milling, calendaring, extrusion, and curing) include safety glasses, steel toe shoes, work gloves and in some areas hearing protection."
Engineering control:	Pg. 7/24: "Given the low potential for worker and ONU exposure to butadiene in the tire manufacturing, engineering controls and PPE have not been specifically designated to control exposures to butadiene. However, throughout the manufacturing process, PPE and local ventilation may be present to limit worker exposures to other substances. For example, ...Engineering controls may include local exhaust ventilation for various operations including mixers (which are also generally enclosed with dedicated exhaust), mills, grinding or machining, and curing ovens. Examples of other engineering controls may include use of pre-melt bagsfor adding minor ingredients to the mixer or mills, various floor sweeper/cleaners to ensure particulate does not accumulate on working surfaces, and isolation of noisy equipment to minimize sound levels in the factory."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	The sampling and analytical method is an OSHA method in the case of all but 4 of the 87 samples.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	Tire manufacture is a COU
Metric 4:	Temporal Representativeness	High	Sampling occurred during the years 1998 – 2018. Although some of the data is more than 10 years old, all sampling occurred after the revised OSHA butadiene standard from 1996.
Metric 5:	Sample Size	High	All data is reported, so samples can be statistically characterized.

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Study Citation:	USTMA, (2020). Comment regarding 1,3-butadiene, submitted by U.S. Tire Manufacturers Association (USTMA), dated 05/26/2020.
HERO ID:	8802198
Conditions of Use:	Processing – incorporation into article: Other: Polymer in: Rubber and plastic product manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most meta data is reported. Exposure frequency is not reported.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	A discussion of uncertainty and variability is lacking.

Overall Quality Determination High

Study Citation:	Vacek, P. M., Albertini, R. J., Sram, R. J., Upton, P., Swenberg, J. A. (2010). Hemoglobin adducts in 1,3-butadiene exposed Czech workers: female-male comparisons. Chemico-Biological Interactions 188(3):668-676.
HERO ID:	1331490
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	Table 1Exposed males: n=30, mean=0.808 mg/m3, S.D.=1.663 mg/m3; Control males: n=25, mean=0.007 mg/m3, S.D.=0.012 mg/m3;Exposed females: n=23, mean=0.397 mg/m3, S.D.=1.094 mg/m3;Control females: n=23, mean=0.008 mg/m3, S.D.=0.015 mg/m3
Exposure duration:	8 hours
Number of workers:	23 exposed females, 26 female controls, 30 exposed males, 25 male controls
Comments:	The exposure data in this study was originally published in [41] R.J. Albertini, R.J. Sram, P.M. Vacek, J. Lynch, P. Rossner, J.A. Nicklas, J.D. McDonald, G. Boysen, N. Georgieva, J.A. Swenberg, Molecular epidemiological studies in 1,3-butadiene exposed Czech workers: female–male comparisons, Chem. Biol. Interact. 166 (2007) 63–77. HERO ID=1329826

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of butadiene as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by making 10 visits to the testing site.

Overall Quality Determination High

Study Citation:	Vallecillos, L., Espallargas, E., Allo, R., Marcé, R. M., Borrull, F. (2019). Passive sampling of volatile organic compounds in industrial atmospheres: Uptake rate determinations and application. Science of the Total Environment 666:235-244.
HERO ID:	5068479
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Site 1: 9.81 µg/m3 Site 9: 6.76 µg/m3 Site 2: 3.27 µg/m3 Site 10: 0.79 µg/m3 Site 3: 3.77 µg/m3 Site 11: 0.87 µg/m3 Site 4: 1.29 µg/m3 Site 12: 0.81 µg/m3 Site 5: 3.19 µg/m3 Site 13: 1.59 µg/m3 Site 6: 3.36 µg/m3 Site 14: 3.16 µg/m3 Site 7: 4.65 µg/m3 Site 15: 1.06 µg/m3 Site 8: 7.35 µg/m3 Site 16: 1.25 µg/m3”
Exposure duration:	6 hours
Comments:	See Table 3. Concentrations of the target VOCs found in air samples from zone A (sites 1–8) in the North Industrial Complex of Tarragona

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved EPA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Spain, an OECD country.
	Metric 3:	Applicability	High	Data are for monomer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites and collecting multiple samples at each site.

Overall Quality Determination High

Study Citation:	Vallecillos, L., Maceira, A., Marce, Maria, R., Borrull, F. (2018). Evaluation of active sampling strategies for the determination of 1,3-butadiene in air. Atmospheric Environment 176:21-29.
HERO ID:	4261630
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	3 different sites inside a butadiene production plant
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Site 1: 69.9-84.7 µg/m3 Site 2: 12.2-28.2 µg/m3 Site 3: 0.31-1.98 µg/m3 El Morell: 0.24-11.3 µg/m3 La Pobla de Mafumet: 0.12-0.41 µg/m3 Puigdelfi: 0.11-0.20 µg/m3”
Comments:	See Table 2: Concentrations of 1,3-butadiene found in air samples from a 1,3-BPP (Site 1–3) and at three locations in the vicinity of the North Industrial Park in Tarragona.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved EPA method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Spain, an OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing measurement method, number of workers, exposure duration & frequency, engineering controls & PPE.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple sites multiple times.

Overall Quality Determination High

Study Citation:	Vodicka, P., Kumar, R., Stetina, R., Musak, L., Soucek, P., Haufroid, V., Sasiadek, M., Vodickova, L., Naccarati, A., Sedikova, J., Sanyal, S., Kuricova, M., Brsiak, V., Norppa, H. (2004). Markers of individual susceptibility and DNA repair rate in workers exposed to xenobiotics in a tire plant. Environmental and Molecular Mutagenesis 44(4):283-292.
HERO ID:	5703361
Conditions of Use:	Rubber product manufacturing (tires)

EXTRACTION

Parameter	**Data**
Worker activity description:	Mixing department of tire plant (includes calendars, extruder operators, dump workers, knead workers, assistants)... Other lower-exposure groups included inner-tube production section, pressing department, fire brigade members, clerks... Others included in separate group as checking and quality control job functions
Physical form:	component of rubber polymer for tires
Personal sampling data:	Concentration of BD in mixing department ranged from 2.4 to 2.8 mg/m3 with mean of 2.6+/-0.2 mg/m3... Concentration of BD in pressing department ranged from 0 to 5.8 mg/m3 with mean of 2.3+/-2.2 mg/m3... Concentration of BD in inner tube production area ranged from 0.1 to 1.2 mg/m3(Pg. 4/10, Results section)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Slovak Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for rubber product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected after 2000 and appears to be greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range, mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Wang, Q., Wang, A. H., Tan, H. S., Feng, N. N., Ye, Y. J., Feng, X. Q., Liu, G., Zheng, Y. X., Xia, Z. L. (2010). Genetic polymorphisms of DNA repair genes and chromosomal damage in workers exposed to 1,3-butadiene. Carcinogenesis 31(5):858-863.
HERO ID:	4687483
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Plant operations, product storage, waste water conduct, administrative offices
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Storage sites: 182.53 mg/m3 Operational sites: 1985.99 mg/m3 Vibrating screen sites: 153.35 mg/m3 Range of all site measurements: 0.05-1985.99 mg/m3”
Exposure duration:	8 hours/day, 5-6 days/week
Exposure frequency:	At least one year of exposure
Number of workers:	166

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for plastic material manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by using a control group, and sampling different locations throughout the plant.

Overall Quality Determination High

Study Citation:	Ward, J. B., Abdel-Rahman, S. Z., Henderson, R. F., Stock, T. H., Morandi, M., Rosenblatt, J. I., Ammenheuser, M. M. (2001). Assessment of butadiene exposure in synthetic rubber manufacturing workers in Texas using frequencies of hprt mutant lymphocytes as a biomarker. Chemico-Biological Interactions 135-136:465-483.
HERO ID:	2959639
Conditions of Use:	Processing (Synthetic rubber manufacturing)

EXTRACTION

Parameter	**Data**
Worker activity description:	"High Exposure Group: reactor, recovery, tank farm, and laboratory workers. Low Exposure Group:Coagulation, baling, packaging, water plant, shipping, warehouse, control room" (Table 1 footnote)
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	From Table 1, pg. 9/19:Tank farm: 4.04+-3.45 ppm Reactor: 0.64+-1.26 ppm Recovery: 1.09+-2.35 ppm Laboratory: 0.29+-0.33 ppm Blending: 0.49+-0.24 ppm Low Areas: 0.05+-0.06 ppm From Table 3, pg. 11/19:Group Mean for High Exposure: 1.71+-0.54 ppm Group Mean for Low Exposure: 0.07+-0.03 ppm
Exposure duration:	8 hours
Number of workers:	37 (sum of subjects not necessarily actual number of workers)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Method is well-described, and it is also stated that the method is very similar to an approved NIOSH method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, standard deviations P-values, confidence intervals provided. Also, a breakdown of the demographics of subjects was provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of theuncertainty in the exposure estimates.

Overall Quality Determination High

Study Citation:	Ward, J. B., Ammenheuser, M. M., Whorton, E. B., Bechtold, W. E., Kelsey, K. T., Legator, M. S. (1996). Biological monitoring for mutagenic effects of occupational exposure to butadiene. Toxicology 113(1-3):84-90.
HERO ID:	2984802
Conditions of Use:	Domestic manufacturing, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Higher exposure defined as areas around reactor, recovery, tank farm, and laboratory ... Lower exposure areas defined as blend, coagulation, bailers, shipping, utilities, and shops
Personal sampling data:	BD production plant... Study 1 - High exposure areas: 3.5 +/- 7.25ppm ; Central Control area: 0.03 +/- 0.03ppm... Study 2 - High exposure: 0.30 +/- 0.59ppm ; Intermediate exposure: 0.21 +/- 0.21ppm ; Low exposure: 0.12 +/- 0.27ppm... SBR plant (Study 3)... Of 40 samples collected in high exposure areas, 20 exceeded detection limit of 0.25ppm and 11 samples exceeded 1ppm; none of 26 samples exceeded detection limit in low exposure areas
Engineering control:	”modernization” of plant for comparing Study 1 and Study 2 at BD production plant; showed decreased exposure levels

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing and synthetic rubber manufacturing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ward, J. B., Jr, Ammenheuser, M. M., Bechtold, W. E., Whorton, E. B., Jr, Legator, M. S. (1995). Biological monitoring of workers exposed to 1,3-butadiene for mutation at the HPRT locus in lymphocytes. Environmental and Molecular Mutagenesis 25(S1):56.
HERO ID:	5549339
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	butadiene monomer production plant. Workers may work in production units (considered higher exposure area), rovers and tank farms (considered intermediate exposure area), and control centers and utilities (considered lower exposure area) (page 1 of 2, lower right article)
Area sampling data:	Article refers to a first study that saw concentrations of 1 ppm (additional context not provided). In the second study area concentrations were 0.3, 0.21, and 0.12ppm in the higher, intermediate, and lower exposure areas respectively. (page 1 of 2, lower right article)
Comments:	Study had personal samples as well but are not present in this abstract. Would need full text to gain more information.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Study from University of Texas Medical Branch, and the Inhalation Toxicology Research Institute (which no longer exists but was once a government research facility)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	In the US
	Metric 3:	Applicability	High	Within scope, 1,3-butadiene manufacturing
	Metric 4:	Temporal Representativeness	Low	from 1995
	Metric 5:	Sample Size	Low	Not mentioned in this abstract
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	study examines variability of different exposure areas. Minimal discussion, more information likely available in the full text.

Overall Quality Determination Medium

Study Citation:	Ward, J. B., Jr, Ammenheuser, M. M., Bechtold, W. E., Whorton, E. B., Jr, Legator, M. S. (1994). HPRT mutant lymphocyte frequencies in workers at a 1,3-butadiene production plant. Environmental Health Perspectives 102(Suppl 9):79-85.
HERO ID:	5684245
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in a chemical production plant with both high and low exposure to butadiene.
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	North Unit: 3.18+-7.13 ppm South Unit: 3.89+-7.60 ppm Central Control: 0.03+-0.03 ppm (Table 2, pg. 4/7)
Area sampling data:	The highest value obtained for an area sample in the production areas was 30 ppm. In central control the mean values were much lower (0.03 ppm) and the highest value obtained was 0.06 ppm. (in text of pg. 4/7)
Exposure duration:	8 hours
Exposure frequency:	"Low-Exposure: 9.3+-13.18 years Medium-Exposure: 17.7+-21.7 years High-Exposure: 3.3+-1.5 years" (Table 1, pg. 3/7)
Number of workers:	65,000 ("engaged in jobs in which there is some level of exposure to BD", pg. 1/7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites within the plant.

Overall Quality Determination High

Study Citation:	Wheatley, A., Sadhra, S. (2010). Carcinogenic risk assessment for emissions from clinical waste incineration and road traffic. International Journal of Environmental Health Research 20(5):313-327.
HERO ID:	1018314
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Worker activity description:	Bottom ash in the air comes from waste incineration.
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	At 12-20m away from carriageway, 0.19-0.23 micrograms/m3. At 22-32m away from carriageway, 0.16 micrograms/m3. At 41-62m away from carriageway, 0.13-0.14 micrograms/m3.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Sampling and Analytical Methodology	High	Uses an EPA method.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data is from USA.
	Metric 3: Applicability	High	Data is within scope.
	Metric 4: Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5: Sample Size	Medium	Statistics are fully characterized with means, ranges, and regression values.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Some data is included, but not all categories are mentioned.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Sources of variability addressed and put into context.

Overall Quality Determination High

Study Citation:	Wickliffe, J. K., Ammenheuser, M. M., Adler, P. J., Abdel-Rahman, S. Z., Ward, J. B. (2009). Evaluation of frequencies of HPRT mutant lymphocytes in butadiene polymer workers in a Southeast Texas facility. Environmental and Molecular Mutagenesis 50(2):82-87.
HERO ID:	2597190
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic rubber manufacturing
Worker activity description:	Production areas and recovery areas
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Mean of 93.5 ppb for all workers.
Exposure frequency:	ranged from 1 to 39 years in industry
Number of workers:	30

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means and medians of subgroups were provided in context, along with p-values and R2 values.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty briefly touched on in the conclusion.

Overall Quality Determination — High

Study Citation:	Xiang, M., Ao, L.,in, Yang, H., Liu, W., Sun, L.,ei, Han, X.,ue, Li, D., Cui, Z., Zhou, N., Liu, J., Cao, J.,ia (2012). Chromosomal damage and polymorphisms of metabolic genes among 1, 3-butadiene-exposed workers in a matched study in China. Mutagenesis 27(4):415-421.
HERO ID:	2335640
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers in the exposed group worked in a procedure control center with a fixed circuit inspection routine
Personal sampling data:	personal 8-hr TWAs had mean of 0.34ppm and uncertainty of +/-0.61ppm
Area sampling data:	stationary sampling in BD production plant was 6.68 +/- 25.52ppm; one outlier measurement was recorded at 147.66ppm; without the outlier, the stationary sampling was 2.27 +/- 3.33ppm... historical records from 2002 showed higher stationary sampling values around 9.7 +/- 15.7ppm (stationary sampling in procedure control, product storage, and pipeline areas) (see text and Table I, pg. 3/7)
Exposure duration:	8-hr/day; routine inspection circuit occured once every hour for a total of no more than 1-hr/day spent in exposure areas
Exposure frequency:	4days/week working shift (top of 2nd column pg. 2/7)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected over 10 years ago
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD, and sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of theuncertainty in the exposure estimates.

Overall Quality Determination Medium

Study Citation:	Xiang, M., Sun, L., Dong, X., Yang, H., Liu, W. B., Zhou, N., Han, X., Zhou, Z., Cui, Z., Liu, J. Y., Cao, J., Ao, L. (2015). Association between genetic polymorphisms of dna repair genes and chromosomal damage for 1,3-butadiene-exposed workers in a matched study in china. BioMed Research International 2015:234675.
HERO ID:	4694616
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	a BD production plant (page 3 of 7)
Exposure route:	Inhalation (page 2 of 7)
Personal sampling data:	Exposed group: 0.34+- 0.61ppm Control group: 0.04+-0.01 ppm (page 3 of 7)
Area sampling data:	BD production plant area: 2.27+-3.33 ppm Control Office area: 0.84+-0.20 ppm (page 4 of 7)
Exposure duration:	8 hours (page 3 of 7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by using a control group, sampling different locations, and using a matched study.

Overall Quality Determination High

Study Citation:	Ye, Y., Galbally, I. E., Weeks, I. A., Duffy, B. L., Nelson, P. F. (1998). Evaporative emissions of 1,3-butadiene from petrol-fuelled motor vehicles. Atmospheric Environment 32(14-15):2685-2692.
HERO ID:	5547367
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for emissions to air , an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure concentration, number of sites, worker activity, number of workers, exposure duration & frequency, particle size, engineering controls, and PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different vehicle makes, models, and years.

Overall Quality Determination High

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
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Worker activity description:	Gas station service workers who work near VOC sources such as gasoline vapor emissions and motor vehicle emissions.
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	”Station 1: 6.3+-2.6 µg/m3 Station 2: 3.8+-0.2 µg/m3 Station 3: 8.6+-0.3 µg/m3 Station 4: 9.0+-0.4 µg/m3 Station 5: 20.4+-2.0 µg/m3 Station 6: 8.9+-0.0 µg/m3 Station 7: 11.1+-2.5 µg/m3 Station 8: 9.2+-1.1 µg/m3 Station 9: 11.3+-0.5 µg/m3”
Exposure duration:	8 hours/day
Exposure frequency:	300 days/year for 70 years
Number of workers:	15 males and 12 females

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Thailand, a non-OECD country.
Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (standard deviations, means, p-values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 9 different gas stations.

Overall Quality Determination High

Study Citation:	Zervas, E., Montagne, X., Lahaye, J. (2001). Emission of specific pollutants from a compression ignition engine Influence of fuel hydrotreatment and fuel/air equivalence ratio. Atmospheric Environment 35(7):1301-1306.
HERO ID:	14152
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	0.07-0.27 ppmv detected in exhaust gas

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	Low	Data are non-occupational and for ambient air, which is similar to the in-scope occupational scenario of outdoor construction/auto workers.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by using different fuels and comparing emissions. Uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Zhang, L., Hayes, R. B., Guo, W., Mchale, C. M., Yin, S., Wiencke, J. K., O'Neill, Patrick, J., Rothman, N., Li, G. L., Smith, M. T. (2004). Lack of increased genetic damage in 1,3-butadiene-exposed Chinese workers studied in relation to EPHX1 and GST genotypes. Mutation Research 558(1-2):63-74.
HERO ID:	5562516
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	Median of 2.0 ppm, mean of 44.0 ppm in air.
Exposure duration:	6 hours
Exposure frequency:	"Exposed Males: 8.2+-6.3 years Exposed Females: 6.7+-5.7 years"
Number of workers:	39 (page 67)
Comments:	See Table 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling two groups of subjects.

Overall Quality Determination Medium

Study Citation:	Zhao, C., Vodicka, P., Srám1, R. J., Hemminki, K. (2000). Human DNA adducts of 1,3-butadiene, an important environmental carcinogen. Carcinogenesis 21(1):107-111.
HERO ID:	2988721
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Personal sampling data:	See Table 1 on page 2 of 5 for all exposure data. For the exposed group, data ranged from <0.011-17.0 mg/m3 and for the control group data ranged from <0.005-0.15 mg/m3.
Exposure duration:	8 hours (page 1 of 5)
Exposure frequency:	mean employment time for exposed workers was 15.3+-10.5 years (page 1 of 5)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Report states that personal and stationary air sampling was used, but doesn't elaborate or include if a standard was used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	Medium	For direct butadiene exposure concentrations, only individual values were reported, and no statistics were presented for them.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Limitations of the study were described.

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
Conditions of Use:	Laboratory Use and General Population Exposure

EXTRACTION

Parameter	**Data**
Worker activity description:	citizens were sampled in residential indoor, outdoor, workplace (office and laboratory) and in-vehicle microenvironments
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Personal sample concentration of 0.67 +- 0.70 μg/m3
Area sampling data:	Indoor air sample concentration of 0.54 +- 0.30 μg/m3 Outdoor air sample concentration of 0.36 +- 0.63 μg/m3 Workplace air sample concentration of 0.25 +- 0.11 μg/m3 Vehicle air sample concentration of 0.62 +- 0.34 μg/m3
Number of workers:	12

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from an non-OECD country.
	Metric 3:	Applicability	Low	Most of the data is for non-occupational scenarios, but the workplace sampling data includes laboratory exposure.
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of sample is fully characterized with regressions, means, standard deviations, p-values, and more.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty in the study was well explained through statistics and mentioned in the report. Variability is addressed by measuring air concentrations at different locations.

Overall Quality Determination Medium

Study Citation:	Zielinska, B., Fujita, E., Ollison, W., Campbell, D., Sagebiel, J. (2012). Quantification of personal exposure concentrations to gasoline vehicle emissions in high-end exposure microenvironments: effects of fuel and season. Journal of the Air and Waste Management Association 62(11):1346-1357.
HERO ID:	1641371
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Worker activity description:	Exposure was measured in 13 microenvironments like tunnels, toll plazas, and freeways.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	From graph, butadiene breath concentrations range from 0-13ppbv.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Uses an EPA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Low	Data is for a personal scenario, but can be compared to occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	The data are more than 10 years old even though the paper was published less than 10 years ago.
	Metric 5:	Sample Size	High	Full range of statistics given, including means, standard deviations, R2 values, p-values, and number of samples.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation explained in report and displayed in graphs.

Overall Quality Determination High

Study Citation:	Šrám, R. J., Rössner, P., Peltonen, K., Podrazilová, K., Mračková, G., Demopoulos, N. A., Stephanou, G., Vlachodimitropoulos, D., Darroudi, F., Tates, A. D. (1998). Chromosomal aberrations, sister-chromatid exchanges, cells with high frequency of SCE, micronuclei and comet assay parameters in 1,3-butadiene-exposed workers. Mutation Research: Genetic Toxicology and Environmental Mutagenesis 419(1-3):145-154.
HERO ID:	2454197
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers at BD monomer production unit at a petrochemical company in Czech Republic (page 2 of 10)
Personal sampling data:	Table 1 on page 4 of 10 shows the results of both exposed and control groups exposure to BD. The exposed group data ranged from <0.011 mg/m^3 to 23.05 mg/m^3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Czech Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker tasks.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Fiserova-Bergerova, V., Pierce, J. T., Droz, P. O. (1990). Dermal absorption potential of industrial chemicals: Criteria for skin notation. American Journal of Industrial Medicine 17(5):617-635.
HERO ID:	32206
Conditions of Use:	Manufacturing, Processing, Use

EXTRACTION

Parameter	**Data**
Exposure route:	Dermal
Physical form:	model utilizes saturated aqueous solution of chemical as a basis
Dermal exposure data:	Dermal exposure data

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Model can be applied to any in-scope occupational scenario in which dermal exposure occurs
	Metric 4:	Temporal Representativeness	Low	Model is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	Medium	Variability addressed by adjusting parameter values, but uncertainty is not addressed

Overall Quality Determination High

Study Citation:	Malachowski, M. S., Levine, S. P., Herrin, G., Spear, R. C., Yost, M., Yi, Z. (1994). Workplace and environmental air contaminant concentrations measured by open path fourier transform infrared spectroscopy: A statistical process control technique to detect changes from normal operating conditions. Journal of the Air and Waste Management Association 44(R01-OH-02666):673-682.
HERO ID:	1009537
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Polymerization in plastic manufacturing
Exposure route:	inhalation
Physical form:	vapor

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	No mathematical errors found, equations described and seem appropriate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA
	Metric 3:	Applicability	Uninformative	Model not applicable to the scope, this report is all theory and equation based, and doesn't say how to apply the model to butadiene exposures.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	All rationale, equations, groupings, and parameters are thoroughly explained.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	Model thoroughly explains uncertainty.

Overall Quality Determination Uninformative

Study Citation:	Ng, M. G., Tongeren, van, M., Semple, S. (2014). Simulated transfer of liquids and powders from hands and clothing to the mouth. Journal of Occupational and Environmental Hygiene 11(10):633-644.
HERO ID:	3222353
Conditions of Use:	COU involving dermal exposure

EXTRACTION

Parameter	**Data**
Exposure route:	hand/object to mouth (inadvertent ingestion)
Physical form:	Liquid and powder
Dermal exposure data:	Dermal exposure data
Exposure frequency:	pg. 2/13: Observational studies of adults have shown average hand-to-mouth contact frequencies of 2–5 contacts per hour
Number of workers:	Pg. 2/13: Cherrie et al. have estimated that inadvertent ingestion could be a significant route of occupational exposure for 16% of the U.K. working population.
Comments:	This data source contains laboratory measurements of the transfer efficiency pertaining to inadvertent ingestion resulting from hand/object -to-mouth transfer. The transfer efficiency is equal to the fraction of the material located on the hand or object that is ingested. The transfer efficiencies reported in the data source pertain to surrogate chemicals. An equation is given for calculating exposure, or the amount of material inadvertently ingested, from these transfer efficiencies. pg. 12/13: "This study has provided evidence that transfer of chemicals from the hands or objects to the mouth is influenced by parameters including physical state, chemical/physical properties, and use of protective clothing. These findings may have implications for exposure modeling and exposure control. This work was preliminary in nature and additional study is required to obtain a greater understanding of the parameters that can affect transfer and the possible interactions between them."

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The equation for amount inadvertently ingested is reasonable. The method of measuring transfer efficiency is sound.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	N/A	The geographic attribute is not relevant in the case of a mathematical model and data obtain via laboratory experiments.
	Metric 3:	Applicability	High	Inadvertent digestion is tentatively in scope (EPA will consider this scenario according to the Scope Documents.)
	Metric 4:	Temporal Representativeness	High	The data were generated less than 10 years ago.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Meta data is complete.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	Variability and uncertainty are well characterized.

Overall Quality Determination High

Study Citation:	3E Company, (1992). Health risk assessment in fulfillment of requirements under the AB2588 Air Toxics Information and Assessment Act of 1987 (final report), Northrop B-2 Division, Pico Rivera, CA, with attachments and letter dated 02/14/1992.
HERO ID:	1356128
Conditions of Use:	Other - combustion byproduct

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor
Exposure duration:	9 hours/day
Exposure frequency:	260 days/yr for 40 years

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	EPA believes that 1,3-butadiene is being emitted as a fuel combustion byproduct, an occupational scenario that is not within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	The occupational exposure information contains no data to evaluate using this metric.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	The occupational exposure information contains no data to evaluate using this metric.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	The occupational exposure information contains no data to evaluate using this metric.

Overall Quality Determination Uninformative

Study Citation:	Albertini, R., Clewell, H., Himmelstein, M. W., Morinello, E., Olin, S., Preston, J., Scarano, L., Smith, M. T., Swenberg, J., Tice, R., Travis, C. (2003). The use of non-tumor data in cancer risk assessment: reflections on butadiene, vinyl chloride, and benzene. Regulatory Toxicology and Pharmacology 37(1):105-132.
HERO ID:	1328548
Conditions of Use:	Processing (SBR)

EXTRACTION

Parameter	**Data**
Worker activity description:	Monomer production workers
Exposure route:	inhalation
Personal sampling data:	Workers in a monomer production facility with BD exposures ranged from <0.02 to 37.6 mg/m3. Another study included 24 BD monomer production workers [mean BD exposure = 0.642 mg/m3] 34 polymerization workers [mean BD exposure = 1.794 mg/m3], and 25 controls [mean BD exposure = 0.023 mg/m3].

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for the use of butadiene in polymerization, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by discussion limitations of animal vs human studies, and current available data. Variability is addressed by including multiple studies in the report.

Overall Quality Determination — High

Study Citation:	ATSDR, (2012). Toxicological profile for 1,3-butadiene.
HERO ID:	2991419
Conditions of Use:	Processing (SBR)

EXTRACTION

Parameter	**Data**
Worker activity description:	Polymerization, coagulation, finishing, maintenance, lab, shipping, and utilities workers
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Within a styrene-butadiene rubber plant, mean exposure concentrations range from 0.20-103 mg/m3 in different areas between 1977 and 1991. Within a petrochemical facility, 0.56 mg/m3 between 1997-2003. (pg. 161/229)Also see Table 6-5

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	NIOSH and EPA methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Most data is from U.S, some supplemental studies are included from Canada.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of any study included in the report are fully characterized. Many studies are summarized, all of which are representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources are all documented and cited.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed throughout the report, and there is a section dedicated to it.

Overall Quality Determination High

Study Citation:	Bolognesi, C., Kirsch-Volders, M. (2016). The ex vivo L-CBMN assay detects significant human exposure to butadiene. Mutation Research 770(Pt A):73-83.
HERO ID:	4656923
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	workers at butadiene production units in a petrochemical plants, butadiene monomer and polymer production plants, polybutadiene latex production plants
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Many different studies and results included, range from 0.24-147.66 ppm.
Exposure duration:	range between various studies, starting at 2 hours/day
Exposure frequency:	range between various studies, starting at 1 year of employment minimum
Comments:	See Table 1 for more data.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is pulled from three countries, two of three are in the OECD.
	Metric 3:	Applicability	High	Data are for synthetic rubber and polymer manufacturing, petrochemical manufacturing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Some data included in the review is over 20 years old, some is between 10 and 20 years old, and some is less than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by using a quality score for included sources. Variability addressed by using various different sources in the literature review.

Overall Quality Determination High

Study Citation:	Bond, G. G., Bodner, K. M., Olsen, G. W., Cook, R. R. (1992). Mortality among workers engaged in the development or manufacture of styrene-based products - an update. Scandinavian Journal of Work, Environment and Health 18(3):145-154.
HERO ID:	10961
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	styrene-butadiene latex production, product research and development, polymerization, coloring, and extruding
Exposure route:	inhalation
Physical form:	vapor
Exposure duration:	8 hours
Exposure frequency:	average of 30.9 years per worker
Number of workers:	2904

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ratios, percentiles, number of samples, confidence intervals) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by grouping workers by work area and exposure duration. Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Brooke, I. M. (1996). Risk assessment of butadiene for the Existing Substances Regulation (ESR) in the European Union. Toxicology 113(1-3):226-230.
HERO ID:	5577276
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Personal sampling data:	”Momoner production: 0.12-2 ppm Polymer production: 0-3 ppm”
Exposure duration:	20 mins

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3: Applicability	High	Data are for monomer and polymer production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by describing the aspects of the data that are lacking. Variability addressed by the different studies included in the report.

Overall Quality Determination High

Study Citation:	Choudhary, G. (1994). Environmental exposure to 1 3-butadiene: A human health perspective. Journal of Environmental Science and Health, Part C: Environmental Carcinogenesis & Ecotoxicology Reviews 12(1):23-61.
HERO ID:	5621174
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers may also be exposed to 1,3-butadiene in the production area of a styrene-butadiene rubber (SBR) factory
Exposure route:	inhalation
Physical form:	gas
Number of workers:	1,221 workers in paper and allied products. 44,980 workers in chemicals and allied products. 84 workers in petroleum and coal products. 9,086 workers in rubber and plastic products. 55 workers in primary metal industries. 96 workers in fabricated metal products. 1,210 workers in machinery. 121 workers in electrical equipment and supplies. 175 workers in transportation equipment. 145 workers in instruments and related products. 2,244 workers in misc. manufacturing. 5,339 workers in misc. business services. 493 workers in medical health services.
Comments:	See Table II.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by stating that there are gaps in the data, and suggesting where more research needs to be conducted. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Downs, T. D., Crane, M. M., Kim, K. W. (1987). Mortality among workers at a butadiene facility. American Journal of Industrial Medicine 12(3):311-329.
HERO ID:	94761
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Utility workers, maintenance personnel, office workers, process workers, lab personnel, storage and transportation workers, supervisors, engineers.
Exposure route:	inhalation
Physical form:	vapor
Exposure frequency:	At least 6 months of employment
Number of workers:	2586
Comments:	See table III

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Social Security Administration records used and Texas state records used. NIOSH reports are referenced.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Many statistics provided that fully characterize the data. Statistics given on all subgroups.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources, assessment methods, and results are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainties are addressed and explained in the report.

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
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	9.50E-03 ug/m3 maximum hourly concentration in storage tank area, 3.06E-04 ug/m3 maximum hourly concentration in the wastewater treatment area.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Sources of uncertainty in the risk assessment are discussed in detail. Variability addressed by considering alternate emission scenarios for the refinery.

Overall Quality Determination High

Study Citation:	ENSR, (1991). AB 2588 Health risk assessment for the Texaco refinery Area 3, Bakersfield, California.
HERO ID:	6339343
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Exposure from the storage tank area.
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	5.27E-04 ug/m3 maximum hourly concentration in storage tank area.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Sources of uncertainty in the risk assessment are discussed in detail. Variability addressed by considering alternate emission scenarios for the refinery.

Overall Quality Determination High

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
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	lubricants, paints, and coatings for aircrafts
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Residential MEI: 0.00030 µg/m3 Occupational MEI: 0.00023 µg/m3”
Exposure duration:	40 hours/week, 50 weeks/year
Exposure frequency:	46 years

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for aircraft lubricants, coatings, and paints, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by selecting parameter values to reflect site conditions. Variability addressed by sampling at multiple sites.

Overall Quality Determination High

Study Citation:	Hallenbeck, W. H. (1992). Cancer risk assessment for the inhalation of 1,3-butadiene using physiologically based pharmacokinetic modeling. Bulletin of Environmental Contamination and Toxicology 49(1):66-70.
HERO ID:	820099
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Personal sampling data:	”workplace” exposures range from 0.06 to 39ppm, generally less than 10ppm
Exposure duration:	Assumes an intake of 10 m3/day of contaminated air over250 days and 45 years. The air intake of an adultengaged in light activity for 8 hours is about 10 m 3(Hallenbeck 1986).
Number of workers:	About 65,000 workers potentially are exposed to BD
Comments:	See Table 1-3 for calculations using various scenarios.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic occupational scenarios, which may include in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Himmelstein, M. W., Baan, R. A., Albertini, R. J., Bird, M. G., Lewis, R. J. (2007). International symposium on the evaluation of butadiene and chloroprene health risks. Chemico-Biological Interactions 166(1-3):1-9.
HERO ID:	4440080
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	styrene-butadiene rubber plant workers, monomer production workers, latex plant workers
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	”Shell facilities in Texas: 4.55 ppm from 1979-1996, 0.25 ppm from 1997-2003 Study of Czech workers: 0.180 ppm and 0.370 ppm in two studies at one facility”

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Assessment does not specify the techniques used, only summarizes findings.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is pulled from many countries, some are in the OECD.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Hurst, H. E. (2007). Toxicology of 1,3-butadiene, chloroprene, and isoprene. Reviews of Environmental Contamination and Toxicology 189:131-179.
HERO ID:	646909
Conditions of Use:	General/Unknown

EXTRACTION

Parameter	**Data**
Personal sampling data:	measured exposures in the range of 1-3.5ppm with max exposures of 10ppm; before 1995 ”occupational exposures”
Number of workers:	Estimated 7,000 workers exposed to butadiene in the workplace (2001)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic occupational exposures, which is similar to the in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Huy, L. N., Lee, S. C., Zhang, Z. (2018). Human cancer risk estimation for 1,3-butadiene: An assessment of personal exposure and different microenvironments. Science of the Total Environment 616-617:1599-1611.
HERO ID:	4283815
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Worker activity description:	five microenvironments: residential home, outdoor, in-vehicle, in-office, and dining
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	”Concentrations from various literature sources for 175 sites given, major sites listed below: Birmingham: 1.1+-2.4 µg/m3 Stockholm: 0.5+-0.5 µg/m3 Tianjin: 0.67+-0.7 µg/m3 Mexico City: 2.9+-2.4 µg/m3 New York: 0.87+-1.29 µg/m3”
Exposure duration:	sampling durations range from 50 min -24 hours
Exposure frequency:	lifetime

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is pulled from many countries, some are in the OECD.
	Metric 3: Applicability	Low	Data are for personal exposures within cities, which is similar to the in-scope occupational scenario of emissions to air.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by mentioning unavailability of data in most countries. Variability addressed by including studies for different microenvironments and age groups.

Overall Quality Determination High

Study Citation: IARC, (1992). Occupational exposures to mists and vapours from strong inorganic acids; and other industrial chemicals.
HERO ID: 1104546
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Worker activity description:	petroleum refining and related operations, production of purified 1,3-butadiene monomer, production of various 1,3-butadiene based rubber and plastics polymers and other derivatives, and the rubber and plastics products manufacturing industry
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Table 3 contains PBZ from European countriesTable 4 contains mean 8-h samples from refineriesTable 5 contains PBZ from USWhat was originally provided below appears to have come from these Tables; "Production workers in refineries: 0.24 ppm Maintenance workers in refineries: 0.11 ppm Distribution workers in refineries: 2.9 ppm Laboratory workers in refineries: 0.18 ppm Control room technician in monomer production: 0.45 ppm Process area technician in monomer production: 2.23 ppm Lab technician in monomer production: 1.06 ppm Process technicians in polymer production: 0.020-14.6 ppm Lab technician in polymer production: 2.27 ppm Maintenance technician in polymer production: 1.37 ppm Utilities operator in polymer production: 0.118 ppm SBR manufacturing: 0.22-58.62 ppm"
Number of workers:	52,000 potentially exposed to BD in USA 1981-83 (pg 242/345)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Most data is from the US, but other countries are included, and the report was published in France.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by the statistics presented in the report. Variability addressed by including many data sources from different sectors of production.

Overall Quality Determination High

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Manufacturing, Processing, Consumer Use

EXTRACTION

Parameter	**Data**
Worker activity description:	Included production, loading transportation and tanks, maintenance, laboratory, etc.
Physical form:	gas/petroleum constituent
Personal sampling data:	Means ranged from ND to 6.4ppm for various worker activities associated with gasoline (1984-1985)... Means ranged from 0.11 to 2.9ppm for various jobs in petrochemical facilities (1984-1987)... Butadiene production plants in EU show personal exposure chart by frequency of samples ranging from <1ppm to >25ppm for various job categories in EU (1986-1993)
Number of workers:	540 (for 1984-1985 study)... 3,096 total samples (for 1986-1993 study)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for petroleum and gas occupational exposures, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (typically give average, range, and/or sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by limitations in each study. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Rubber and plastic product manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	ABS molding, tire and tube manufacturing
Physical form:	unreacted butadiene; detected as trace (0.04-0.2mg/kg) in 15 of 37 bulk samples from polymers and other BD products 1985-1986
Personal sampling data:	Various exposure measurements from different studies; 0.007-0.05ppm in samples from tire plant; ABS molding operation showed personal 8hr TWAs of <0.05-1.9mg/m3

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for petroleum and gas occupational exposures, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (typically give average, range, and/or sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by limitations in each study. Variability is not addressed.

Overall Quality Determination Medium

Study Citation: IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID: 201838
Conditions of Use: Manufacturing, Monomer Production

EXTRACTION

Parameter	Data
Worker activity description:	Included process workers, control room, loading, lab exposures
Personal sampling data:	Exposure level means ranged from 0.44 to 126ppm for various job categories; also included the geometric mean and range (US 1985 study)... Exposures ranged from 0 to 60ppm for various job categories; TWA and range of values given (EU 1985 study)... General data for various other plants: ambient air conc averaged 3.5ppm in production areas and 0.03ppm for control areas; Finnish plant 16 process workers had conc mean 11.5ppm

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petroleum and gas occupational exposures, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (typically give average, range, and/or sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by limitations in each study. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Synthetic rubber manufacturing, Polymerization

EXTRACTION

Parameter	**Data**
Worker activity description:	Included process operators, maintenance, recovery, lab exposures, unloading/loading, polymerization, purification, finishing, etc.
Personal sampling data:	Exposure level means ranged from 0.020 to 14.6ppm for various job categories; included geometric mean and range of values (US 1986 study)... Synthetic rubber production plants in EU show personal BD exposure chart by frequency of samples ranging from <1ppm to >25ppm for various job categories in (EU 1984-1993)... Exposure TWA means for different years and worker categories ranged from 0.54 to 5.45ppm ; included range and monitoring method (Norway 1990-1997 study)... Exposure level TWAs for various job classifications in SBR manufacturing plants ranged between 0.08 to 58.6ppm (US 1976-1979 study)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for petroleum and gas occupational exposures, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (typically give average, range, and/or sample size) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by limitations in each study. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	*Specified for each exposure data source*
Exposure route:	inhalation
Personal sampling data:	Personal exposures associated with butadiene in gasoline (includes refining), monomer production, polymer and derivatives production, and rubber and plastic product manufacture; compilation of data from numerous studies presented in table and text form, covers both United States and European countries primarily (covers PDF pages 121-131)
Number of workers:	50,000 workers in the United States

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for inexact occupational exposure scenarios, though similar to the in-scope occupational scenarios for processing and manufacturing.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	not applicable
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by specific data sources. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1986). Some chemicals used in plastics and elastomers.
HERO ID:	5549343
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Tank car loaders, vessel cleaners, reactor operators, stripping-column operators, coagulation operators, dryer operators, packing operators, warehousemen, lab analysts, maintenance workers, foremen, waste treatment workers
Exposure route:	inhalation, ingestion
Physical form:	vapor, plastics
Personal sampling data:	”SBR Production: 2-44 mg/m3 SBR Polymerization: 1 mg/m3 SBR Supervisors: 2.2 mg/m3 SBR Tank Farm: 1-55 mg/m3 SBR Maintenance: 0.5-17 mg/m3 SBR labs: 3-73 mg/m3 SBR general production: 13-88 mg/m3 ABS fabrication: 1.5-3 mg/m3 PBR warehouse: 0.02-0.03 mg/m3 PBR break-down mill: ND-0.11 mg/m3”
Exposure duration:	8 hours
Number of workers:	65000

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data & techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from many countries, most of which are in the OECD.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing and synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty addressed by stating where data is lacking, or there are too few samples. Variability addressed by referencing many studies done in different countries and workplace environments.

Overall Quality Determination High

Study Citation:	IARC, (2008). 1,3-Butadiene, ethylene oxide and vinyl halides (vinyl fluoride, vinyl chloride and vinyl bromide). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 97 97:3-471.
HERO ID:	755320
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Included process workers, production, control room, maintenance, handling transport containers, loading/unloading tank trucks and rail cars, lab exposures, polymerization, purification, finishing, ABS molding, tire and tube manufacturing, etc.
Physical form:	Gasoline/petroleum constituent, purified BD with some impurities, unreacted butadiene detected as trace amount
Personal sampling data:	Personal exposures associated with petroleum refining and monomer production, polymer and derivatives production, and rubber and plastic product manufacture; compilation of data from numerous studies presented in table and text form, covers both North American and European countries primarily (covers PDF pages 62-75)
Number of workers:	50,000 workers in the United States... 31,500 worker in European countries separated into major categories as: 8,000 in industrial chemicals, 7,000 in rubber products, 7,000 in plastic products, 2,200 in petroleum refining, and 1,600 in building construction

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Some data are from the U.S.
	Metric 3:	Applicability	High	Data are for various in-scope occupational scenarios including manufacturing, processing, and commercial use.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (in most cases a range, mean, and/or sample size are given) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by overall risk assessment methods and some individual study measurement uncertainties. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	IISRP, (1982). Mortality of workers in the styrene-butadiene rubber polymer manufacturing industry (final report) with attached status report, cover sheets and letter dated 120282.
HERO ID:	5372807
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in the production, utilities, maintenance, and other areas.
Exposure route:	inhalation
Physical form:	vapor
Exposure frequency:	at least one year of exposure
Number of workers:	13,920

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data and methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S., and one site in Canada.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by stating unknown values and population statistics in the sampling process. Variability addressed by running statistics with and without certain groups to see the sensitivity.

Overall Quality Determination High

Study Citation:	IISRP, (1986). Mortality of a cohort of workers in the styrene-butadiene polymer manufacturing industry 1943-1982 (final report) with cover letter dated 040888.
HERO ID:	5555546
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	production, warehouse and shipping, laboratory, research and development, administration, maintenance, utilities and other operations
Exposure route:	inhalation
Physical form:	gas
Exposure duration:	8 hrs
Exposure frequency:	at least one year
Number of workers:	13422

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data and methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study, and where more research needs to occur. Variability addressed by sampling sites more than once, sampling different sites, and dividing the study into subgroups.

Overall Quality Determination High

Study Citation:	Johns Hopkins University, (1988). Initial submission: 1,3-butadiene: study of lymphopoietic cancers in workers of the styrene-butadiene polymer manufacturing industry (final report) with cover letter dated 072492.
HERO ID:	5665273
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Process workers, utility workers, maintenance workers, service workers, warehouse workers, administrative workers, laboratory workers, pilot plant operators, engineers, and laborers
Exposure route:	inhalation
Exposure frequency:	at least one year of employment
Number of workers:	13,686

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for polymerization in synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by explaining possible sources of confounding in the data. Variability addressed by including different age groups and job classifications.

Overall Quality Determination High

Study Citation:	Johns Hopkins University, (1992). Initial submission: mortality of workers in the styrene-butadiene rubber polymer manufacturing industry with cover letter dated 082492.
HERO ID:	5790933
Conditions of Use:	Processing as a Reactant: Synthetic Rubber Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	cancers frequently associated with work in compounding, milling, calendaring, extrusion, and cementing (page 8 of 55) along with shipping and receiving group, mixing, inspection, finishing and repair groups (page 9 of 55) In the analysis the jobs were combined into four general work areas for comparison; production, utilities, maintenance, and other jobs (page 15 of 55)
Number of workers:	13,920 (page 18 of 55)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S., and one site in Canada.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing possible errors within the study. Variability addressed by sampling at 8 different sites.

Overall Quality Determination High

Study Citation:	Keshava, N., T-M, Ong (1999). Occupational exposure to genotoxic agents. Mutation Research 437(2):175-194.
HERO ID:	1267396
Conditions of Use:	Processing: Manufacturing synthetic rubber and plastics

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers involved in the production of polymers and synthetic rubber
Number of workers:	Approximately 10,000 workers involved in the production of polymers and synthetic rubber exposed to 1,3-butadiene when the report was written

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	NIOSH data was referenced.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data is from USA.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Data sources mentioned in report are all cited and referenced in the body of the report.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Landrigan, P. J. (1993). Critical assessment of epidemiological studies on the carcinogenicity of 1,3-butadiene and styrene. IARC Scientific Publications No. 127 (127):375-388.
HERO ID:	199999
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Employees at tire manufacturing plants involved in production of elastomers, employees at a butadiene manufacturing plant, employees at a styrene-butadiene manufacturing plant, employees at a SBR plant.
Exposure route:	inhalation
Number of workers:	8017 tire plant workers, 2749 butadiene manufacturing workers, 2756 styrene-butadiene manufacturing workers, 13,920 SBR plant workers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing and domestic manufacturing, both in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (number of workers) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by listing the potential sources of error in each study. Variability addressed by comparing multiple cohort studies.

Overall Quality Determination High

Study Citation:	Lawryk, N. J. (1994). Automobile commuter exposures to volatile organic compounds: Emissions, malfunctions, and policy.
HERO ID:	6025389
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Exposure duration:	The national daily average in-vehicle duration is 93.2 minutes.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by including a section of the report to discuss it. Variability addressed by sampling at different commute routes, and using different cars.

Overall Quality Determination High

Study Citation:	Matanoski, G. M., Schwartz, L. (1987). Mortality of workers in styrene-butadiene polymer production. Journal of Occupational and Environmental Medicine 29(8):675-680.
HERO ID:	73591
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Polymer in rubber manufacturing
Exposure frequency:	at least a year of employment
Number of workers:	13920

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Records were pulled using Social Security numbers and driving records, which aren't frequently used methods, but no indication of flaws.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA and Canada.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Data is well-characterized, with specific information given about the sample population, like age ranges and race.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources, assessment methods, and results are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is briefly mentioned at the end of the report.

Overall Quality Determination — High

Study Citation:	Meinhardt, T. J., Lemen, R. A., Crandall, M. S., Young, R. J. (1982). Environmental epidemiologic investigation of the styrene-butadiene rubber industry: Mortality patterns with discussion of the hematopoietic and lymphatic malignancies. Scandinavian Journal of Work, Environment and Health 86(4):250-259.
HERO ID:	62365
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic Rubber manufacturing
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	”0.11-4.17ppm at plant A, 0.34-174ppm at plant B mean of 1.24 ppm at plant A, 13.5ppm at plant B”
Exposure duration:	8hr/day
Exposure frequency:	9.48 years of employment at plant A, 10.78 years of employment at plant B
Number of workers:	3494 at plant A, 2015 at plant B

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	NIOSH method used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data from USA.
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	High	Data is characterized well, lots of information on individual sampling groups.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Sources are cited and referenced.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is mentioned, but not spoken about in detail.

Overall Quality Determination High

Study Citation:	Melnick, R. L., Huff, J. E., Bird, M. G., Acquavella (1990). Symposium overview: Toxicology, carcinogenesis, and human health aspects of 1,3-butadiene. Environmental Health Perspectives 86:3-5.
HERO ID:	5554903
Conditions of Use:	Processing (synthetic rubber manufacture)

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	gas
Area sampling data:	Occupational exposure to 1,3-butadiene in monomer production or from polymer manufacturing plants is generally less than 20 ppm; however, excursions in certain jobs resulted in exposures as high as 375 ppm. (2nd paragraph, pg. 2/3)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by discussing the limitations of the cohort study and where data is lacking. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1994). Initial submission: Mortality study of workers employed in 1,3-butadiene refining units identified from a large chemical workers cohort with cover letter dated 062094.
HERO ID:	5790851
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	butadiene refining units
Number of workers:	NIOSH has estimated that approximately 9500 workers in the United States are occupationally exposed to 1,3-butadiene

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (confidence intervals, p-values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study. Variability addressed by sampling different sites.

Overall Quality Determination High

Study Citation:	Northrop Corporation, (1992). Northrop corporation aircraft division: Health risk assessment for west complex (final report) with attachments and cover letter dated 021492.
HERO ID:	1577139
Conditions of Use:	Unknown

EXTRACTION

Parameter	**Data**
Worker activity description:	The facility is a large manufacturing plant which produces major aircraft sub-assemblies and components. Toxic compounds are emitted by the following processes:• Degreasing activities to clean tools and parts. Emissions are due mostly to chemical solvents such as 1,1,1-trichloroethane.• Coating operations which perform spray application of paints and hand applications of adhesives and sealants. Emissions are primarily in the form of volatile organic compounds (VOCs) emitted during drying and particulate matter (PM) emitted during spraying.• Surface cleaning operations which most often use 1,1,1-trichloroethane.• Refrigerant recharge and purging of equipment lines. Emissions are fluorocarbons such as freon.• Combustion products from boilers, autoclaves, process heating ovens and space heaters.
Exposure route:	Inhalation, Dermal
Exposure frequency:	5 days a week for 46 years

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The data are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Low	It is not known why butadiene is being emitted from the facility and if it is the result of an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	The extracted occupational exposure data is qualitative, therefore this metric is not applicable.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	The extracted occupational exposure data is qualitative, therefore this metric is not applicable.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	The extracted occupational exposure data is qualitative, therefore this metric is not applicable.

Overall Quality Determination Medium

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.
HERO ID:	3808976
Conditions of Use:	Use (paints and coatings)

EXTRACTION

Parameter	**Data**
Worker activity description:	transferring and mixing liquid products, container cleaning, transferring mixed coating to application equipment, overspray
Exposure route:	dermal and inhalation
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile liquids Inhalation: Provides methods for modeling exposures to mists”
Dermal exposure data:	nan
Exposure frequency:	250 days/yr (default)
Number of workers:	8 workers/site
Personal protective equipment:	air-purifying respirators or air-supplied respirators, Gloves (typically latex or nitrile), paint suits, and face masks/eye protection

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.
HERO ID:	3827299
Conditions of Use:	Processing: Adhesive Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading, container cleaning, mixing operations, sampling, equipment cleaning, packaging
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to both solids and non-volatile liquids Inhalation: Provides methods for modeling exposures to both solids and volatile liquids
Exposure frequency:	Exposure frequency: days/yr equal to number of bt/yr
Number of workers:	22 workers/site

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are reasonably expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.

Overall Quality Determination High

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.
HERO ID:	3827300
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Worker activity description:	unloading, container cleaning, adhesive application, equipment cleaning, curing/drying
Exposure route:	dermal and inhalation
Personal sampling data:	”dermal: Provides methods for modeling exposures to solids and non-volatile liquids Inhalation: Provides methods for modeling exposures to mists and volatile liquids”
Exposure frequency:	nan
Number of workers:	26-106 workers/site
Personal protective equipment:	chemical-resistant gloves and safety glasses. Heat-resistant gloves are used when applying hot-melt adhesives
Engineering control:	Spray booths

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.
HERO ID:	3833136
Conditions of Use:	Adhesive Application

EXTRACTION

Parameter	**Data**
Worker activity description:	unloading, container cleaning, adhesive application, equipment cleaning, curing/drying (Section 5, starting page 76)
Exposure route:	dermal and inhalation
Personal sampling data:	Inhalation: Provides methods for modeling exposures to mists and volatile liquids (Section 5, starting page 76)
Dermal exposure data:	nan
Exposure frequency:	up to 250 days/yr
Number of workers:	up to 106 workers/site (starting on page 78 of 189)
Personal protective equipment:	chemical-resistant gloves and safety glasses. Heat-resistant gloves are used when applying hot-melt adhesives
Engineering control:	Spray booths

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.
HERO ID:	3840003
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading, container cleaning, sampling, equipment cleaning, filter media changeout, packaging
Exposure route:	dermal and inhalation
Personal sampling data:	”dermal: Provides methods for modeling exposures to both solids and non-volatile liquids Inhalation: Provides methods for modeling exposures to both solids and volatile liquids”
Dermal exposure data:	nan
Exposure frequency:	nan
Number of workers:	18-39 workers/site
Personal protective equipment:	”fabric or non-woven long sleeved shirts and pants, coveralls, and neoprene or rubber gloves. Barrier creams may be used to facilitate hand washing when materials or products penetrate gloves or other PPE. A rubber apron or rubber suit and rubber boots may also be worn in cases where there is potential for splashing on or penetration through clothing”

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of UV curable products.

Overall Quality Determination Medium

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.
HERO ID:	6385735
Conditions of Use:	Processing and Commercial Use: Lubricant additives

EXTRACTION

Parameter	**Data**
Worker activity description:	"PROC: unloading, container cleaning, formulation, sampling, equipment cleaning, loading USE: Unloading, container cleaning"
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to non-volatile liquids. Inhalation: Provides methods for modeling exposures to volatile liquid chemical vapors.
Exposure frequency:	250 days/year
Number of workers:	"PROC: 22 workers/site USE: 4 workers/site"
Personal protective equipment:	"PROC: Respirators, gloves, safety glasses USE: gloves, protective footwear, protective headwear, dust masks or respirators"
Engineering control:	LEV

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination — High

Study Citation:	Omenn, G. S. (1996). Risk assessment for butadiene: Introductory and summary comments. Toxicology 113(1-3):5-11.
HERO ID:	5620716
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Personal sampling data:	1 ppm or less
Area sampling data:	1 ppb.
Number of workers:	250,000 workers exposed. Page 7 of the document.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene monomer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing discrepancies in different literature reports. Variability addressed by including different report from different sectors and time periods.

Overall Quality Determination High

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.
HERO ID:	5184986
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Exposure route:	dermal and inhalation
Personal sampling data:	Emission Scenario Document (ESD) states exposures not expected
Personal protective equipment:	clean room suits (fitted cap, face cover, gloves, and boots)
Engineering control:	equipment adhering to SEMI S-2 guidelines

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ott, M. G., Teta, M. J., Greenberg, H. L. (1989). Assessment of exposure to chemicals in a complex work environment. American Journal of Industrial Medicine 16(6):617-630.
HERO ID:	104202
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Number of workers:	30.5% of production worker employees exposed to 1,3-BD across three Union Carbide facilities, 1940-1978

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for manufacturing and processing, which is similar to the in-scope occupational scenarios specific to butadiene.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by limitations in data. Variability is not addressed.

Overall Quality Determination — Low

Study Citation:	Penn, A., Snyder, C. A. (2018). 13.26 - 1,3-butadiene and cardiovascular disease. :538-544.
HERO ID:	5727580
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation (page 4 of 7)
Physical form:	vapor (page 2 of 7)
Personal sampling data:	Reports of routine occupational exposures exceeding the 1-ppm TLV in the United States and other Western countries are rare. In a Finnish study (reported in 2006) that assessed personal exposure of 28 workers over 4 months in a styrene–BD copolymer manufacturing facility, only 21/885 air samples of BD exceeded 1 ppm and nearly three-fourth of the 885 were below 0.01 ppm, the limit of quantification of the personal monitors used. (page 2 of 7)8h TWA of 0.180 ppm in female and 0.370 ppm for male Czech chemical workers. Maximum values were 4.45 ppm for females and 5.70 ppm for males. (page 3 of 7)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages, maximums) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by including multiple studies in the report but uncertainty is not addressed.

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
Conditions of Use:	Other-Combustion byproduct

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers at the Exxon Co., USA, Benicia Refinery
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	TABLE 7. TOTAL CONCENTRATION OF CARCINOGENS IN AMBIENT AIR AT RECEPTOR OF MAXIMUM IMPACTButadiene 1.30E-03 µg/m3

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The data are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data is from USA.
	Metric 3: Applicability	Uninformative	EPA believes that the butadiene exposure is the result of its production as a byproduct of combustion, an occupational scenario that is not within scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Low	The butadiene air concentration is not characterized by statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The assessment does not address the variability or uncertainty of the air concentrations

Overall Quality Determination — Uninformative

Study Citation:	Research Statistics Inc, (1992). Initial submission: Mortality among workers at a butadiene production facility with cover letter dated 051492.
HERO ID:	5665284
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Group 1: utility workers, welders, electricians, office workers, management. Group 2: process workers, laboratory personnel, receiving, storage, and transport workers. Group 3: skilled maintenance workers. Group 4: supervisors and engineers.
Exposure frequency:	"Group 1: 5.4 years of employment Group 2: 4.5 years of employment Group 3: 4.9 years of employment Group 4: 7.9 years of employment"
Number of workers:	2586 (page 9)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by mentioning shortcomings of the study, like incorrect race classifications. Variability addressed by sampling many different types of workers.

Overall Quality Determination High

Study Citation:	Research Statistics Inc, (1985). Report - mortality among workers at a butadiene production facility - with cover letter dated 051586.
HERO ID:	5665530
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Group 1: utility workers, welders, electricians, office workers, management. Group 2: process workers, laboratory personnel, receiving, storage, and transport workers. Group 3: skilled maintenance workers. Group 4: supervisors and engineers.
Exposure frequency:	"Group 1: 5.4 years of employment Group 2: 4.5 years of employment Group 3: 4.9 years of employment Group 4: 7.9 years of employment"
Number of workers:	2586

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by mentioning shortcomings of the study, like incorrect race classifications.. Variability addressed by sampling many different types of workers.

Overall Quality Determination High

Study Citation:	Santos-Burgoa, C., Matanoski, G. M., Zeger, S., Schwartz, L. (1992). Lymphohematopoietic cancer in styrene-butadiene polymerization workers. American Journal of Epidemiology 136(7):843-854.
HERO ID:	11043
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Job categories were: process workers, utilities, maintenance, services, warehouse, administration, laboratory, pilot plant, engineering, and labor. Each category is broken down into even more specific job titles.
Exposure route:	inhalation
Number of workers:	13,686

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality analysis methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (ratios, percentiles, number of samples, confidence intervals) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in statistical analysis and in conclusion paragraphs. Variability is addressed by grouping workers by work area and exposure duration.

Overall Quality Determination — High

Study Citation:	Science Applications International Corporation, (1996). Generic scenario for automobile spray coating: Draft report.
HERO ID:	6311222
Conditions of Use:	Paints and Coatings: Automobile Spray Painting

EXTRACTION

Parameter	**Data**
Worker activity description:	Worker activities in or near automobile OEM painting operations include robotics operation, paint mixing, paint booth cleaning, inspection, and manual "touch-up" painting. It is expected that manual touch-up painting operations would be conducted in spray booths, allowing minimal or no overspray to other sections of the plant.Worker activities at automobile refinishing shops include wet sanding, car washing, stripping (paint removal), machine sanding, blowing, buffing, polishing, paint spraying, paint and primer mixing, and inspection.
Exposure route:	Inhalation, Dermal
Physical form:	Automobile spray painting operations produce aerosols containing droplets and solvent vapors to which workers may be exposed.
Personal sampling data:	TABLE 5Auto Refinishing: 7 cars/shift, 40 min/car, 4.0 - 16.1 mg/m3Kessler AFB: Spray painting trucks, 4 - 8 mg/m3Langley AFB: Spray painting aircraft ground equipment, 28 - 34 mg/m3Auto Refinishing: Spray painting automobiles, 0.26 - 18 mg/m3Auto Refinishing: Spray painting automobiles, GM = 1.9 mg/m3, GSD = 3.0 mg/m3Auto Refinishing: Spray painting automobiles, GM = 23 mg/m3, GSD = 1.8 mg/m3
Area sampling data:	TABLE 5Kessler AFB: Spray painting trucks, 7 - 15.8 mg/m3Langley AFB: Spray painting aircraft ground equipment, 15 - 46.9 mg/m3
Dermal exposure data:	Dermal exposure data
Exposure duration:	Default is 8 hours for either automobile OEM or refinishing. Thisduration is reasonable for OEM but is conservative for refinishing. Aduration of 1-2 hours can be, used as typical duration for automobile refinishing because other activities such as car preparation, paint mixing, and equipment cleaning take up most of the day. However, in some shops up to seven cars are painted per day and exposure duration is extended.
Exposure frequency:	For new automobile manufacturing: Assume 250. Basis: one automobile assembly plant operates one of its painting lines 2 shifts per day, 5 days per week.For automobile refinishing: Assume 170. Basis: Assume 250 days per year of shop operation, with the paint containing the material used 67 % of the time.
Number of workers:	For new automobile manufacturing: Default: 17 /site (includes only those workers directly involved in manual "touch-up" spray painting).For automobile refinishing: Default: 3/site. Basis: a typical shop employs 4 employees in production (BSB, 1995); only some of these employees would paint (i.e. <4). The number of production employees ranges from 1.9 to 10.1, on average depending on shop size, and the overall average for all shops is 3.88.
Personal protective equipment:	Because potential occupational exposures can exceed OSHA PELs during spray painting operations, respiratory protection is normally required for spray operations. Many types of respirators are available for such operations. If properly selected and used respirators can reduce worker exposure significantly. However, data from a NIOSH study indicates that respirator usage at five of six auto body repair shops evaluated was inappropriate.
Engineering control:	Spraying is often conducted in a spray booth to protect workers from paint spray toxics, to provide a mechanism for forced air drying, and to remove volatiles and paint solids from the workplace. In new automobile manufacture, all painting is expected to be performed in spray booths.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The generic scenario document uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned.
Metric 4:	Temporal Representativeness	Low	Generic scenario was created over 20 years ago.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.

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Study Citation: Science Applications International Corporation, (1996). Generic scenario for automobile spray coating: Draft report.
HERO ID: 6311222
Conditions of Use: Paints and Coatings: Automobile Spray Painting

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed through collection of inhalation data for multiple scenarios, but measurement uncertainty is not addressed.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).
HERO ID:	10480466
Conditions of Use:	Use - Laboratory Chemicals

EXTRACTION

Parameter	**Data**
Worker activity description:	container unloading (liquids and solids), container cleaning, equipment cleaning, laboratory analyses, disposal of laboratory chemicals. Some generic descriptions provided on page 5-6
Exposure route:	Dermal, Inhalation, table 5-1 on page 5-1
Physical form:	Liquid or solid
Exposure duration:	8-12 hr/day (throughout document)
Exposure frequency:	250 days/yr (page 3-2)
Number of workers:	3 workers/facility and 3 ONUs/facility (page 5-3)
Personal protective equipment:	Basic PPE includes wearing long sleeves (lab coats), long pants, closed-toe shoes, safety glasses or goggles, and gloves during the use of laboratory chemicals. Additional PPE may be worn depending on the level of hazard or specifics of the process. (page 2-2)
Engineering control:	fume hood (page 2-2)
Comments:	This is a generic scenario and not 1,3-butadiene-specific. Please refer to the generic scenario to determine the best values for this chemical's situation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	This GS is based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	11182966
Conditions of Use:	Repackaging

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading transport containers, container cleaning, equipment cleaning, loading of transport containers.
Exposure route:	Dermal, Inhalation
Physical form:	Solid or liquid
Area sampling data:	Inhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids.
Dermal exposure data:	Dermal exposure data
Exposure duration:	8-12 hr/day
Exposure frequency:	The number of operating days is given in a range of 174-260 days/yr with an EPA default of 260 days/yr.
Number of workers:	3 workers/facility and 1 ONUs/facility (total number of employees and facilities given in Table 5-3).
Personal protective equipment:	Commonly used PPE includes safety glasses, face shields, aprons, and gloves.
Engineering control:	Local exhaust ventilation.
Comments:	Note that none of the above information is specific to 1,3-butadiene. The generic scenario itself should be consulted when determining values to use for 1,3-butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple worker activities.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).
HERO ID:	11203977
Conditions of Use:	Fuels and Fuel Additives

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading transport containers, cleaning transport containers, equipment cleaning, fuel combustion exposures.
Exposure route:	Dermal, Inhalation
Physical form:	Liquid
Personal sampling data:	Inhalation: Provides methods for modeling exposures to volatile liquids. Also provides PBZ data reported in literature.
Dermal exposure data:	Dermal exposure data
Exposure duration:	8 hr/day
Exposure frequency:	250 days/yr
Number of workers:	1 worker/site
Personal protective equipment:	Respiratory protection.
Engineering control:	Routine maintenance, engine filters, avoiding idling, exhaust vents.
Comments:	This document is a generic scenario, not specific to 1,3-butadiene. When using the information please refer to the scenario itself to see the context of the above information and determine the relevancy to 1,3-butadiene.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples related to spray application is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering exposure to multiple fuel and additive types, and considering different worker activities.

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Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).
HERO ID:	11203977
Conditions of Use:	Fuels and Fuel Additives

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene: Final report.
HERO ID:	1565
Conditions of Use:	Processing, processing as a reactant

EXTRACTION

Parameter	**Data**
Worker activity description:	Greatest occupational exposure likely to occur in plants that manufacture 1,3-butadiene or use it to produce polymers or elastomers. (17 of 146). A study looked at the comparison between 28 work areas within the plant which included product fabrication (tire and beads), product fabrication (valves, tube, and flaps), bulk chemicals and metal products, cast film manufacture, special products manufacture, milling, miscellaneous, general service department, shipping and receiving department, industrial chemicals department, stock preparation department (page 85-86 of 146). In an SRB plant the Departments were tank farm, reactor and recovery, latex blending and solution, shipping and receiving, storeroom, factory service, maintenance areas. (89 of 146)
Exposure route:	inhalation or airborne concentrations and, to a lesser extent, by dermal contact (17 of 146)
Personal sampling data:	TWA was 20.03 ppm in the tank farm area. All other areas had less than 2ppm. (89 of 146) See pages 79 to 97 for more detail on various cohort studies.
Area sampling data:	At one SRB plant studied the TWA environmental sample for butadiene was 1.24 ppm (range of 0.11 to 4.17), and at a second adjacent SRB plant was 13.5 ppm (range of 0.34 to 174.0) (91 of 146)
Number of workers:	almost 14,000 styrene-1,3-butadiene rubber workers participated in one of the cohort studies (13 of 146). Approximately 65,000 workers are potentially exposed to 1,3-butadiene (17 of 146) See pages 79 to 97 for more detail on various cohort studies.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1985
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination — High

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

EXTRACTION

Parameter	**Data**
Personal sampling data:	Surveys conducted at six user facilities found worker exposure levels of 0.06-39 ppm, significantly below the OSHA standard of 1000 ppm (2200 mg/m3) (page 28 of 92)
Number of workers:	~65,000 US workers are potentially exposed to 1,3-butadiene between 1972 and 1974 (page 11 and 28 of 92)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	from EPA
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The user facilities at which the monitoring data were collected are not described, so there is some uncertainty about whether the extracted monitoring data pertain to facilities that are associated with COUs.
	Metric 4: Temporal Representativeness	Low	1989
	Metric 5: Sample Size	Medium	The monitoring data are a range of values.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	The only information contained in the data source is the range of values.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability is conveyed by the range of worker exposure monitoring data. Uncertainty in the monitoring data or the number of workers is not mentioned.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.
HERO ID:	3827197
Conditions of Use:	Formulation of Coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	The following worker activities that lead to exposures were identified: Unloading solid/liquid chemicals (Exposure A); Cleaning of transport containers (Exposure B); Sampling product (Exposure C); Cleaning of process equipment (Exposure D); Replacing spent filter media (Exposure E); Loading liquid coating (Exposure F)
Exposure route:	Inhalation and dermal
Dermal exposure data:	nan
Exposure duration:	EPA assumes an exposure duration of eight hours per day.
Exposure frequency:	EPA assumes a maximum of 250 days per year.
Number of workers:	Default Number of Production Workers per Facility: Architectural coating - 40, OEM coating - 38, Special purpose coating - 25.The methodology for determining the EPA default number of workers for each activity and each type of coating is presented in Appendix D.
Personal protective equipment:	Based on information provided by industry, current practices may have an effect on worker exposures during normal handling and processing operations. Workers who handle raw materials and formulations use personal protective equipment (PPE) when there is a possibility of contact. The type of PPE depends on the type of potential exposure. Typically, PPE used in the workplace include safety glasses and gloves. Face shields and a particulate respirator may also be required in cases where there is a potential for dust exposure (USEPA, 2006a,b).
Comments:	Explains EPA/OPPT models for inhalation and dermal exposure.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation, but data is not chemical-specific.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including different worker activities but uncertainty is not addressed.

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Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.
HERO ID:	3827197
Conditions of Use:	Formulation of Coatings

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID:	52153
Conditions of Use:	Various

EXTRACTION

Parameter	**Data**
Worker activity description:	Occupational exposure to 1,3-butadiene is expected to occur at facilities that manufacture 1,3-butadiene or convert it into commercial polymers. Toll collectors, bus drivers, or other workers who spend extended time periods near roadways are likely to have higher exposures than the general population. (page 51 of 435)
Exposure route:	the primary route of exposure to 1,3-butadiene is via inhalation (page 52 of 435)
Number of workers:	See table 8-1 on page 275 of 435 for a table of the various studies done on workers of 1,3-butadiene, the dates, and the number of workers involved

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	report from 2002
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385719
Conditions of Use:	Paints and coatings: Furniture Industry

EXTRACTION

Parameter	**Data**
Worker activity description:	unloading, spray application, equipment cleaning
Exposure route:	Dermal and inhalation. Inhalation: Provides methods for modeling exposures to mists.
Dermal exposure data:	Dermal exposure data
Exposure frequency:	250 days/yr
Number of workers:	12-98 workers/site
Personal protective equipment:	Air-supplied full face piece respirator; Disposable overalls and head covering; Gloves specific to the chemicals used; and boots and boot coverings.
Engineering control:	Spray booths

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	The GS is based on data that is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385741
Conditions of Use:	Fabric Finishing

EXTRACTION

Parameter	**Data**
Worker activity description:	mixing
Exposure route:	Dermal and inhalation. Inhalation is negligible.
Physical form:	Concentrated solutions or waxy solids
Dermal exposure data:	Dermal exposure data
Number of workers:	3-6 workers/site

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Low	Data is general and not specific to the chemical. Also, fabric finishing is not in scope for the risk evaluation but the information extracted might be used for an in-scope scenario like Organic Fiber Manufacturing.
Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting into finished products) -generic scenario for estimating occupational exposures and environmental releases. Draft.
HERO ID:	6549571
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)

EXTRACTION

Parameter	**Data**
Worker activity description:	Receipt of compounded resin, Forming (Heating), Molding/Shaping, Trimming, Finishing (including coating)
Exposure route:	Inhalation and Dermal
Physical form:	Exposure to solids during unloading of compounded resin from transport containers and charging to forming operation; Exposure to dusts generated from converting processes; Exposure to liquids during equipment cleaning of equipment; Exposure to solids during trimming activities.
Personal sampling data:	Exposure from Unloading and Charging Compounded Resin; Exposure from Converting Processes; Exposure from Trimming Processes: Inhalation exposure = OSHA PEL x breathing rate x hours x fraction of additive in resin x fraction of chemical in additive (if applicable)Exposure from Converting Equipment Cleaning: Not expected, particles are expected to be contained in water.
Dermal exposure data:	Dermal exposure data
Exposure duration:	8 hours/day assumed for inhalation calculations
Exposure frequency:	CEB standard assumption, 250 days per year based on 5 day work week and two weeks per year of operation shut down.
Number of workers:	Overall, there were 736,698 workers employed in the Plastic Product Manufacturing industry in 2001. Table 1 provides Number of Workers for subcategories of NAICS 3261 Plastic Product Manufacturing.
Engineering control:	Water: According to the Development Document for Effluent Limitation Guidelines for the Plastics Molding and Forming Point Source Category (1984), approximately 31% of surveyed sites that use process water directly discharged their process water; 44% indirectly discharged (POTW); and 25% had a zero discharge. Zero discharge methods include recycling, evaporation pond, septic tank with leach field, evaporation from equipment, land application, and contract haul. Types of on-site treatment include settling, pH adjustment, activated sludge, activated carbon adsorption, filtration, and vacuum filtration.Air: The Emissions Scenario Document on Plastic Additives suggests that bag filters used to collect particulate emissions are 99% efficient. However, the prevalence of bag filter use was not available.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses high quality data that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data are not chemical specific.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	N/A	Sample size criteria are not applicable to data extracted.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.

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Study Citation: U.S. EPA, (2004). Additives in plastics processing (converting into finished products) -generic scenario for estimating occupational exposures and environmental releases. Draft.
HERO ID: 6549571
Conditions of Use: Additives in Plastics Processing (Converting into Finished Products)

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability in worker activities is captured through identification of various NAICS codes associated with plastic additive use, but uncertainty associated with number of workers is not characterized.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2016). Chemical Data Reporting (CDR): Complete 2016 submissions.
HERO ID:	7315471
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Physical form:	Out of the 27 sites that reported data to CDR for butadiene, 4 sites reported gas/vapor, 17 sites reported liquid, and 6 sites claimed CBI/withheld.
Number of workers:	Out of the 27 sites that reported data to CDR for butadiene, 6 sites had fewer than 10 workers, 1 site had at least 50 but fewer than 100 workers, 6 sites had at least 100 but fewer than 500 workers, 3 sites had at least 500 but fewer than 1,000 workers, 4 sites had at least 1,000 but fewer than 10,000 workers, and 7 sites claimed CBI/withheld.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided)
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by listing ranges for reported values. Variability isn't addressed.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	transfer of additive at 100% concentration
Exposure route:	inhalation and dermal
Personal sampling data:	negligible due to low vapor pressure
Dermal exposure data:	Dermal exposure data
Exposure frequency:	250 days/year
Number of workers:	45 workers

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Processing as a reactant, Lubricants and lubricant additives in Petroleum lubricating oil and grease manufacturing.

EXTRACTION

Parameter	**Data**
Worker activity description:	transfer of additive at 10% concentration
Exposure route:	inhalation and dermal
Personal sampling data:	negligible due to low vapor pressure
Dermal exposure data:	Dermal exposure data
Exposure frequency:	250 days/year
Number of workers:	30 workers

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Industrial and commercial use of Fuel and related products; Industrial and commercial use of Lubricants and greases

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers drain out oil from automobiles and add fresh oil containing 1% fuel additive. Used oil is collected and recycled
Exposure route:	inhalation and dermal
Physical form:	inhalation exposure negligible due to low vapor pressure
Dermal exposure data:	Dermal exposure data
Exposure frequency:	Pure lube: 250 days/yearGeneral Automotive: 250 days/year
Number of workers:	Pure lube: 190 workersGeneral Automotive: 1,851 workers exposed

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation: UAB, (2007). A follow-up study of women in the synthetic rubber industry.
HERO ID: 6544020
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Worker activity description:	Three main work areas were observed: SBR-related operations, administration, and residual operations. SBR-related operations were subdivided into five major subgroups: production, maintenance, labor, laboratories, and other. There were also seven minor subgroups: production subgroups, polymerization, coagulation and finishing, maintenance subgroups, shop and field, labor subgroups, production and maintenance.
Personal sampling data:	The median exposure for all subjects in the study was 8.0 ppm-years. Table 14 breaks down median exposures for all subjects based on cause of death.
Number of workers:	4863

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, ratios, CIs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling at 8 different plants. Uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Ackley, M. W. (1987). Chemical cartridge respirator performance: 1,3-butadiene. American Industrial Hygiene Association Journal 48(5):447-453.
HERO ID:	5663760
Conditions of Use:	All (respirator cartridge performance)

EXTRACTION

Parameter	**Data**
Exposure route:	vapor
Physical form:	inhalation
Personal protective equipment:	Respirators may be required to reduce exposures when e engineering or work practice controls are not feasible. Activated carbon is used within these respirators in cartridges. Different cartridges may be used for respirators depending on the need.See Conclusion section, pgs 7-8/8 for more info regarding respirator selection considerations

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Medium	Data is for use of various types of charcoal for air purifying respirators.
Metric 4:	Temporal Representativeness	Low	This is a reprint of an article originally published in 1987.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation:	ASRC, (2007). Request for modification of the EA goal applicable to a single process for a single TAC: Flare and plant-wide fugitive emissions.
HERO ID:	11273427
Conditions of Use:	Processing as a reactant: Rubber manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Fugitive exposure- finishing operations where the rubber is dried, bailed and packaged
Exposure route:	inhalation
Physical form:	Vapor
Number of workers:	350 (page 6 of 28)
Engineering control:	(page 8-9 of 28) increased cooling of Butadiene storage tanksRecycle unused Butadiene to feedstockRecycle Butadiene from pump priming processImplement LDARInstallation of zero-emission control valvesInstallation of GC filter purge systemAdd temperature transmitters to reduce process upsetsInstallation of combustible gas detectorsInstallation of compressor-based tank car unloading

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The report used site specific data
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	USA
Metric 3:	Applicability	High	Tire Manufacture of rubber
Metric 4:	Temporal Representativeness	Medium	2007 (16 years ago)
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	site-specific information
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID:	11273448
Conditions of Use:	Import

EXTRACTION

Parameter	**Data**
Engineering control:	Compressor-based tank car unloading system eliminated the use of pumps. Installed a system to purge residual 1,3-BD to the plant's vent header system. Eliminated use of quick-disconnect fittings to unloading hoses. Connected storage tank safety relief vents to the plant's vent header system. Installed zero-emission bellows-sealed control valves. Stopped sampling and gauging tank cars. Expanded use of combustible gas detectors. Installed decontamination system to purge residual 1,2-BD from piping and equipment prior to unbolting and opening for maintenance. Installed low emission shutoff valves. Upgraded pipe gaskets. Initiated leak detection and repair program. Initiated rupture disc inspections. Initiated a mechanical integrity program for relief valves, piping, tanks, and pressure vessels. Initiated a formal program to train and certify operating personnel prior to starting work.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for Import and Processing, in-scope occupational scenarios
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	N/A - Engineering Controls
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	N/A - Engineering Controls

Overall Quality Determination High

Study Citation:	Bender, H. F., Eisenbarth, P. (2007). Occupational safety and health at the workplace: Sections 6.1–6.8. :147-256.
HERO ID:	7309849
Conditions of Use:	all

EXTRACTION

Parameter	**Data**
Personal protective equipment:	defines the type of mask appropriate for 1,3-Butadiene (page 92-3 of 110) which is described as in ”Group 1” of the low-boiling compounds
Comments:	Group 1, Use area Protection by AX-filter achievable (Page 93)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Unclear data source but appears well referenced
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	PP data appears appropriate for US
	Metric 3: Applicability	High	Mask recommendations are applicable for all applications
	Metric 4: Temporal Representativeness	Low	date unknown
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	reasonably referenced
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	This metric is not applicable to the data being extracted

Overall Quality Determination Medium

Study Citation:	Burgess, W. A. (1991). Potential exposures in the manufacturing industry—Their recognition and control. :595-674.
HERO ID:	1267867
Conditions of Use:	Processing (rubber)

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in rubber plants.
Exposure route:	inhalation
Physical form:	vapor, dust
Number of workers:	200,000 in the U.S.
Engineering control:	When possible, additives are pre-measured or are measured by a computer to avoid dust exposure. Local exhaust hoods should be present in rubber plants, and replacement air should be ventilated into these hoods. During rubber milling, operators have an emergency shut-off switch. Water is also used to suppress dust in mixtures.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing and domestic manufacturing, both in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	Chen, H., Carter, K. E. (2017). Modeling potential occupational inhalation exposures and associated risks of toxic organics from chemical storage tanks used in hydraulic fracturing using AERMOD. Environmental Pollution 224:300-309.
HERO ID:	3603006
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Exposure route:	releases from chemical storage tanks
Area sampling data:	Ambient concentrations modeled by AERMOD; did not include 1,3-BD
Comments:	Not specific to the 1,3-butadiene, however, can be relevant for the class of chemical.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for chemical storage tanks, which is similar to the the in-scope occupational scenario relating to manufacturing and processing.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented. Supplementary documentation available.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by model and parameters. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Cometto-Muniz, J. E., Abraham, M. H. (2015). Compilation and analysis of types and concentrations of airborne chemicals measured in various indoor and outdoor human environments. Chemosphere 127:70-86.
HERO ID:	3256955
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Indoor Commercial Setting: 2.7+-2.26 µg/m3
Comments:	Data from table 6. Paper also reports other relevant data on the chemical.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data included from U.S, OECD, and non-OECD countries.
	Metric 3:	Applicability	Medium	Data are for consumer and commercial uses, which is similar to the in-scope occupational scenario of emissions to air.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, average, and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by using many different literary sources, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Grub, J., Löser, E. (2011). Butadiene. :381-396.
HERO ID:	9493526
Conditions of Use:	Rubber processing

EXTRACTION

Parameter	**Data**
Exposure route:	Workers usually are exposed to butadiene by inhalation. Contact of liquid butadiene with skin may exceptionally occur.
Physical form:	Liquified butadiene is stored at normal temperatures in liquid-gas containers or, preferably,for safety reasons at a temperature of 4 C in almost pressureless containers. It is transported at normal temperatures and raised pressures in tankers, railroad tank wagons, and in ships. Especially in ships, temperatures of 4 C and pressureless containers are required.
Personal sampling data:	A hematology survey of workers at a styrene – butadiene rubber plant showed no pronounced evidence of hematological abnormalities in the peripheral blood. Exposure to butadiene was up to an average of 20 ppm in the tank farm area; in other departments less than 2 ppm occurred.
Area sampling data:	Samples were personal breathing zone.
Number of workers:	Personal air samples and blood specimens were obtained from 157 production workers.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The assessment uses high quality data that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Inhalation monitoring data is from U.S. rubber manufacturing plant.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Inhalation monitoring data is over 20 years old.
Metric 5:	Sample Size	Medium	Sample information may be provided in source cited for inhalation monitoring data. However, the assessment provides mean air concentration in the Tank Farm and low-end values for other areas of the facility.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty of inhalation monitoring data is not addressed.

Overall Quality Determination Medium

Study Citation:	Howell, P. P. (2010). Plant explosion emphasizes importance of implementing PSM. Process Safety Progress 29(2):144-149.
HERO ID:	4702535
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Engineering control:	"Seven recommendations were made to avoid future incidents. These were to have clear and comprehensible SOP's, have a properly designed pressure relief system, perform adequate process hazard analysis and to take appropriate corrective actions, have an adequate training program, learn from previous incidents, and evacuate contractors. "

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use in polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Lemen, R. A., Young, R. (1976). Investigations of health hazards in styrene butadiene rubber facilities.
HERO ID:	51473
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic manufacturing, synthetic rubber manufacturing
Worker activity description:	manually adding materials into blend tanks through tank openings, vessel entry to clean reactors and stripping columns, operator desk in areas where toxic materials are stored/handled
Number of workers:	workforce as of study (1976) was total of ”less than 1,000” workers for two SBR plants
Personal protective equipment:	Indicate no respiratory protection worn during vessel entry for clean-out

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for processing for synthetic rubber, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Medium

Study Citation: Levy, L. S., Lee, W. R. (1994). Aliphatic chemicals. :139-190.
HERO ID: 664424
Conditions of Use: Various

EXTRACTION

Parameter	Data
Exposure route:	Primarily via inhalation
Physical form:	boiling point -4.4 deg C; easily liquefied
Number of workers:	Estimated that 65,000 workers in the USA exposed in 1984

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for all undefined occupational scenarios, which likely include in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Lewis, R. (1999). Overview of the rubber industry and tire manufacturing. Occupational Medicine: State of the Art Reviews 14(4):707-718.
HERO ID:	2988430
Conditions of Use:	Processing (rubber/tire production)

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Number of workers:	236,300 employees in the rubber industry in the U.S. in 1992. (Table 2, pg.5/13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability between rubber making processes are explained, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Lynch, M. (2001). Manufacture and use of chloroprene monomer. Chemico-Biological Interactions 135-136(SI):155-167.
HERO ID:	625182
Conditions of Use:	Processing as an intermediate

EXTRACTION

Parameter	**Data**
Worker activity description:	chloroprene manufacturing process is sealed and normally installed in open buildings; exposure potential normally exists only during sampling, infrequent strainer cleaning, leaks, and spills
Personal protective equipment:	respiratory protection typically used in non-routine exposures (leaks, spills, sampling, etc.)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality information from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for processing as an intermediate/reactant, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Macaluso, M., Larson, R., Delzell, E., Sathiakumar, N., Hovinga, M., Julian, J., Muir, D., P, Cole (1996). Leukemia and cumulative exposure to butadiene, styrene, and benzene among workers in the synthetic rubber industry. Toxicology 113(1-3):190-202.
HERO ID:	51490
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic Rubber Manufacturing
Exposure route:	inhalation
Personal sampling data:	8-hr TWA estimates varied from 0 to 64ppm with median between 0.7ppm and 1.7ppm for the six plants evaluated...estimates decreased from 4.2ppm average in 1940s to 0.4ppm average in 1990s for active workers
Number of workers:	Investigation initially included 17,964 men working at one of eight plants for at least one year during 1943-1991
Comments:	Retroactive exposure estimates based on a variety of plant information

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by limitations in data. Variability addressed by various plant sites and temporal change.

Overall Quality Determination Medium

Study Citation:	Macaluso, M., Larson, R., Lynch, J., Lipton, S., Delzell, E. (2004). Historical estimation of exposure to 1,3-butadiene, styrene, and dimethyldithiocarbamate among synthetic rubber workers. Journal of Occupational and Environmental Hygiene 1(6):371-390.
HERO ID:	646914
Conditions of Use:	Synthetic rubber manufacturing, monomer used in polymerization

EXTRACTION

Parameter	**Data**
Worker activity description:	Peak exposures in production area tasks include purging excess water from tanks containing recycled BD, charging reactors in batch mode, and performing minor maintenance on reactor area equipment... Lab tasks include sampling new BD shipments and sampling unstripped latex... Maintenance tasks include skilled and unskilled employees; cleaned vessels and lines taken out of operation and other cleaning activities
Exposure route:	Inhalation; prolonged exposure from monomer losses from equipment (such as pumps and compressors)
Personal sampling data:	Estimates (not samples) for job groups and specific tasks given as 90% CI for varying ranges of years occurring between 1945 and 1992, provide min, max, mean, and 90% UI for each job group/task description... Mean and 90% UI for job groups in 1945, 1955, 1965, 1975, 1985, and 1992... Mean estimates from each job group as 8hr TWAs - Tank farm operator: 13ppm Reactor operator: 4ppm Recovery operator: - Finishing operator: 0ppm Maintenance, skilled: 3.8ppm Maintenance, unskilled: - Lab technician: 5ppm... Compares to NIOSH exposure survey in 1984-1987 (pull directly from NIOSH) see table 8
Exposure duration:	range of duration times given for each task description. See table 1
Exposure frequency:	exposure frequency per shift given for each task description

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use in synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of sources of uncertainty in estimations and use of confidence intervals. Variability addressed by variability among worker groups and change over time as well as comparison to NIOSH data.

Overall Quality Determination High

Study Citation:	Matanoski, G. M., Santos-Burgoa, C., Schwartz, L. (1990). Mortality of a cohort of workers in the styrene-butadiene polymer manufacturing industry (1943-1982). Environmental Health Perspectives 86(0):1990.
HERO ID:	51499
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Provides list of jobs and processes occurring at production site

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Manufacturing/Processing, Plasticizer

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers that use or produce 1,3-butadiene may breathe in vapors. Exposure in the general population is expected to be less, but may occur from breathing contaminated air released from chemical, plastic, and rubber factories that use or produce 1,3-butadiene. A small amount of exposure may occur when breathing car exhaust, tobacco smoke, wood smoke, or fumes from burning rubber or plastic. 1,3-Butadiene can also be released to the air during forest fires. (page 2 of 52)
Exposure route:	Inhalation (page 2 of 52) dermal (page 19 of 52)
Physical form:	colorless gas with a mild smell of gasoline; vapor (page 2 of 52)
Number of workers:	According to the 2012 TSCA Inventory Update Reporting data, 29 reporting facilities estimate the number of persons reasonably likely to be exposed during the manufacturing, processing, or use of 1,3-butadiene in the United States may be as low as <10 workers and as high as 1000-9999 workers per plant; the data may be greatly underestimated due to confidential business information (CBI) or unknown values... NIOSH (NOES Survey 1981-1983) has statistically estimated that 51,971 workers (1,410 of these are female) are potentially exposed to 1,3-butadiene in the US(1). (page 19 of 52)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	NIOSH, (2007). NIOSH pocket guide to chemical hazards.
HERO ID:	192177
Conditions of Use:	General

EXTRACTION

Parameter	**Data**
Exposure route:	dermal, eye, inhalation
Physical form:	colorless gas; A liquid below 24°F. Shipped as a liquefied compressed gas

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data extracted.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Datasources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A- no scope to assess metric

Overall Quality Determination High

Study Citation:	NIOSH, (2019). NIOSH pocket guide to chemical hazards: 1,3-Butadiene.
HERO ID:	7348615
Conditions of Use:	All-generic

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation, skin and/or eye contact (liquid)
Physical form:	Colorless gas
Personal protective equipment:	NIOSHAt concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand orother positive-pressure mode(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or otherpositive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatusEscape:(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canisterproviding protection against the compound of concernAny appropriate escape-type, self-contained breathing apparatus

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	NIOSH document
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation. Relevant to various scenarios.
Metric 4:	Temporal Representativeness	High	no more than 10 years old
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination High

Study Citation:	NIOSH, (1992). Occupational safety and health guideline for butadiene (1,3-butadiene).
HERO ID:	8408503
Conditions of Use:	General

EXTRACTION

Parameter	**Data**
Worker activity description:	These activities may lead to exposure to 1,3-butadiene: manufacture of styrene-butadiene-rubber (SBR), neoprene elastomer, nitrile elastomer, styrene-butadiene(SB) copolymer, and acrylonitrile-butadiene-styrene (ABS) resins, which are used as reinforcing and stiffening agents for rubbers; manufacture of high-impact polystyrene containing SBR/polybutadiene elastomer and of SBR foams; molding and vulcanizing operations that process synthetic rubber products from SBR; Use of butadiene in latexes and resins to make carpet backing, paper coatings, high-impact-resistant pipes and parts for automobiles, appliances, business machines, telephones, and recreational vehicles; manufacture of tires, hoses, belts, gaskets, seals, and oil resistant textile and paper products; manufacture of adiponitrile, cyclo-olefins, 1,4-hexadiene tetramethylene sulfone, tetrahydrophthalic anhydride, hexamethylenediamine, ethylidenenorbornene, and 1,5,9-cyclodecatriene; use of butadiene in the Diels-Alder condensation reaction for synthesis of compounds; use of butadiene in food wrappings, the latex paint industry, rocket fuels, pesticides, and fungicides
Engineering control:	Following methods are effective in controlling worker exposure to butadiene, depending on the feasibility of implementation: process enclosure, local exhaust ventilation, general dilution ventilation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from NIOSH.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	U.S. data.
Metric 3:	Applicability	High	Applicable to multiple occupational scenarios.
Metric 4:	Temporal Representativeness	Low	More than 20 years old.
Metric 5:	Sample Size	N/A	N/A- qualitative information.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1978). Occupational health guideline for butadiene.
HERO ID:	8435202
Conditions of Use:	General

EXTRACTION

Parameter	Data
Exposure route:	Butadiene can affect the body if it is inhaled or if the liquid comes in contact with the eyes or skin.
Physical form:	Liquid and vapor
Personal protective equipment:	Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health. See Table in Appendix for detailed RESPIRATORY PROTECTION FOR BUTADIENE.Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent the skin from becoming frozen from contact with liquid butadiene or from contact with vessels containing liquid butadiene. Employees should be provided with and required to use splash-proof safety goggles where liquid butadiene may contact the eyes.
Engineering control:	General dilution ventilation and local exhaust ventilation

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Report is greater than 20 years old and practices may be outdated.
Metric 5:	Sample Size	N/A	Sample size not applicable to qualitative exposure information.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	Variability and uncertainty are not applicable to qualitative exposure information.

Overall Quality Determination High

Study Citation:	Turnbull, D., Rodricks, J. V., Brett, S. M. (1990). Assessment of the potential risk to workers from exposure to 1,3-butadiene. Environmental Health Perspectives 86(0):159-171.
HERO ID:	2961803
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Report states that workplace concentrations have generally not exceeded 10-20 ppm
Exposure duration:	8 hours
Exposure frequency:	40 years

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report describes data from EPA studies and journal articles.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data is from USA.
	Metric 3: Applicability	Medium	Report discusses occupational exposure briefly, but the majority of the report focuses on animal studies.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Low	Report is mainly qualitative and doesn't provide statistics for human workplace exposure.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	The report clearly documents all sources, and cites them in the text.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is discussed multiple times throughout the report.

Overall Quality Determination Medium

Study Citation:	U.S. BLS, (2023). U.S. Census Bureau of Labor Statistics Data from 2021.
HERO ID:	11138808
Conditions of Use:	All

EXTRACTION

Parameter	**Data**
Number of workers:	Used to develop a method to estimate number of sites and workers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	BLS is expected to use reliable survey methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	U.S. based economic data.
	Metric 3:	Applicability	High	These economic data cover all industry and occupation types in scope for all chemicals.
	Metric 4:	Temporal Representativeness	High	The BLS OES data are from 2021.
	Metric 5:	Sample Size	High	The BLS OES program provides detailed statistics and estimated relative standard error for each state, industry, and occupation survey conducted (https://www.bls.gov/oes/current/oes_research_estimates.htm).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	BLS documents results and methods, but underlying survey results not accessible.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Limited discussion of variability and uncertainty in results.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene. Review draft.
HERO ID:	10293377
Conditions of Use:	Processing as a Reactant

EXTRACTION

Parameter	**Data**
Worker activity description:	rubber plant workers (page 11 of 104) Most occupational exposures occur in plants manufacturing 1,3-butadiene or using it to produce polymers or elastomers (15 of 104)
Exposure route:	mainly inhalation, to a lesser extent dermal contact (page 15 of 104)
Physical form:	colorless gas (page 9, 15 of 104)
Number of workers:	Approximately 62,000 workers exposed annually to 1,3-butadiene (page 15 of 104)
Comments:	See pages 47-70 for summary of epidemiologic studies, most of which did not have extractable information but did have general information about various studies done in different specific plants such a number of workers that work at a given facility and how many years worked (mostly rubber plants)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2020). 2020 CDR: Commercial and consumer use.
HERO ID:	10366189
Conditions of Use:	Manufacture and Import

EXTRACTION

Parameter	**Data**
Number of workers:	Provides number of workers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA is a trusted source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	CDR is U.S. based data.
	Metric 3:	Applicability	High	CDR covers chemical manufacturers and importers, which are in scope for all chemicals.
	Metric 4:	Temporal Representativeness	High	EPA used data from the 2020 CDR.
	Metric 5:	Sample Size	Medium	Due to reporting threshold, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Submissions do not include method of how production volumes were determined. CDR industry sector codes, industrial processing and use codes, industrial function codes, and commercial product codes provide good metadata; but lack of clarifying information and narratives and occasional misreportings limit clarity of data.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	CDR data do not address variability or uncertainty in submitter provided data.

Overall Quality Determination — High

Study Citation: U.S. EPA, (2013). Updating CEB's method for screening-level estimates of dermal exposure.
HERO ID: 11224653
Conditions of Use: All

EXTRACTION

Parameter	Data
Dermal exposure data:	Dermal exposure data

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Document published by EPA CEB.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are applicable to all COUs involving dermal contact, but not specific to 1,3-butadiene
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	N/A - Document describes general dermal exposure parameters. Sample size is not applicable.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by describing dermal exposure parameters for different exposure scenarios but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1980). Physician report RE cancer found in rubber mill workers.
HERO ID:	2148658
Conditions of Use:	Synthetic rubber manufacturing, Commercial use in plastic and rubber products

EXTRACTION

Parameter	**Data**
Worker activity description:	Various health issues case studies from Rubber and Tire Company: -one man was maintenance worker, worked on Banbury machinery 25% of the time; worked on conveyors calendars (heated and sealed rubber and fabric together), and various tire processing equipment... -one man cleaned Banbury machines by removing hot raw rubber, also worked in Banbury mill... -one man cured tires by placing them in a mold and heating them, built rubber fuel tanks; tube department where raw rubber squeezed through a machine and then a water tank... -grind tires with an emery wheel... Another worker in latex department of a company made paint; loaded butadiene and several other chemicals into reactors
Physical form:	Monomer in rubber, component in latex paint

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing and commercial uses, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2011). Exposure factors handbook: 2011 edition.
HERO ID:	786546
Conditions of Use:	Occupational Exposures (multiple COUs)

EXTRACTION

Parameter	**Data**
Personal sampling data:	Starting page 347, list of default inhalation rates
Dermal exposure data:	Dermal exposure data

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for all in-scope scenarios involving dermal and inhalation exposures.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by citing data from multiple sources but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.
HERO ID:	8726953
Conditions of Use:	Drum cleaning

EXTRACTION

Parameter	**Data**
Worker activity description:	Equipment cleaning after unloading of liquid from drums. See Process Description for details on drum cleaning processes.
Exposure route:	Inhalation and dermal
Physical form:	Liquid

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned specifically.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size not applicable to data evaluated.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Uncertainty and variability not applicable to data evaluated.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2016). Federal research action plan on recycled tire crumb used on playing field and playgrounds. Status report.
HERO ID:	9102524
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Worker activity description:	Recommended maintenance practices include brushing the field for infill redistribution, raking to rejuvenate the fibers and to relevel the top portion of the infill, and sweeping for debris removal (STC et al., 2016a; FieldTurf, n.d.-b). It is recommended that someof these practices be performed more frequently than others, depending on the frequency with which the field is used and specific guidelines for the sport played on the field.
Exposure route:	inhalation, oral, dermal
Exposure duration:	0.54-10
Exposure frequency:	24-365 d/yr; 4-7 d/wk
Comments:	unique exposure/behavioral factors provided pg. 63

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States
Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but information is not chemical-specific.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by explaining two turf production processes. Uncertainty isn't addressed in terms of facility information..

Overall Quality Determination High

Study Citation:	Ward, E. M., Fajen, J. M., Ruder, A. M., Rinsky, R. A., Halperin, W. E., Fessler-Flesch, C. A. (1995). Mortality study of workers in 1,3-butadiene production units identified from a chemical workers cohort. Environmental Health Perspectives 103(6):598-603.
HERO ID:	646931
Conditions of Use:	General/Unknown

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor
Exposure frequency:	9-39 months see table 3
Number of workers:	364

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic occupational exposures, which is similar to the in-scope occupational scenarios, though not specific.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Number of worker information
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ward, E. M., Fajen, J. M., Ruder, A. M., Rinsky, R. A., Halperin, W. E., Fesslerflesch, C. A. (1996). Mortality study of workers employed in 1,3-butadiene production units identified from a large chemical workers cohort. Toxicology 113(1-3):157-168.
HERO ID:	2454177
Conditions of Use:	Manufacture and Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	9,500 workers in United States occupationally exposed to BD each year (pg. 2/12, Fajen et al. 1993)
Comments:	Identical to HERO ID 646931

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for workers that ”are occupationally exposed” which should be considered in scope.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Wright, S. L., Kelly, F. J. (2017). Plastic and Human Health: A Micro Issue?. Environmental Science & Technology 51(12):6634-6647.
HERO ID:	3862800
Conditions of Use:	Processing as a monomer, Incorporation into an article

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation and ingestion of microplastics
Physical form:	monomer in polymer as microplastics and microfibers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from United Kingdom, an OECD country.
	Metric 3:	Applicability	Low	Data are for consumer exposures and generic plastic manufacturing, which is similar to the the in-scope occupational scenario for butadiene processing as a monomer for plastics.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	[Anonymous] (1995). 1,3-Butadiene air-quality standard. Food and Chemical Toxicology 33(7):620.
HERO ID:	5651525
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Most 1,3-butadiene in ambient air arises from combustion of petrol and diesel fuel, particularly the former; emissions from diesel cars are about one tenth of those from non-catalyst petrol cars
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3:	Applicability	Medium	Data are for the use of fuels and related products, but mention ambient air in the analysis.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release source and pollution prevention, but no frequencies or quantities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	APR, (2020). U.S. post-consumer plastic recycling data.
HERO ID:	11360400
Conditions of Use:	Recycling of plastics

EXTRACTION

Parameter	**Data**
Release quantity:	The figures on page 1 list the quantities of plastics recycled by type from 2010-2020. The figures on page 5 list the quantity recycled from US sources.
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Most recent data are from 2020, which is less than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed through multiple years of data. Uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	ASRC, (2007). Request for modification of the EA goal applicable to a single process for a single TAC: Flare and plant-wide fugitive emissions.
HERO ID:	11273427
Conditions of Use:	Processing as a reactant: Rubber manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Stack equipped with thermal oxidizer flare, described in detail starting on page 11 of 28Fugitive emissions, seven areas where they occur, liquid polymer source, daytanks, purification level 1, purification level 2, purification level 3, BD spheres area, and the fail car unloading area. For each area, a portion of total fugitive emissions were allocated on a percentage basis based on best engineering judgement... sources of potential fugitive emissions from process equipment at the facility include storage vessels, process vents, equipment leaks, and transfer loading operations... because manufacturing processes that use BD are pressurized, the amount of fugitive emissions at the facility is not related to the amount of BD directed to vent header, and is not related to or controlled by the amount of production. Instead, fugitive emissions at ASRC are primarily the result of leaks and accidental releases. (page 15 of 28)Fugitive emissions Equipment leaks 57,975 components of which 9,300 are in Butadiene service. These components includes pumps, valves, relief valves, threaded connectors, and the vent header. (page 16 of 28). Breakdown of number of components on page 17 of 28.
Release quantity:	Figure 1 on page 10 shows graph with 1,3-butadiene emissions from 2001-2006 Controlled stack emissions 950 pounds (page 14 of 28)Fugitive emissions permit limit 10kg of HAP per megagram of product.Equipment leaks
Release or emission factors:	Release or emission factors
Release frequency:	Flare permitted 876 hour of operation (10% of annual operations not to exceed 36 days in 12 months)
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	stack and fugitive emission sources were included but the methodology of the emission estimates not provided - probably from their permit
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	USA
Metric 3:	Applicability	High	Tire manufacture
Metric 4:	Temporal Representativeness	Medium	2007 (16 years ago)
Metric 5:	Sample Size	Low	only single estimates and emission factors provided
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	No unit specific information was provided
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	nothing to allow assessment of variance or uncertainty.

Overall Quality Determination Medium

Study Citation:	ASRC, (2004). Study of the flare used as an emissions control device for 1,3-butadiene emissions for American Synthetic Rubber Company.
HERO ID:	11273449
Conditions of Use:	Processing - synthetic rubber manufacture

EXTRACTION

Parameter	**Data**
Description of release source:	The flare stack at American Synthetic Rubber Company (ASRC) was part of the original construction of the facility in the early 1940s. Although the flare serves as an efficient mechanism to reduce the amount of emissions, its main purpose is as a safety device designed to accept and burn gases from the ASRC process that otherwise could cause overpressurization of pressure vessels throughout the plant. To avoid a build-up of these gases that could cause overpressurization, those pressure vessels are protected by rupture disks and relief valves, which allow the gases to leave the pressure vessels and ultimately travel to the flare stack to be burned. Process vents from the emulsion rubber processes were also vented to the flare for thermal destruction. (pg 5)
Release quantity:	Enclosure 3 contains the flow and heating value and analysis of the composition of the samples taken during 2002 and 2003. (begins page 167)Enclosure 11 on page 256 of 264 has an ”Example of Flare Stack Velocity and Concentration Calculation” table that includes BD concentration and total lbs per day and year
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	Author], [No (2018). Sinopec chooses Topsoe CATOX catalyst for Asia's largest styrene butadiene rubber emissions control project. Focus on Catalysts 2018(12):4.
HERO ID:	5677048
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Sinopec Qilu Petrochemical Corporation's styrene butadiene rubber (SBR) facility in Zibo, China
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release source and pollution prevention, but no frequencies or quantities.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination **Low**

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Among multi-industrial activities in Ulsan, the petrochemical, oil refinement, and nonferrous metal industries are likely to be major sources of VOCs and PAHs due to the nature of their operational processes. In addition, shipbuilding and car manufacturing industries are potential sources of VOCs and HMs.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Sampling method is an approved EPA method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
Metric 3:	Applicability	Low	Data are non-occupational and for ambient air near industrial facilities, which is similar to the in-scope occupational scenario of petrochemical manufacturing
Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Release source provided only.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by taking during four seasons and 5 sites.

Overall Quality Determination Medium

Study Citation:	CalEPA, (2008). TSD for noncancer RELs - Appendix D.3 Chronic RELs and toxicity summaries using the previous version of the Hot Spots Risk Assessment guidelines (OEHHA 1999).
HERO ID:	628645
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	industrial releases to air
Release quantity:	20,486 lbs of BD for state of CA annually, estimated for year 2000

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for general industrial releases, which is similar to the in-scope occupational scenarios for disposal from manufacturing and processing.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total emissions value) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Medium

Study Citation:	California Office of Environmental Health Hazard Assessment :: OEHHA (2014). Appendix D: Individual acute, 8-hour, and chronic reference exposure level summaries.
HERO ID:	5155603
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	78.8% of releases are non-point or mobile; 1.6% are accidental or fugitive during manufacture, use, transport, storage, or disposal; remainder of releases from direct volatilization from gas, stack emissions, cigarette smoke, and burning of plastics... similar breakdown for CA specifically; wildfires are largest natural source
Release quantity:	Total statewide emissions in California in 2008 was 3,754 tons

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic scenarios, which are similar or may include in-scope occupational scenarios such as vehicle emissions and manufacturing/processing emissions.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing breakdown of individual release sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Campolina, J. M., Sigrist, C., Paiva, F.d., J. M., Nunes, A. O., Moris, d.S., V. A. (2017). A study on the environmental aspects of WEEE plastic recycling in a Brazilian company. International Journal of Life Cycle Assessment 22(12):1957-1968.
HERO ID:	4706777
Conditions of Use:	Processing-Recycling

EXTRACTION

Parameter	**Data**
Description of release source:	ABS within waste from electrical and electronic equipment. The recycling process of WEEE usually starts with its collection and subsequent sorting into several components, such as ferrous and non-ferrous metals and plastics, among others. The material is then compacted in crushers. Plastics are sent to recycling plants. Materials considered scraps according to the Brazilian National Policy on Solid Waste are sent for final disposal in suitable landfills
Release quantity:	270 tons of ABS resin recycled per year
Release or emission factors:	nan
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Brazil, a non-OECD country.
Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing daily release quantity and release days per year.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	CARB, (2002). Ltr FR Intl Truck and Engine Corp to USEPA submitting studies on emissions from diesel and compressed natural gas vehicles, w/attchmnts and dated 042202.
HERO ID:	5674656
Conditions of Use:	Commercial Use - Fuels and related products

EXTRACTION

Parameter	**Data**
Description of release source:	For the most part Butadiene was only detected in compressed natural gas engine vehicle exhaust (page 59 and 137 of 222)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air via fuel, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics. (Graphs)
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release quantities, P2, and release days per year.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by listing detection limits for each testing procedure. Variability addressed by sampling excerpts from many studies.

Overall Quality Determination High

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	kerosene space heaters
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Uses a well-documented method that seems to be equivalent to a common method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Data is within scope.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	High	Subgroups are categorized and may statistics are provided that characterize all data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Some data is included, but not all categories are mentioned.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation is described once, but the statistics describe most variation in detail.

Overall Quality Determination High

Study Citation: CEPE, (2020). SpERC fact sheet: Industrial application of coatings by spraying.
HERO ID: 10442901
Conditions of Use: Paints and coatings

EXTRACTION

Parameter	Data
Description of release source:	Industrial application of coatings by spraying
Release or emission factors:	Release or emission factors
Release frequency:	225 days/year
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but data is general and not chemical specific.
Metric 4:	Temporal Representativeness	High	Fact sheet is from 2020.
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by including emission factors for different processes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Chandrasekaran, S. R., Avasarala, S., Murali, D., Rajagopalan, N., Sharma, B. K. (2018). Materials and energy recovery from e-waste plastics. ACS Sustainable Chemistry & Engineering 6(4):4594-4602.
HERO ID:	4718003
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	plastics within electronic wastes (page 4 of 9)
Release quantity:	In 2012, 3.4 million tons of e-waste plastic (page 1 of 9)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	Data are for solid wastes, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by conducting baselines tests and control tests but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Claggett, M., Miller, T. L., TRB (2006). Variability of mobile source air toxic emissions factors with MOBILE6.2. Transportation Research Record 1987(1):103-109.
HERO ID:	1957829
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Mobile sources
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the conclusion and methods of the report. Variability is addressed throughout the report and attributed to factors like temperature and speed.

Overall Quality Determination High

Study Citation:	Coburn, T. C., Kelly, K. J., Bailey, B. K. (1998). Reduction in vehicle emissions attributable to alternative transportation fuels and its prospective impact on air quality and public health. Applied Occupational and Environmental Hygiene 13(6):395.
HERO ID:	5700217
Conditions of Use:	Disposal (vehicle emissions)

EXTRACTION

Parameter	**Data**
Description of release source:	light-duty alternative fuel vehicles using methanol, ethanol, and compressed natural gas as fuel
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard errors, sample sizes) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing number of release days, waste treatment, and disposal method.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by the statistics provided in the analysis. Variability addressed by sampling different makes and models of vehicles.

Overall Quality Determination — High

Study Citation:	Cocker, D. R., Shah, S. D., Johnson, K. C., Zhu, X., Miller, J. W., Norbeck, J. M. (2004). Development and application of a mobile laboratory for measuring emissions from diesel engines. 2. Sampling for toxics and particulate matter. Environmental Science & Technology 38(24):6809-6816.
HERO ID:	1652297
Conditions of Use:	Use of fuel products (vehicle exhaust)

EXTRACTION

Parameter	**Data**
Description of release source:	Heavy heavy-duty diesel trucks (HHDDT)
Release quantity:	Table 2, pg. 4/8: A HHDDT emits 37.9 +-5.7 mg butadiene/hr during cold start idle
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some metadata provided, but not all.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination Medium

Study Citation:	Contos, D. A., Holdren, M. W., Smith, D. L., Brooke, R. C., Rhodes, V. L., Rainey, M. L. (1995). Sampling and analysis of volatile organic-compounds evolved during thermal-processing of acrylonitrile-butadiene-styrene composite resins. Journal of the Air and Waste Management Association 45(9):686-694.
HERO ID:	5673168
Conditions of Use:	Disposal/release (ABS processing)

EXTRACTION

Parameter	**Data**
Description of release source:	gaseous emissions generated during the extrusion of acrylonitrile butadiene styrene (ABS) resin
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty addressed when describing the modeling method used. Variability addressed by sampling a mix of different resins, and by duplicating samples.

Overall Quality Determination High

Study Citation:	Cook, R., Phillips, S., Houyoux, M., Dolwick, P., Mason, R., Yanca, C., Zawacki, M., Davidson, K., Michaels, H., Harvey, C., Somers, J., Luecken, D. (2011). Air quality impacts of increased use of ethanol under the United States' Energy Independence and Security Act. Atmospheric Environment 45(40):7714-7724.
HERO ID:	1056185
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Ethanol-based fuel emissions
Release quantity:	Using RFS1, 14,458 short tons/yr. Using RFS2, 14,264 short tons/year.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses an EPA method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
Metric 5:	Sample Size	High	Statistics are fully characterized with percentiles, means and ranges. Individual subpopulations of the USA analyzed.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some data is included, but not all categories are mentioned.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is mentioned throughout the report and explained thoroughly.

Overall Quality Determination High

Study Citation:	Cordova-Orellana, C. (2017). Air toxic emissions and associated health risks in Cook County, IL.
HERO ID:	6026136
Conditions of Use:	All

EXTRACTION

Parameter	**Data**
Release quantity:	This report includes NEI data to display the top 20 air toxics that contribute to total air emissions in Illinois on page 84 of 143. 1,3-Butadiene appears on this list in 1999 (at 1,484 tpy) and 2011 (at 663 tpy). It also appears in a top 20 list for toxic contributions from major/point air emissions in IL in 2002 (136 tpy) on page 85 of 143, in a top 20 list for non-road air emissions in IL in all years of the table at tpys between 214 and 382 (page 88 of 143). Similar data from just Cook County (rather than all of IL) can be found with 1,3-butadiene included on pages 99 and 103 of 143.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	from NEI
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Within USA
	Metric 3: Applicability	High	releases from facilities
	Metric 4: Temporal Representativeness	Medium	Some data is more than 20 years old, but most between 10 and 20 years
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Details of the releases are not included
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Some variability expressed through the comparison of various years and focus of the emission type (non-road, point source, overall amounts, etc.)

Overall Quality Determination Medium

Study Citation:	Cote, I. L., Bayard, S. P. (1990). Cancer risk assessment of 1,3-butadiene. Environmental Health Perspectives 86(0):149-153.
HERO ID:	3262636
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	industrial emissions arise primarily from process vents or stacks and fugitive sources (like equipment leaks) (page 3 of 5)
Release quantity:	annual emissions from all industrial 1,3-BD sources are estimated to be approximately 12 million pounds per year (page 3 of 5)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic industrial air emissions, which includes in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Effluents from water reclamation plants in Nanjing, China
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	See Table 1 for data.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the disposal of butadiene-containing wastes, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty and variability are both addressed with a Monte Carlo simulation and sensitivity analysis.

Overall Quality Determination High

Study Citation:	Dollard, G. J., Dore, C. J., Jenkin, M. E. (2001). Ambient concentrations of 1,3-butadiene in the UK. Chemico-Biological Interactions 135-136(Special Issue):177-206.
HERO ID:	1942872
Conditions of Use:	Vehicle emissions

EXTRACTION

Parameter	**Data**
Description of release source:	Road transport exhaust emissions (68%), off-road vehicles, and machinery (14%). Emissions also from rubber manufacturing. (18%)
Release quantity:	From Table 3, pg 9/30In 1996, 10.60 kTonnes emitted in the UK. 1.06 kTonnes from chemical industry use, 0.88 kTonnes from chemical industry manufacturing, 6.31 kTonnes from petrol vehicles, 0.90 kTonnes rom DERV vehicles, and 1.45 kTonnes from off-road transport and machinery.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report pulls data from an official UK national laboratory.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	High	Statistical distribution fully characterized. Many subgroups are broken down and analyzed, and many statistics are provided on the data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most metadata provided.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty described for each section of the report, and variations in calculations explained also.

Overall Quality Determination High

Study Citation:	Dollard, G. J., Dore, C. J., Jenkin, M. E. (2001). Ambient concentrations of 1,3-butadiene in the UK. Chemico-Biological Interactions 135-136(Special Issue):177-206.
HERO ID:	1942872
Conditions of Use:	Processing (emissions during industrial processes)

EXTRACTION

Parameter	**Data**
Description of release source:	Road transport exhaust emissions (68%), off-road vehicles, and machinery (14%). Emissions also from rubber manufacturing. (18%)
Release quantity:	From Table 4, pg 10/30Styrene–butadiene rubber manufacture, 751 tonnesNitrile rubber production, 38 tonnesPolybutadiene manufacture, 170 tonnesABS and SAN resins, 100 tonnes

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report pulls data from an official UK national laboratory.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from an OECD country.
	Metric 3: Applicability	High	Data is within scope.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution fully characterized. Many subgroups are broken down and analyzed, and many statistics are provided on the data.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Most metadata provided.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty described for each section of the report, and variations in calculations explained also.

Overall Quality Determination High

Study Citation:	Durbin, T. D., Miller, J. W., Younglove, T., Huai, T., Cocker, K. (2007). Effects of fuel ethanol content and volatility on regulated and unregulated exhaust emissions for the latest technology gasoline vehicles. Environmental Science & Technology 41(11):4059-4064.
HERO ID:	90901
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	passenger cars & light duty trucks
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Release data methodology is described, and comes from a reliable source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Data is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Distribution is fully characterized with many different statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media along with P2 data provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination High

Study Citation:	Earthjustice, (2020). Exhibit 1 to comments of rubbertown emergency action et al., re: TSCA risk evaluations for high-priority substances and substances undergoing manufacturer-requested risk evaluations.
HERO ID:	10385015
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Pg. 35/102 to pg. 37/102 contains information about chemical process industry sites that are sources of release of 1,3-Butadiene either routinely or accidently.
Release quantity:	The appendices contains release quantities of 1,3-butadiene as reported in TRI. For example, the tables on pg. 44/102 and 58/102 contain total releases to various media and waste transfer amounts that occurred in the Port Arthur, TX, and Houston, TX areas, respectively, during the years 2012-2018. Other examples are the tables on pg. 53/102 and 69/102 which contain releases of 1,3-butadiene from specific sites located in Port Arthur, TX and Houston, TX, respectively, that occurred during the same period of time mentioned above. The appendices also contain similar information applicable to Mossville, LA and "Cancer Alley", LA.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Methodology not specified
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	Data are for Disposal, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by data from multiple sites, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	EC, (2002). Summary risk assessment report for 1,3-butadiene.
HERO ID:	7348613
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	The releases from production and the major use processes were estimated using emission factors from a US report, which gathered data from the US chemical industry. The amounts produced or used on representative sites were taken from information in IUCLID or from statistics produced by the IISRP (International Institute of Synthetic Rubber Producers). There are also a number of indirect sources of 1,3-butadiene emissions. It is a component of both gasoline and diesel vehicle exhausts (although not of the original fuel). Emissions from this source were estimated based on emission factors per mile (derived from measurements) and statistics on total vehicle mileage in the EU. Emissions in cigarette smoke were also estimated. Forest fires and biomass burning are also sources of 1,3-butadiene, but emissions from these sources within the EU could not be quantified.
Release quantity:	1,3-BUTADIENE PRODUCTION RELEASE ESTIMATES[WW= Wastewater]Amount released per site (tonnes/year): 93.6 to WW, 3.2 to AirAmount released in regional model (tonnes/year): 89 WW, 3 AirAmount released in continental model (=total EU releaseregional release) (tonnes/year): 797 WW, 27.3 Air

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The releases from production and the major use processes were estimated using emission factors from a US report, which gathered data from the US chemical industry.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	Assessment was done 20 years ago. However, data is expected to be relevant.
	Metric 5: Sample Size	Low	No sample size or discrete data provided for estimates.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and annual release quantity, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty related to release estimation.

Overall Quality Determination Medium

Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	In the absence of information, for 1,3-butadiene, the default release would be 1-25 kg/tonne to air and 3 kg/tonne to wastewater, depending on whether the 1,3-butadiene is isolated in the overall process or not. See pages 34 and 35 for more detailed release descriptions. Summary of all releases can be found on page 48 of 204.
Release quantity:	Taking the figure of Western European production of 1,892,000 tonnes/year and emission factors as above, releases to water and air are 885 tonnes/year and 30.3 tonnes/year respectively for the EU as a whole. (page 35 of 204)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	EU
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	2002
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	In the absence of information, for 1,3-butadiene, the default release would be 1-25 kg/tonne to air and 3 kg/tonne to wastewater, depending on whether the 1,3-butadiene is isolated in the overall process or not. See pages 34 and 35 for more detailed release descriptions of release in general. See page 36-40 for individual release descriptions by industry. Summary of all releases can be found on page 48 of 204.
Release quantity:	See release quantities within the text, by product, on pages 36-40 of 204
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	EU
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	EU
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	EIC, (2004). Louisiana toxic air pollutants dispersion modeling analysis report for Shell Chemical LP - Norco Chemical Plant - West Site, T-Unit.
HERO ID:	11272716
Conditions of Use:	Manufacturing and Processing as a Reactant Condition of Use

EXTRACTION

Parameter	**Data**
Description of release source:	Equipment descriptions on page 5 of 47
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Stack emission rates are provided but detailed information about how the release data were derived is not indicated
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Chemical plant
	Metric 4:	Temporal Representativeness	Medium	2004
	Metric 5:	Sample Size	Low	Data used to estimate the release data were not included
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Emissions were estimated only for stacks, associated processes were not included
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty were not noted

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
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Release quantity:	Average landfill gas concentration has 3.98 ppmv of 1,3-butadiene (Page 3 of 5). 1,3-butadiene also comprises 0.1% of VOCs compared to total VOCs in landfill gas collection system, and is not detectable for passive vents or flux chamber samples at landfill (Page 4 of 5).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	Data are for disposal, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by methods. Variability addressed by different landfills and point sources.

Overall Quality Determination High

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

EXTRACTION

Parameter	**Data**
Description of release source:	Table 3-A-3 lists the various storage tanks in Area 3 of the Texaco Bakersfield Refinery
Release quantity:	Tables 3-A-3 and 3-A-5 contains annual emissions data of 1,3-butadiene for various storage tanks and "Valves and Flanges", respectively. Tables 3-B-3 and 3-B-5 contain hourly emissions data of 1,3-butadiene for various storage tanks and "Valves and Flanges", respectively.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	expected to be accurate
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	US data
	Metric 3: Applicability	Uninformative	Based upon information provided in source, EPA assumes that 1,3-butadiene is produced as a combustion byproduct, which is not in scope.
	Metric 4: Temporal Representativeness	Low	data are more than 20 years old
	Metric 5: Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	release data study does not address variability or uncertainty

Overall Quality Determination Uninformative

Study Citation:	ENSR, (1991). Initial submission: AB 2588 health risk assessment for the Texaco refinery areas 1 & 2 (volume I & II) (draft report) with attachments and cover letter dated 030692. 920001410:#88-920001410.
HERO ID:	1270212
Conditions of Use:	Other-Combustion Byproduct

EXTRACTION

Parameter	**Data**
Description of release source:	Boilers, Heaters and coolers at Texaco Inc. Bakersfield Refinery Areas 1 and 2, which produces diesel and gasoline
Comments:	Most pages of the source are not readable. Report appears to show annual and hourly emissions to air, but the numbers are illegible.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	Uninformative	Based on information provided in source, EPA assumes that 1,3-butadiene is produced as a combustion byproduct, which is not within scope of the risk evaluation
Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination Uninformative

Study Citation:	Environmental Defense Fund, (2021). Comment submitted by Environmental Defense Fund (EDF) regarding information on potentially exposed or susceptible subpopulations associated with 1,3-butadiene, formaldehyde, and ortho-phthalates undergoing TSCA risk evaluations.
HERO ID:	10385454
Conditions of Use:	Unknown COUs: COUs associated with sites that are required to report to TRI

EXTRACTION

Parameter	**Data**
Description of release source:	Pg. 4/21, Table (2): According to U.S. Coast Guard National Response Center data for 2021 (up to date of data source which is Dec 8, 2021), 1,3-butadiene release incidents were reported in Texas (88 incidents), Louisiana (18 incidents) and Illinois, Kentucky, Ohio, Tennessee, Washington, and Wyoming (a total of 6 incidents.) This table also contains the names of counties in the above mentioned states with the highest numbers of reported incidents. The sites associated with the reported releases are not identified in the data source.
Release quantity:	Pg. 3/21, Table (1): According to 1,3-butadiene 2015 - 2020 TRI emissions data, the Range of 1,3-butadiene released from individual facilities among the top decile of emitters (lbs) is 81,756 – 940,265 (release to air) and 0 – 887 (release to water.). The sites from which these releases occur are not identified in the data source.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	TRI data and Coast Guard data
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	US data
	Metric 3: Applicability	Medium	The COUs are unknown, but the TRI release data and the Coast Guard incident data likely pertains to sites that are associated with COUs.
	Metric 4: Temporal Representativeness	High	The data is less than 10 years old.
	Metric 5: Sample Size	High	The TRI data and the Coast Guard data account for all sites according to the data source.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Only release media is reported.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Environmental Defense Fund, (2022). Comment submitted by Environmental Defense Fund (EDF) containing the data file on fenceline and background exposure analyses in TSCA risk evaluations.
HERO ID:	10386449
Conditions of Use:	Unknown COUs: COUs associated with sites that are required to report to TRI

EXTRACTION

Parameter	**Data**
Description of release source:	Facility locations are reported - see release quantities.
Release quantity:	The data source contains information about releases of 1,3-butadiene from facilities that are located near each other. This information is provided as guidance to facilitate fence line exposure assessment by EPA. In such fence line exposure assessment, exposure that results from releases from multiple facilities, and not just a single facility, is assessed. The various groups of facilities that are located near each other are referred to as clusters of facilities. These clusters are located in differing parts of the U.S. There are two types of clusters: the 1 kilometer cluster and the 10 kilometer cluster. In the case of the 1 and 10 kilometer clusters, all facilities are located in an area whose diameter is 1 kilometer and 10 kilometers, respectively. The information contained in the data source is specifically the following: (1) the names and locations of facilities in each of the various clusters of facilities and the total of amounts of 1,3-butadiene released to any media from each facility in each cluster or, instead of amounts released, the amounts of 1,3-butadiene transferred to a facility if the facility is a waste management facility; (2) the total amounts of 1,3-butadiene released or transferred in the case of each cluster; (3) distances between a facility that is designated as the anchor of the cluster and all other facilities in the cluster.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	TRI data
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	Medium	The COUs are unknown, but sites for which there are TRI release data are likely sites associated with COUs.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
Metric 5:	Sample Size	High	Data about all sites are reported.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	The data is total release data.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Data for all sites is reported.

Overall Quality Determination High

Study Citation:	Fishbein, L. (1992). Exposure from occupational versus other sources. Scandinavian Journal of Work, Environment and Health 18(S1):5-16.
HERO ID:	200024
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Description of release source:	99% of releases from 1,3-BD production were from equipment leaks (1984 EPA survey)
Release quantity:	approx. 3.8million lbs/yr from US production of 1,3-BD in 1984 EPA survey... approx. 5million lbs/yr from styrene-butadiene copolymer production
Comments:	The largest consumption of 1,3-butadiene in the United States is for the production of styrene-butadiene copolymers, which accounts for over 40% of the total amount of butadiene produced. The EPA has estimated that the total emission of butadiene to the atmosphere from this category is approximately 5 million pounds (2.27 · lQ6 kg) a year, or 0.3% of the amount produced

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Forrest, M. J., Jolly, A. M., Holding, S. R., Richards, S. J. (1995). Emissions from processing thermoplastics. Annals of Occupational Hygiene 39(1):35-53.
HERO ID:	1009549
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Thermoplastic processing
Release quantity:	No butadiene emissions detected
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Method comes from UK's Health Safety and Environmental Branch.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Data is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Sample size is representative and sample distribution is fully characterized
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Only release media and statement of no emissions provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination — Medium

Study Citation:	Friedrich, R., Obermeier, A. (1999). Chapter 1: Anthropogenic emissions of volatile organic compounds. :1-39.
HERO ID:	6201718
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Combustion processes, production, treatment, storage, and distribution of fossil fuels, application of volatile organic solvents and solvent-containing products, industrial production processes, and biological processes. (page 3 of 39, not Butadiene specific)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, emission factors) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by providing ranges of uncertainty and best estimates. Variability is addressed by including emissions data from many different sectors under different conditions.

Overall Quality Determination — High

Study Citation:	Grant, R. L., Leopold, V., Mccant, D., Honeycutt, M. (2007). Spatial and temporal trend evaluation of ambient concentrations of 1,3-butadiene and chloroprene in Texas. Chemico-Biological Interactions 166(1-3):44-51.
HERO ID:	3004860
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Industrial sites in Texas
Release quantity:	695 tonnes per year
Release or emission factors:	Release or emission factors
Comments:	See Table 2

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution fully characterized. Means, ranges, percentages, medians, and standard deviations given for individual sites.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata is included, but missing additional fields.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed and explained.

Overall Quality Determination High

Study Citation:	Harlow, H. W., Shannon, E. S., Sercu, C. L. (1961). A petrochemical waste treatment system. Engineering Extension Series No. 109 :156-166.
HERO ID:	5701791
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Dow Chemical Petrochemical Plant in Saginaw Bay, Michigan.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Hearn, D. (1995). Health Risks Due to Motor Vehicle Emissions in Melbourne. Clean Air 29(2):37.
HERO ID:	5773789
Conditions of Use:	Fuels and related products

EXTRACTION

Parameter	**Data**
Description of release source:	motor vehicle emissions (page 1 of 8)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages, maximums, rates) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing number of release days, waste treatment, and disposal method.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by listing factors that could have impacted the study. Variability addressed by sampling nine locations.

Overall Quality Determination Medium

Study Citation:	Higashino, H., Mita, K., Yoshikado, H., Iwata, M., Nakanishi, J. (2007). Exposure and risk assessment of 1,3-butadiene in Japan. Chemico-Biological Interactions 166(1-3):52-62.
HERO ID:	646907
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	includes registered industrial sources (broken down into chemical industry and other), mobile sources (broken down into car exhaust, car cold start, and other mobiles), and other non-registered sources... mobile sources are primary source of BD emissions
Release quantity:	Japan releases in tonnes/yr... Industrial sources: 627 (2001), 403 (2002), 293 (2003).... Mobile Sources: 3762 (2001), 4291 (2002), 4966 (2003)
Release or emission factors:	Release or emission factors
Comments:	See Figure 1, Emission amounts and annual trends. See Table 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	Medium	Data are for general industrial sources, which is similar to the in-scope occupational scenarios for butadiene manufacturing and processing.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided; provides in-text references to data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of data limitations. Variability addressed by temporal changes.

Overall Quality Determination — High

Study Citation:	Hsu, Y. C., Chen, S. K., Tsai, J. H., Chiang, H. L. (2007). Determination of volatile organic profiles and photochemical potentials from chemical manufacture process vents. Journal of the Air and Waste Management Association 57(6):698-704.
HERO ID:	608305
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	ABS production plant: emission from stacks at plant sites; reactor vents and dryer vents
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan
Comments:	Table 3

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are for general disposal from ABS polymer processing, which is similar to the in-scope occupational scenario for butadiene disposal in ABS processing.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by measurements as explained in methodology section. Variability addressed by comparison to EPA AP-42 emissions.

Overall Quality Determination Medium

Study Citation:	Huang, P., Tan, D., Luo, Y. (2010). A case study of cleaner production in acrylonitrile butadiene styrene resin companies in China. Journal of Environmental Science and Technology 3(3):148-158.
HERO ID:	5708486
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	ABS resin production plants
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (flows, emission factors, savings) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Kado, N. Y., Okamoto, R. A., Kuzmicky, P. A., Kobayashi, R., Ayala, A., Gebel, M. E., Rieger, P. L., Maddox, C., Zafonte, L. (2005). Emissions of toxic pollutants from compressed natural gas and low sulfur diesel-fueled heavy-duty transit buses tested over multiple driving cycles. Environmental Science & Technology 39(19):7638-7649.
HERO ID:	88146
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Buses emit butadiene from the exhaust of using compressed natural gas (CNG) and low-sulfur diesel fuel.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Uses an NIST method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Data is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistics are fully characterized with individual cases and scenarios disclosed and analyzed.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	About half the metadata categories are included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in the discussion of the report.

Overall Quality Determination — High

Study Citation:	Karavalakis, G., Durbin, T. D., Shrivastava, M., Zheng, Z., Villela, M., Jung, H. (2012). Impacts of ethanol fuel level on emissions of regulated and unregulated pollutants from a fleet of gasoline light-duty vehicles. Fuel 93(1):549-558.
HERO ID:	1056410
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	gasoline-powered light-duty vehicles
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses a federally regulated method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
Metric 5:	Sample Size	High	Statistics are fully characterized, with individual statistics provided for each fuel type and car.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some data is included, but not all categories are mentioned.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty and possible errors in data are explained. The report tells the reader when assumptions were made that my affect results.

Overall Quality Determination High

Study Citation:	Kaye, J. B. (1971). Reuse-facility rehabilitation. Journal of the American Water Works Association 63(10):641-643.
HERO ID:	5699827
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	The process, coolant, and wash waters used in the manufacture of styrene-butadiene latexes by emulsion polymerization at Dow's Dalton, GA plant.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release source and pollution prevention, but no frequencies or quantities.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination Medium

Study Citation:	Kirchstetter, T. W., Singer, B. C., Harley, R. A. (1999). Impact of California reformulated gasoline on motor vehicle emissions 1 Mass emission rates. Environmental Science & Technology 33(2):318-328.
HERO ID:	87257
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	motor vehicles
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses an NIST method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
Metric 5:	Sample Size	High	Statistics are fully characterized with percentiles and standard deviations.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Critical metadata is included, but additional details missing.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Paper thoroughly explains uncertainty.

Overall Quality Determination High

Study Citation:	Knighton, W. B., Herndon, S. C., Wood, E. C., Fortner, E. C., Onasch, T. B., Wormhoudt, J., Kolb, C. E., Lee, B., Zavala, M., Molina, L., Jones, M. (2012). Detecting fugitive emissions of 1,3-butadiene and styrene from a petrochemical facility: An application of a mobile laboratory and a modified proton transfer reaction mass spectrometer. Industrial and Engineering Chemistry Research 51(39):12706-12711.
HERO ID:	2660787
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Petrochemical plants
Release quantity:	18.2 lbs/hr, 80 tons/yr. Page 5
Comments:	The 1,3-butadiene plumes appear to be fugitive emissions, asopposed to gas flare, since there is no evidence of elevatedconcentrations of the major combustion related products, CO2or CO, associated with these events. This observation isconsistent with the reported emission inventory. For 1,3-butadiene, the 2009 emission inventory reports that 86% (18.3tons/year) of TPC's and 58% (4.3 tons/year) of GY'semissions are fugitive with the remaining being stack releases. Page 4.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Method is described well, and seems to be equivalent to a commonly used method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
Metric 5:	Sample Size	Medium	Graphs are shown, but statistics aren't listed alongside them for clarity. Also, only vague ranges are given in the text.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some metadata provided, but not all.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainties addressed on multiple occasions, and suggestions are provided on how to improve sampling and modeling.

Overall Quality Determination High

Study Citation:	Lazzaro, E., Sbarski, I., Bishop, J. (2007). Recycling of engineering thermoplastics used in consumer electrical and electronic equipment. :717-724.
HERO ID:	5735801
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	ABS plastics within waste electrical and electronic equipment
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release source and pollution prevention, but no frequencies or quantities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Lough, G. C., Schauer, J. J., Lonneman, W. A., Allen, M. K. (2005). Summer and winter nonmethane hydrocarbon emissions from on-road motor vehicles in the Midwestern United States. Journal of the Air and Waste Management Association 55(5):629-646.
HERO ID:	4140756
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions measured at road tunnel outlets (specifically in Wisconsin) (page 3 of 19)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (measured/calculated values and measurement uncertainties) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing characterization of car types.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by uncertainties in methodology. Variability addressed by seasonal changes.

Overall Quality Determination — High

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
Conditions of Use:	Other-Combustion Product

EXTRACTION

Parameter	**Data**
Description of release source:	Heaters, tanks, boilers, flares, sulfur recovery units, and fugitive emissions from Area 3 of the Texaco Bakersfield petroleum refinery.
Release quantity:	Appendix B-1, Page B-1-7: "Heaters (3): 2.151-2.571 lb/yr each Boilers(2): 0.4578-0.9019 lb/yr each Flare: 0.1632 lb/yr Tanks(10): 3.530E-05 to 2.464E-03 lb/yr each Sulfur Recovery: 0.3804 lb/yr Fugitives(7): 0.5218-5.402 lb/yr each TOTAL: 28.08 lb/yr" "Heaters(3): 2.369E-03 to 2.943E-03 lb/hr each Boilers(2): 3.186E-04 lb/hr each Flare: 1.861E-05 lb/hr Tanks(10): 4.041E-09 lb/hr to 2.820E-07 lb/hr each Sulfur Recovery: 4.325E-05 lb/hr Fugitives(7): 5.958E-05 to 6.168E-04 lb/hr each TOTAL: 3.677E-03 lb/hr"
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Uninformative	EPA believes that the butadiene is released as a combustion byproduct, an occupational scenario that is outside the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Uncertainty and variability of the results are not addressed in the study.

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Heaters, internal combustion engines, flares, tanks, cooling towers, wastewater treatment areas, sulfur recovery units, and fugitive emissions from valves at a petroleum refinery.
Release quantity:	Emissions per source are listed in Table B-1 (lb/day) but due to the photocopy job, they are illegible.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — High

Study Citation:	Luft Environmental Consulting, (1993). AB 2588 Health risk assessment for Texaco Refining and Marketing Inc.'s Bakersfield Plant-Area 3 Reporting Year 1991.
HERO ID:	6570010
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Three heaters, two boilers, and a flare at a petroleum refinery.
Release quantity:	Emissions per each individual unit are listed in Table B-1. Total butadiene emissions for all processes are 28.08 lb/yr.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — High

Study Citation:	Melnick, R. L., Shackelford, C. C., Huff, J. (1993). Carcinogenicity of 1,3-butadiene. Environmental Health Perspectives 100(0):227-236.
HERO ID:	646923
Conditions of Use:	Manufacturing, processing

EXTRACTION

Parameter	**Data**
Description of release source:	Release sources may include automobile exhaust, gasoline formulations, and small amounts from burning plastics or rubber
Release quantity:	10million pounds of BD per year from facilities that produce or process BD
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic industrial scenarios, which is similar to the in-scope occupational scenarios for manufacturing and processing.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing specific release source or emission duration.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Mo, Z., Shao, M.,in, Lu, S., Qu, H., Zhou, M., Sun, J.,in, Gou, B.,in (2015). Process-specific emission characteristics of volatile organic compounds (VOCs) from petrochemical facilities in the Yangtze River Delta, China. Science of the Total Environment 533:422-431.
HERO ID:	3075174
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Petrochemical facilities in the Yangtze River Delta, China, through evaporation of raw materials in open areas and fugitive emission vapor leaks from the process equipment.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	EPA method used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data is from an non-OECD country.
	Metric 3: Applicability	High	Report is within scope.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5: Sample Size	Medium	Only weight percentages provided. There are graphs, but they aren't labeled with specific values.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Most critical metadata is included, but missing additional fields.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed and explained well in the conclusion

Overall Quality Determination — High

Study Citation:	Morrow, N. L. (2001). Significance of 1,3-butadiene to the US air toxics regulatory effort. Chemico-Biological Interactions 135-136:137-143.
HERO ID:	82389
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Vehicles, open burning, polymer and resins, chemical manufacturing, petroleum refining, tire production, lead smelting
Release quantity:	"Mobile sources: on-road vehicles: 36900 tons (51.4%) Open burning: forest and wildfires: 10700 tons (14.9%) Mobile sources: non-road — other: 10100 tons (14.0%) Open burning: prescribed burns: 9200 tons (12.8%) Polymer and resins: 1120 tons (1.6%) Industrial organic chemicals manufacturing: 1080 tons (1.5%) Miscellaneous organic chemical manufacturing: 1010 tons (1.4%) Mobile sources: non-road — aircraft: 833 tons (1.2%) Secondary lead smelting: 530 tons (0.74%) Petroleum refining — other: 175 tons (0.24%) Agricultural chemicals and pesticides: 106 tons (0.15%) Petroleum refining: cyclic crude and intermediate production: 36 tons (0.05%) Hydrochloric acid production: 36 tons (0.05%) Alkali and chlorine production: 24 tons (0.03%) Industrial inorganic chemical manufacturing: 8.4 tons (0.01%) Tire production: 6.0 tons (0.01%) 12 Other categories: 9.5 tons (0.01%)"
Waste treatment methods and pollution control:	nan
Comments:	See table 1 for emission estimates

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses EPA and TRI data.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	Medium	Values are given, but no statistics about values are given in addition.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some data is included in the paper, but not all categories are mentioned.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The study provides only limited discussion of the variability and uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Mullins, J. A. (1990). Industrial emissions of 1,3-butadiene. Environmental Health Perspectives 86(0):9-10.
HERO ID:	5554351
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Equipment leaks from styrene-butadiene copolymer production, production of polybutadiene, and production of neoprene/chlorine."Equipment leaks occur as the result of imperfect sealing at connections such as flanges, screwed fittings, sealing surfaces on rotating equipment such as pumps and compressors, and at devices designed to protect equipment from overpressure such as relief valves. The category also includes losses that may occur as the result of sampling process streams for quality control. "
Release quantity:	5 million lbs./yr. from production of styrene-butadiene copolymers. Of this total, about 50% attributed to equipment leaks and 50% to process venting. 900,000 lbs./yr. from polybutadiene production, 98% from equipment leaks. 86,000 lbs./yr. from neoprene/chlorine production, almost all from equipment leaks.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for Emissions to Air, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing how much the results may differ than the values provided in the report. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Murphy, C. F., Allen, D. T. (2005). Hydrocarbon emissions from industrial release events in the Houston-Galveston area and their impact on ozone formation. Atmospheric Environment 39(21):3785-3798.
HERO ID:	121742
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Description of release source:	Various industrial sources including organic chemicals and petroleum refining; SIC codes listed
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for chemical manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (release amounts, duration, and rates) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing specific process unit and facility information.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples from multiple sites and different times, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Myers, J. L., Phillips, T., Grant, R. L. (2015). Emissions and ambient air monitoring trends of lower olefins across Texas from 2002 to 2012. Chemico-Biological Interactions 241:2-9.
HERO ID:	3364823
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	The primary way 1,3-butadieneis released into the environment is from emissions from gasoline and diesel-powered vehicles and equipment. Also from industrial facilities in Texas.
Release quantity:	Top five emitters of 1,3-BD in Texas and % of total emissions in Texas (total 407 tons per year in Texas): Equistar Chemicals LP, Channelview - 17.6% ... INEOS USA LLC, Chocolate Bayou - 10.9% ... BASF Total Petrochemicals - 9.3% ... Lanxess Corp, Orange Plant - 6.0% ... Shell Chemical LP, Deer Park - 6.0% ... Statewide emissions in 2002 were 675.3 tons per year
Comments:	See table 1 and 2 for more data on the chemical.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for industrial emissions including petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by data for multiple sites and variability over a few years, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Nagpure, A. S., Gurjar, B. R., Kumar, V., Kumar, P. (2016). Estimation of exhaust and non-exhaust gaseous, particulate matter and air toxics emissions from on-road vehicles in Delhi. Atmospheric Environment 127:118-124.
HERO ID:	3372788
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release quantity:	Graph shows total 1,3-BD emission from 1991-2020 in Delhi with breakdown of vehicle types contributing emissions; biggest contributor shifted from cars to Light Commercial Vehicles around 2010-2014 ... most recent total emissions over past few years is between 1500-2000kg of 1,3-BD
Comments:	Used the VAPI model; details of input data are provided in a supplemental information document

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided; supplementary document available
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Nakamura, J., Azuma, N., Kameya, T., Kobayashi, T., Urano, K. (2008). Analysis of the toxicity-weighted release amount ranking of PRTR chemicals in Japan. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 43(5):452-459.
HERO ID:	1025153
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	4.8% reported releases, 92.8% mobile sources, 1.8% households
Release quantity:	6.0E+6 kg/year

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Uses an OECD method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Data is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	Medium	Mostly ranges and rough averages on large orders of magnitude given.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Only annual release and disposal sources mentioned.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty briefly mentioned in conclusion.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1993). NTP technical report on the toxicology and carcinogenesis studies of 1,3-butadiene (CAS no. 106-99-0) in B6C3F1 mice (inhalation studies).
HERO ID:	5160111
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	facilities that produce or process 1,3-BD; 70% of emissions from equipment leaks and 30% from process venting (pg. 16/389)
Release quantity:	10 million pounds/yr in 1984 (pg. 16/389)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1999). NTP report on carcinogens background document for 1,3-butadiene.
HERO ID:	5160135
Conditions of Use:	Disposal/emissions to air, water, and land

EXTRACTION

Parameter	**Data**
Description of release source:	facilities producing 1,3-BD, styrene-BD copolymer, polyBD, neoprene, ABS copolymer, nitrile elastomer, and adiponitrile; lesser emissions in other processing operations in 1992, petroleum refineries were fourth largest emitter of 1,3-BD emitted from furnaces at secondary lead smelting facilities handling lead-acid batteries with plastic battery separators (pgs. 8-10/143)
Release quantity:	annual emissions 102,000 Mg/yr for 1990 (included vehicle emissions and manufacturing and producing facilities)... volatilization of 1,3-BD from POTWs handling SB copolymer wastewaters emitted total 21 tons/yr in 1996... 5,398 lbs to surface water and 277 lbs to land in 1995 (pg. 9/143)
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for disposal, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fifteenth edition: 1,3-butadiene.
HERO ID:	5160138
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Release quantity:	calculated annual butadiene emissions to air to be 102 million kilograms (225 million pounds) in 1990 (included vehicle emissions and manufacturing and producing facilities)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for disposal, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Nunez, C., McMinn, B., Vitas, J. (1996). Barriers to the use of radiation-curable adhesives in the coated and laminated substrate manufacturing industry. Journal of Hazardous Materials 45(1):59-78.
HERO ID:	5466433
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	air releases (page 6 of 20. Butadiene not specifically mentioned.)
Release quantity:	In 1990, total air releases (fugitive and point emissions) by facilities operating under SIC 2671 were 10.5 million pounds (4.7 Mkg). SIC 2672 facilities emitted nearly 40.1 Mlb (18 Mkg) of reportable chemicals to the air. (page 6 of 20. Butadiene not specifically mentioned.)
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources including the EPA.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	In the USA
Metric 3:	Applicability	High	Data are for solvents in synthetic rubber/coating manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by describing different methods of curing and coating rubbers, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	OEHHA, (2013). 1,3-Butadiene reference exposure levels.
HERO ID:	5099113
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	78.8% of releases are non-point or mobile; 1.6% are accidental or fugitive during manufacture, use, transport, storage, or disposal; remainder of releases from direct volatilization from gas, stack emissions, cigarette smoke, and burning of plastics... similar breakdown for CA specifically; wildfires are largest natural source
Release quantity:	Total statewide emissions in California in 2008 was 3,754 tons
Comments:	different draft/version of HERO ID 5155603

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic scenarios, which are similar or may include in-scope occupational scenarios such as vehicle emissions and manufacturing/processing emissions.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing breakdown of individual release sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Outapa, P., Thepanondh, S. (2014). Development of air toxic emission factor and inventory of on-road mobile sources. Air, Soil and Water Research 7:1-10.
HERO ID:	5587959
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Mobile sources
Release quantity:	250-300 tons/yr estimated for 2009-2024 (Figure 3)
Release or emission factors:	Release or emission factors
Comments:	See Figure 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Thailand, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges, percentages, means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning discrepancies in results, such as the model over or under-estimating values.. Variability addressed by using different fuels and motor vehicles.

Overall Quality Determination High

Study Citation:	Pelz, N., Dempster, N. M., Shore, P. R. (1990). Analysis of low molecular weight hydrocarbons including 1,3-butadiene in engine exhaust gases using an aluminum oxide porous-layer open-tubular fused-silica column. Journal of Chromatographic Science 28(5):230-235.
HERO ID:	5067380
Conditions of Use:	Commercial Use - Fuel and Related Products

EXTRACTION

Parameter	**Data**
Description of release source:	engine exhaust gases (page 1 of 6)
Release quantity:	At both engine conditions the 1,3-butadiene level was about 5 ppm by volume (page 3 and 4 of 6) See page 5 of 6 for visual.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	From Department FVA/VE in Germany
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	from Germany, and OECD country
	Metric 3: Applicability	Low	The release data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario (vehicle exhaust)
	Metric 4: Temporal Representativeness	Low	from 1990
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination Medium

Study Citation:	Perry, R., Gee, I. L. (1995). Vehicle emissions in relation to fuel composition. Science of the Total Environment 169(1-3):149-156.
HERO ID:	77338
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Motor Vehicles- Butadiene is emitted into the atmosphere in the exhaust from gasoline vehicles.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Release data methodology not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
Metric 3:	Applicability	High	Report is in scope.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Medium	Samples are characterized with percentages and graphs, but no other statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release media and emission factors included, but not much else.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed.

Overall Quality Determination — Medium

Study Citation:	Pervier, J. W., Barley, R. C., Field, D. E., Friedman, B. M., Morris, R. B. (1974). Survey reports on atmospheric emissions from the Petrochemical Industry.
HERO ID:	5441658
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Petrochemical processes
Release quantity:	6,210 million lbs/year of adiponitrile via butadiene emissions1,040 million lbs/year from styrene butadiene rubber
Comments:	It is unclear how much of the releases are actually butadiene or overall hydrocarbon emissions that include butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for Emissions to Air, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing disposal/treatment method, emission factors, daily release quantity, number of release days, waste treatment, and P2.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by using a weighting system when calculating statistics, and stating when numbers are estimates. Variability addressed by screening the questionnaires that industry members provided.

Overall Quality Determination Medium

Study Citation:	programs, E.O. (1974). Air pollution control engineering and cost study of the paint and varnish industry.
HERO ID:	6580284
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Non-fugitive emissions from varnish and resin cooking, thinning, handling and storage, milling, blending, and filling. Fugitive emissions from paint and pigment particulate solvents.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for emissions to air, but metrics and emission factors are given as totals and are not specific to butadiene.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the explanations of calculation methods. Variability is addressed by including various sites and production methods in the report.

Overall Quality Determination High

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
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	General Electric engine maintenance and services
Release quantity:	”Engine Maintenance: 1.59 lbs/hr Jet Engine Test Cell: 0.795 lbs/hr Jet Engine Test Cell 2: 0.797 lb/hr””Engine Maintenance: 264 lbs/yr Jet Engine Test Cell: 121 lbs/yr Jet Engine Test Cell 2: 144 lb/yr”
Release or emission factors:	Release or emission factors
Comments:	See Table 3-x

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty addressed when describing the modeling method used. Variability addressed by sampling at locations around the plant.

Overall Quality Determination High

Study Citation:	Riservato, M., Rolla, A., Davoli, E. (2004). An isotopic dilution approach for 1,3-butadiene tailpipe emissions and ambient air monitoring. Rapid Communications in Mass Spectrometry 18(4):399-404.
HERO ID:	1942367
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Butadiene is released in the exhaust gas from vehicle tailpipes after fuel combustion.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Italy, an OECD country.
	Metric 3:	Applicability	Medium	Data are for the use of fuels and related products, but also include ambient air samples.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the description of the sampling and analysis method. Variability is addressed by sampling multiple vehicles and ambient air.

Overall Quality Determination High

Study Citation:	Rosenfeld, P. E., Feng, H., L.G. (2011). The petroleum industry. :57-71.
HERO ID:	6108171
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	Oil and gas field operations as well as gas processing plants are also significant sources of emissions. As such, air emissions consist of point, fugitive, and area sources. Fugitive emissions are the emissions from equipment leaks, such as from valves, storage tanks, and various support equipment. Solid wastes are generated from the refining process, petroleum handling operations, and wastewater treatment.
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variations in release sources were addressed. Uncertainty is not addressed.

Overall Quality Determination — High

Study Citation: Schuetzle, D., Siegl, W. O., Jensen, T. E., Dearth, M. A., Kaiser, E. W., Gorse, R., Kreucher, W., Kulik, E. (1994). The relationship between gasoline composition and vehicle hydrocarbon emissions: A review of current studies and future research needs. Environmental Health Perspectives 102(SUPPL. 4):3.
HERO ID: 1518425
Conditions of Use: Emissions of 1,3-Butadiene as a combustion product from vehicles

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	exhaust from gasoline powered vehicles
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Data are for Emissions of 1,3-Butadiene as a combustion product from vehicles which does not apply to any occupational scenario within scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, ranges, means. Standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing disposal method, emission factors, release quantity, release days, number of sites, and waste treatment.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed within the methodology, and by statistics. Variability addressed by running tests at various speeds and various fuel compositions.

Overall Quality Determination Uninformative

Study Citation:	Singh, D., Shukla, S. P., Sharma, M., Behera, S. N., Mohan, D., Singh, N. B., Pandey, G. (2014). GIS-based on-road vehicular emission inventory for Lucknow, India. Journal of Hazardous, Toxic and Radioactive Waste 20(4):A4014006.
HERO ID:	5705158
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release quantity:	Release in g/day for various vehicle types in city of Lucknow: 81.37 for 2W, 46.49 for 3W, 33.15 for 4W, 60.68 for LCVs, and 2.84 for HDVs
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total vehicle miles traveled, example parking lot survey, emission factors) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing derivation of emission factors.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by spatial variation and vehicle type, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Sponza, D. T., Pala, A. I. (1997). The impacts of wastewater treatment plants in air pollution and control technologies. Retrospective Collection :654-659.
HERO ID:	1969567
Conditions of Use:	Disposal (general wastewater treatment methods)

EXTRACTION

Parameter	**Data**
Description of release source:	Industrial wastewater treatment plants, including municipal and industrial discharges, wastewater sewers, pump stations, bar racks, and grit chambers. The basic mechanisms governing the release of volatile organic compounds (VOCs) in wastewater treatment systems are volatilization and gas stripping. The volatilization term is the release of VOCs from wastewater surfaces to the atmosphere because the partition between the gas and water phase until equilibrium concentrations reached. The transfer of VOCs usually occurs from wastewater to the atmosphere because the VOCs concentration is extremely low in the atmosphere. The gas stripping term is the gas entraining to the wastewater. When a gas diffused into a wastewater, VOCs transferred from the wastewater to the gas. In wastewater treatment , air stripping occurs most commonly in aerated biological treatment plant due to gas stripping is most effective when contaminated wastewater exposed to contaminant free air.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Methodology is not specified.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Turkey, an OECD country.
	Metric 3: Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Steinle, P. (2016). Characterization of emissions from a desktop 3D printer and indoor air measurements in office settings. Journal of Occupational and Environmental Hygiene 13(2):121-132.
HERO ID:	3124670
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Description of release source:	desktop 3D printers (page 2 of 13)
Release quantity:	See table 1 (page 5 of 13) for concentrations and emission rates of substances measured in the emission test chamber that was measuring the emissions from the 3D printer, including ABS. Background concentrations, printing concentrations, and emission rates in particles or micrograms per object/gram printed/minute are all expressed for each component of ABS. Discussion of results on pages 6, 7, and 11 out of 13. Table 2 on page 8 of 13 shows concentrations (particles/cm3) and classification of emitted ultrafine particles from ABS collected on TEM grids.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Switzerland, an OECD country.
Metric 3:	Applicability	High	Data are for 3D printer emissions in an office space, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning undetectable species and explaining differences between printer types. Variability addressed by multiple visits to the same site 7 months apart.

Overall Quality Determination High

Study Citation:	Stroud, C. A., Zaganescu, C., Chen, J., Mclinden, C. A., Zhang, J., Wang, D. (2016). Toxic volatile organic air pollutants across Canada: multi-year concentration trends, regional air quality modelling and source apportionment. Journal of Atmospheric Chemistry 73(2):137-164.
HERO ID:	3259673
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	breakdown of percent contribution to total national emisions from each sector source; largest contributor at 47% is rail/air/marine followed by 24% from miscellaneous area sources... model to determine emissions category contributions in different regions during different seasons of the year
Release quantity:	Canadian national total is 4.4 kilotons/yr of 1,3-BD emitted
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3: Applicability	Medium	Data are for generic emissions to air, which includes in-scope occupational scenarios pertaining to air emissions.
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by different regions and change over seasons, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Stump, F. D., Knapp, K. T., Ray, W. D., Siudak, P. D., Snow, R. F. (1994). Influence of oxygenated fuels on the emissions from three pre-1985 light-duty passenger vehicles. Journal of the Air and Waste Management Association 44(6):781-786.
HERO ID:	6590
Conditions of Use:	Commercial use, Fuels and related products

EXTRACTION

Parameter	**Data**
Description of release source:	motor vehicle emissions (page 2 of 7) 1,3-Butadiene is not a gasoline component but a product of the vehicle combustion process. The compound is emitted largely in the initial 2 minutes of vehicle start-up, when the air-to-fuel is rich and the emission control systems are warming up (Page 5 of 7 and see additional brief discussion on page 7 of 7).
Release quantity:	See tables III, IV, and V for on page 5 of 7 for tables of vehicle tailpipe emissions from various fuel, each table representing a different temperature. The values range from 0.35 mg/ml to 99.10 mg/ml

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site, done by EPA
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation, fuels and related products
	Metric 4:	Temporal Representativeness	Low	from 1994
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	Stump, F. D., Knapp, K. T., Ray, W. D., Snow, R., Eudy, L. (1992). The composition of motor vehicle organic emissions under elevated temperature summer driving conditions (75 to 105 F): Part II. Journal of the Air and Waste Management Association (1990-1992) 42(10):1328-1335.
HERO ID:	1650380
Conditions of Use:	Use in Fuels (vehicle emissions)

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Late-model motor vehicles with four-cylinder engines. Butadiene emitted through vehicle tailpipe.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses a federally regulated method for testing vehicle tailpipe emissions.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Only tested 4 cylinder behicles
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination Medium

Study Citation:	Tang, J. H., Chu, K. W., Chan, L. Y., Chen, Y. J. (2014). Non-methane hydrocarbon emission profiles from printing and electronic industrial processes and its implications on the ambient atmosphere in the Pearl River Delta, South China. Atmospheric Pollution Research 5(1):151-160.
HERO ID:	2652846
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Molding machines in the electronics industry. acrylonitrile butadiene styrene is melted along other polymers to form plastic casting

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	A regional transport model in China was used, but not described.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data is from an non-OECD country.
	Metric 3: Applicability	Medium	Emissions are given as ”source signatures” and percentages of industry departments. Also, butadiene is only mentioned once in the report, and most data is given for non-methane hydrocarbons overall.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution fully characterized. Individual numbers are given for many chemicals, and means, standard deviations, percentages and ratios provided.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Some metadata provided, but not all.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainties addressed in the model, and standard deviations are given as well.

Overall Quality Determination — Medium

Study Citation:	Tang, T., Claggett, M., Byun, J., Roberts, M., Granell, J., Aspy, D. E. (2005). MOBILE6.2 modeling of exhaust air toxic emission factors - Trend and sensitivity analysis. Transportation Research Record 1941(1):99-106.
HERO ID:	1970148
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Mobile sources
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are less than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (in graphs) with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed throughout the report and attributed to factors like temperature and speed. Uncertainty isn't addressed.

Overall Quality Determination — High

Study Citation:	Tansel, B. (1998). Automotive wastes. Water Environment Research 70(4):620-629.
HERO ID:	1620378
Conditions of Use:	Use of fuel products (Vehicle exhaust)

EXTRACTION

Parameter	**Data**
Description of release source:	motor vehicle exhaust
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan
Comments:	Article contains section about disposal of waste vehicle tires (rubber) butadiene is not mentioned in this section though. Might contain useful process and disposal info for rubber tires which is in scope for 1,3-BD.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data sourced in this article is greater than 20 years old (1997)
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene. Review draft.
HERO ID:	10293377
Conditions of Use:	Processing as a Reactant

EXTRACTION

Parameter	**Data**
Release quantity:	Up to 45 ppm reported in air samples and factory emissions at petrochemical plants (page 15 of 104)
Comments:	See pages 47-70 for summary of epidemiologic studies, most of which did not have extractable information but did have general information about various studies done in different specific plants such a number of workers that work at a given facility and how many years worked (mostly rubber plants)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report from 1985.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation:	U.S. EPA, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.
HERO ID:	46492
Conditions of Use:	Commercial - Use in Fuels

EXTRACTION

Parameter	**Data**
Description of release source:	Burning of tires (page 349 of 2050), uncontrolled diesel engines (396 of 2050)Flaring is a high-temperature oxidation process used to bum combustible components, mostly hydrocarbons, of waste gases from industrial operations. Natural gas, propane, ethylene, propylene, butadiene and butane constitute over 95 percent of the waste gases flared. (page 1861 of 2050)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 1995
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.
HERO ID:	46492
Conditions of Use:	Processing - processing as a reactant

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 1995
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2015). Chapter 5: Petroleum industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	5097885
Conditions of Use:	Multiple

EXTRACTION

Parameter	**Data**
Description of release source:	Leaks of total organic compound emission rates; Table 3-3 has list of equipment leak emission sources pg.84
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but only covers one release media (Air) at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The release data are for equipment leaks, which could be applicable for multiple occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation: U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID: 6389860
Conditions of Use: Manufacture

EXTRACTION

Parameter	Data
Description of release source:	Pg. 4-11: Sources of releases for any chemical process in general are process vent discharges, equipment leaks, emissions from secondary sources (wastewater, liquid waste, or solid waste discharges), storage related releases, and emergency or accidental releases. Pg. 4-11: see Fig 4-1,2,3 for sources pertaining specifically to 1,3-butadiene manufacturing.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Most of the emission factors for the production of 1,3-butadiene reported in this data source are based on data (PV and emission rates from source categories - e.g., process vents) reported by the Chemical Manufacturer's Association (CMA) in 1984 in response to EPA requests. The emission rates for equipment leaks were developed by the CMA and are based on a 1989 study of equipment leak emissions at butadiene production facilities.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	EPA data source
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability in some emission factors given but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID:	6389860
Conditions of Use:	Processing as a reactant: Plastic material and resin manufacturing & Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Refer to Section 5 for information about release sources
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Section 5 includes a subsection for each major use (which are listed in the form above) . Each subsection provides a general discussion of the production process, estimates of the associated butadiene emissions, and a description of any existing emissions control practices. These discussions are primarily based on summary memoranda of industry responses to EPA Section 114 questionnaires,National Institute for Occupational Safety and Health (NIOSH) survey reports, and various otherreports as referenced, and represent information gathered prior to 1986. The level of detailvaries according to the availability of information. In view of these limitations, the reader isadvised to contact individual facilities or review State permit files for more complete andaccurate information.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	EPA data source
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability in some emission factors given but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID:	6389860
Conditions of Use:	Multiple COU

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA data source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	Several of the uses are occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Meta data is included in other parts of the report.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including different sources but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2019). National Emissions Inventory (NEI) [database]: CASRNs 79-00-5, 75-34-3, 107-06-2, 78-87-5, 84-61-7, 106-99-0, 106-93-4, 50-00-0, 85-44-9, 106-46-7, 85-68-7, 84-74-2, and 115-86-6.
HERO ID:	6535959
Conditions of Use:	All - emissions data from the EPA National Emissions Inventory

EXTRACTION

Parameter	**Data**
Release quantity:	details are provided by SCC and County FIP
Release or emission factors:	Release or emission factors
Release frequency:	365 (estimates are annual)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA NEI
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Includes all emission sources
	Metric 4:	Temporal Representativeness	Medium	Appears to be data for 2008
	Metric 5:	Sample Size	N/A	Annual emissions data
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Includes annual total by county and sources
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	uncertainty and variability in the numbers themselves not included, but variability represented among the many data points provided

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7310513
Conditions of Use:	Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	EMISSION FACTORS FOR EMULSION STYRENE-BUTADIENE COPOLYMER PRODUCTION
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Source is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Emission factors provided for different processes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7315820
Conditions of Use:	Paints and coatings

EXTRACTION

Parameter	**Data**
Description of release source:	The only pollutants emitted in significant quantities from solvent base coating using plasticizers are volatile organic compounds from solvent evaporation. In an uncontrolled facility, essentially all of the solvent used in the coating formulation is emitted to the atmosphere. Of these uncontrolled emissions, 80 to 95 percent are emitted with the drying oven exhaust. Some solvent (from zero to 5 percent) can remain in the final coated product, although this solvent will eventually evaporate into the atmosphere. The remainder of applied solvent is lost from a number of small sources as fugitive emissions. There are also VOC losses from solvent storage and handling, equipment cleaning, miscellaneous spills, and coating formulation mixing tanks. Fugitive solvent emissions during the coating process come from the evaporative loss of solvent around the coating head and from the exposed wet web prior to its entering the drying oven.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation but is not specific to 1,3-Butadiene.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by discussing emissions from different processes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1995). Ap-42: Chapter 4.12 - Manufacture of rubber products.
HERO ID:	7315841
Conditions of Use:	Rubber Product Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	The mechanically-created or externally-added heat present during the six principal processes (mixing, milling, extrusion, calendering, curing, and grinding) cause volatile organic compounds (VOC) and hazardous air pollutants (HAP) to be emitted. Particulate matter is primarily emitted from the dry chemicals utilized in mixing and as a result of grinding. pg. 16
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site (only covers air releases).
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	High	The release data are for an occupational scenario (rubber product manufacturing) within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Variability is addressed by providing emission factors for different processes, and uncertainty is also discussed in the document.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2021). National analysis TRI dataset (TRI): Data used for TSCA risk evaluations, reporting year 2019.
HERO ID:	8347325
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Releases from various processes
Release quantity:	Total on and off site releases (lbs/yr) for 2019, 2018, 2017, 2016, 2015, respectively: 1,420,871; 1,106,323; 1,362,314; 1,243,518; 1,890,882.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data are from the past 10 years.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release quantity, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by collecting sampling over several years from several releasing facilities. However, release estimate uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2019). TRI on-site and off-site reported disposed of or otherwise released (in pounds), for all industries.
HERO ID:	8784984
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	TRI On-site and Off-site Reported Disposed of or Otherwise Released (in pounds), for All industries. Reporting year (RY) 2017 is the most recent TRI data year available.
Release quantity:	Total On-site Disposal (lbs): 1,389,910Total Off-site Disposal (lbs): 1,312Total On + Off-site Disposal (lbs): 1,391,222

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The release data methodology is known (Toxics Release Inventory data) and is expected to cover all pertinent release sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Release data are from TRI Reporting Year 2017.
	Metric 5: Sample Size	Low	Individual data used to determine total on and off-site releases are available within the TRI database, however, those data are not presented here.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Provides only a high-level summary of releases from 2017 TRI, but does not provide any additional metadata on releases.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2023). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	Petroleum Refining

EXTRACTION

Parameter	**Data**
Description of release source:	Within the petroleum refining process, emissions can be expected for the following unit operations:1. Vacuum distillation2. Catalytic cracking3. Thermal cracking processes4. Utility boilers5. Catalytic reforming6. Hydrogen Production7. Sulfur recovery8. Blowdown systems9. Heaters10. Compressor engines11. Sweetening12. Asphalt Blowing
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation, but data is not chemical-specific.
	Metric 4:	Temporal Representativeness	Low	Most data is from more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release data includes release media and process but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including emission factors for different process units but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2023). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	Transportation And Marketing Of Petroleum Liquids

EXTRACTION

Parameter	**Data**
Description of release source:	Evaporative emissions from the transportation and marketing of petroleum liquids may be considered, by storage equipment and mode of transportation used, in four categories:1. Rail tank cars, tank trucks, and marine vessels: loading, transit, and ballasting losses.2. Service stations: bulk fuel drop losses and underground tank breathing losses.3. Motor vehicle tanks: refueling losses.4. Large storage tanks: breathing, working, and standing storage losses.
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation, but information is not chemical-specific.
Metric 4:	Temporal Representativeness	Low	Most of the data used is more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by assessing several aspects of the emission sources within transportation of petroleum products, but uncertainty of emission factors is not characterized.

Overall Quality Determination Medium

Study Citation:	Utell, M. J., Warren, J., Sawyer, R. F. (1994). Public health risks from motor vehicle emissions. Annual Review of Public Health 15:157-178.
HERO ID:	76007
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Motor Vehicles
Release quantity:	18.7 million metric tons/yr for all VOC's
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Release data methodology not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Report is in scope.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Low	Qualitative report, has a few numbers on emissions, but they are estimates.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release media and volume is included, but not much else.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Uncertainty is mentioned once, but not in context of butadiene emissions.

Overall Quality Determination Low

Study Citation:	Wei, L., Cheung, C. S., Ning, Z. (2017). Influence of waste cooking oil biodiesel on combustion, unregulated gaseous emissions and particulate emissions of a direct-injection diesel engine. Energy 127:175-185.
HERO ID:	3867301
Conditions of Use:	Consumer Use, Fuels

EXTRACTION

Parameter	**Data**
Description of release source:	Exhaust from diesel and biodiesel engines (page 2 of 11)
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (graph) with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the presentation of results with error bars. Variability is addressed by sampling different compositions of biodiesel.

Overall Quality Determination High

Study Citation:	Wei, W., Wang, S. X., Chatani, S., Klimont, Z., Cofala, J., Hao, J. M. (2008). Emission and speciation of non-methane volatile organic compounds from anthropogenic sources in China. Atmospheric Environment 42(20):4976-4988.
HERO ID:	622601
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	various; transportation contributed 98% of butadiene emissions in China 2005
Release quantity:	0.06 Tg/yr of butadiene in China
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions and some other point sources, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of limitations of study. Variability addressed by various estimation and data methods.

Overall Quality Determination Medium

Study Citation:	Wheatley, A., Sadhra, S. (2010). Carcinogenic risk assessment for emissions from clinical waste incineration and road traffic. International Journal of Environmental Health Research 20(5):313-327.
HERO ID:	1018314
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Waste incineration and vehicle emissions. Bottom ash from incineration is disposed to landfills. Vehicle exhaust emits butadiene into air.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Uses an EPA method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Data is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	High	Statistics are fully characterized with means, ranges, and regression values.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some data is included, but not all categories are mentioned.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Sources of variability addressed and put into context.

Overall Quality Determination High

Study Citation:	Winebrake, J. J., Deaton, M. L. (1999). Hazardous air pollution from mobile sources: a comparison of alternative fuel and reformulated gasoline vehicles. Journal of the Air and Waste Management Association 49(5):576-581.
HERO ID:	10584
Conditions of Use:	vehicle emissions

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle exhaust
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA data and NREL data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Standard deviation and number of samples provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination High

Study Citation:	Xiao, F.,ei, Peng, X., Qian, S. (2010). A study on addictives for fume reduction in asphalt pavement construction. Intelligent Automation and Soft Computing 16(5):797-803.
HERO ID:	4716263
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	The smoke generated from asphalt when heated comes from three sources: smoke from volatilization of light component in asphalt, dissolve of substance of macromolecule in asphalt and interaction of respective components under high temperature.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are from asphalt manufacture, which could be applied to the in-scope occupational scenario of incorporation into an article.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release source and pollution prevention, but no frequencies or quantities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Xin,H, Ireland, J. C., Zigler, B. T., Ratcliff, M. A., Knoll, K. E., Alleman, T. L., Luecke, J. H., Tester, J. T. (2010). The impacts of mid-level alcohol content in gasoline on sidi engine-out and tailpipe emissions.
HERO ID:	1545143
Conditions of Use:	Use of fuel products/Vehicle emissions

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle exhaust
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	Data more than 10 years but no more than 20 years old.
Metric 5:	Sample Size	Medium	Only a rough estimate of emissions are provided in a percentage. Otherwise, a graph is shown but it is not easy to read.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata such as ambient temperature and humidity
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination Medium

Study Citation:	Yang, J., Chang, P., Chie, W., Liu, J., Wu, F.,u, C. (2016). Large-scale search method for locating and identifying fugitive emission sources in petrochemical processing areas. Process Safety and Environmental Protection 104(Part A):382-394.
HERO ID:	4701807
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Pipeline, tank, and valve leaks in a synthetic rubber plant

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of data collection. Variability addressed by taking many samples and sampling at different locations.

Overall Quality Determination High

Study Citation:	Ye, Y., Galbally, I. E., Weeks, I. A., Duffy, B. L., Nelson, P. F. (1998). Evaporative emissions of 1,3-butadiene from petrol-fuelled motor vehicles. Atmospheric Environment 32(14-15):2685-2692.
HERO ID:	5547367
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	Australian light-duty passenger vehicles.
Release or emission factors:	nan
Comments:	The contribution from evaporative emissions to the total amount of 1,3-butadiene released into theatmosphere from motor vehicles was estimated to be 4% with a possible range from 1 to 15%.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for emissions to air , an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing disposal/treatment method, release quantity, number of sites, release days, and pollution prevention.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by statistics and methodology. Variability addressed by sampling different vehicle makes, models, and years.

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
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	Although all of the pollutants chosen here have large contributions from on-road mobile sources, contribution from other emission categories are substantial, and the relative contribution of each emission category differs by pollutant. On-roadmobile sources (both inside and outside Hillsborough County) contributed over 50% of the anthropogenic emissions of all pollutants, and over 50% of the total emissions (including biogenic emissions) of NOx, benzene, and 1,3-butadiene.
Release quantity:	Hillsborough County, Florida (total 395 tonnes of BD per year)... -Major roads contribute 19 tonnes/yr -Minor roads contribute 43 tonnes/yr -On-road emissions outside county contribute 150 tonnes/yr -Nonroad mobile contribute 106 tonnes/yr -Point and biogenic sources not significant -Nonpoint sources contribute 77 tonnes/yr
Release or emission factors:	Release or emission factors
Comments:	Table 1

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data includes vehicle emissions, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Release data include all associated metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by geographic variability and release sources, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Zhou, Z., Tan, Q., Deng, Y.,e, Song, D., Wu, K., Zhou, X., Huang, F., Zeng, W., Lu, C. (2020). Compilation of emission inventory and source profile database for volatile organic compounds: A case study for Sichuan, China. Atmospheric Pollution Research 11(1):105-116.
HERO ID:	6072297
Conditions of Use:	Use in fuel/emissions to air

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are for alkene emissions from various sources including vehicles, which is similar to the in-scope occupational scenario for butadiene specifically.
	Metric 4:	Temporal Representativeness	High	Most data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	AECOM, (2017). Strategic Toxic Air Reduction (STAR) environmental acceptability demonstration.
HERO ID:	11273446
Conditions of Use:	Processing as a Reactant

EXTRACTION

Parameter	**Data**
Description of release source:	Source parameters described in Table A-1 on page 18 of 52
Release quantity:	Fugitive emissions from this facility in 2013 as 6,994.6 lbs (pdf page 5 of 52).
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for Processing as a Reactant, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
Domain 3: Accessibility/ Clarity			
Metric 5:	Metadata Completeness	Medium	Release media and release frequency provided but missing operating time.
Domain 4: Variability and Uncertainty			
Metric 6:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	EIC, (2007). Louisiana toxic air pollutant dispersion modeling analysis report for Shell Chemical LP - Norco Chemical Plant - West Site.
HERO ID:	11272715
Conditions of Use:	Unknown COUs: COUs associated with undefined chemical plant

EXTRACTION

Parameter	**Data**
Description of release source:	The types fo LTAP emission sources addressed in this modeling analysis include, but are not limited to, storage tanks, area process and wastewater fugitive emissions from piping and equipment components, and a nonhazardous biosolids incinerator. Fugitive emissions from process components and wastewater systems (i.e., sumps, area drain systems, etc.) were modeled as area sources... Emissions from storage tanks and combustion sources were modeled as individual point sources. (pg 14 of 33)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The model is free of mathematical errors and is based on scientifically sound approaches or methods. However, equations and choice of parameter values are not fully described and some equations and/or parameter values may not be appropriate for the model's application.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The model is based on data that are generally more than 10 years but no more than 20 years old. However, the model is based on operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values is provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	The model characterizes variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	EIC, (2002). Toxic air pollutant dispersion modeling and VOC air quality analysis report for Shell Chemical LP, Norco Chemical Plant - West Site.
HERO ID:	11273371
Conditions of Use:	Unknown COUs: COUs for chemical plant with unknown products

EXTRACTION

Parameter	**Data**
Description of release source:	A generic description of source parameters is described on page 11 of 57 of the PDF but not butadiene specific. For example, "emission sources include storage tanks, process and area fugitive emissions from piping and equipment components, cooling water towers, flares, and other combustion units."
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The model is free of mathematical errors and is based on scientifically sound approaches or methods. Equations and choice of parameter values are appropriate for the model's application (note: peer review may address appropriate application).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The model is based on data that are more than 20 years old. The model is based on operations, equipment, and worker activities that are expected to be outdated.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values is provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	The model characterizes variability and uncertainty in the results.

Overall Quality Determination High

Study Citation: KEC, (2006). Modeling of LMAPCD Category 1 Toxic Air Contaminants.
HERO ID: 11273144
Conditions of Use: Processing as a reactant: Synthetic rubber manufacturing

EXTRACTION

Parameter	Data
Description of release source:	Page 17 describes the assumptions of release source for fugitive emissions, essentially that there is no accurate way to allocate fugitive emissions to a specific location within a plant, but for modeling sake total fugitive emissions were assigned to seven areas of the plant based on engineering judgement
Release quantity:	Maximum amount of 1,3-butadiene to the vent header of 9,500,000 lbs/yr (pg. 1 of 71)Total Flare Thermal Oxidizer emissions - 855 lbs/yrTotal emissions Flare - 19,000 lbs/yrTotal emissions Plant-wide Fugitives - 2,868 lbs/yr (pg 12)
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The model is free of mathematical errors and is based on scientifically sound approaches or methods. Equations and choice of parameter values are appropriate for the model's application (note: peer review may address appropriate application).
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	The model is based on data that are generally more than 10 years but no more than 20 years old. However, the model is based on operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
Domain 3: Accessibility/ Clarity			
Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values is provided.
Domain 4: Variability and Uncertainty			
Metric 6:	Metadata Completeness	High	The model characterizes variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	Middleton, P., Sockwell, R., Carter, L., W.P. (1990). Aggregation and analysis of volatile organic compound emissions for regional modeling. Atmospheric Environment, Part A: General Topics 24(5):1107-1133.
HERO ID:	87136
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	81% motor vehicles, 3% other vehicles, 9% burning, 7% other
Release quantity:	175,000 metric tons/yr
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model seems to have no errors, equations are appropriate and steps are described in detail.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Model can be applied to the scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	All rationale, equations, groupings, and parameters are thoroughly explained.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	Model thoroughly explains uncertainty.

Overall Quality Determination High

Study Citation:	Milbrandt, A., Coney, K., Badgett, A., Beckham, G. T. (2022). Quantification and evaluation of plastic waste in the United States. Resources, Conservation and Recycling 183:106363.
HERO ID:	11360398
Conditions of Use:	Disposal of plastics

EXTRACTION

Parameter	**Data**
Release quantity:	Of the estimated 44 Mt of plastic waste managed in 2019 domestically (abstract). See Table 2 and 3 for granular breakdown of amount of each type of plastic disposed.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Model generally describes the sources of data for release quantities and fractions applied to get amounts to each media, but some assumptions are not clearly explained.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Based on US data.
	Metric 3:	Applicability	High	Disposal is in scope.
	Metric 4:	Temporal Representativeness	High	Article is based on 2019 data, which is less than 10 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	Medium	Model approach, equations, and choice of parameter values are transparent. However, rationale for selection of approach, equations, and parameter values is not provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	The model characterizes variability and uncertainty in the results.

Overall Quality Determination — High

Study Citation:	Propper, R., Wong, P., Bui, S., Austin, J., Vance, W., Alvarado, Á., Croes, B., Luo, D. (2015). Ambient and emission trends of toxic air contaminants in California. Environmental Science & Technology 49(19):11329-11339.
HERO ID:	3019734
Conditions of Use:	Mobile Source Fuel Combustion

EXTRACTION

Parameter	**Data**
Engineering control:	1,3-Butadiene emissions depend upon fuel composition, enginetype, emission control devices, operating temperature, and theage and condition of the engine (p. 5).
Description of release source:	1,3-Butadiene is emitted mainly from incomplete fuel combustionfrom mobile sources (p. 2).
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Published, peer reviewed, model was used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from California.
Metric 3:	Applicability	High	Emissions from combustion are possibly in scope.
Metric 4:	Temporal Representativeness	High	Model run was completed in 2014, which is not more than 10 years old.
Domain 3: Accessibility/ Clarity			
Metric 5:	Metadata Completeness	Medium	Modeling inputs/methodology is generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 6:	Metadata Completeness	Medium	Temporal variability is addressed but more input parameters appear to be static.

Overall Quality Determination — High

Study Citation:	URS Corporation, (2010). Air dispersion modeling report, 1,3-butadiene analysis: Shell Chemical LP, Deer Park Facility, Deer Park, Texas.
HERO ID:	11272626
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Description of release source:	Storage vessel de-inventory, Vessel startup, Pipeline decommission, electrical outage, purge dead leg, railcar maintenance, de-inventory cleaning, MSS steam fugitive, pump decontamination, sampling emissions. unit decommissioning, BD3 tank farm pump decontamination, loading sample, unit decontamination, ground flare, analyzer vent, cold flare gas, hot flare gas, A&S flare, North property flare, West property flare, cooling tower, dock fugitive emissions, MTBE fugitive emissions, BD3 fugitive emissions, CIPX fugitive emissions, FugCoker, HVI unit, PYRO3 fugitive emissions, Site 3 Fugitive emissions, IRU fugitive emissions, HT-2 fugitive emissions. (page 16 of 102)
Release quantity:	Sitewide annual release quantities are given on the permit rate and modelling rate on PDF Pg. 45-47.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Model can be applied to processing as a reactant, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Model is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Domain 3: Accessibility/ Clarity			
Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty			
Metric 6:	Metadata Completeness	Medium	Variability addressed by modeling emissions from various specified sources with specific parameters for each source, but uncertainty is not addressed

Overall Quality Determination High

Study Citation:	URS Corporation, (2013). Air dispersion modeling report, emission event analysis: Additional information request, Shell Chemical LP, RN 100211879, Deer Park, Texas; Harris County.
HERO ID:	11272627
Conditions of Use:	Processing - Petroleum Refining

EXTRACTION

Parameter	**Data**
Description of release source:	The analysis included the following vents: RV Vent; atmospheric vent line 1; atmospheric vent line 2; and atmospheric vent line 3.Since the emissions were released from the elevated vent stacks, the actual vent stack location and parameters (physical height, temperature, velocity, and diameter) were used and modeled as point sources. The emissions from these vents started at 22:00 on January 10, 2013 and ended at 6:30 on January 11, 2013. The modeled emission rates and stack parameters are shown in Appendix A and C.The analysis included the following tank: T-B3-301The emissions from tank were modeled as pseudo-point source since the emissions are released as fugitives. The emissions from the tank started at 7:00 on January 11, 2013 and ended at 21:45 on January 11, 2013. The modeled emission rates and stack parameters are shown in Appendix A and C. (pg 12 of 64)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The model is free of mathematical errors and is based on scientifically sound approaches or methods. Equations and choice of parameter values are appropriate for the model's application (note: peer review may address appropriate application).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The model is based on data that are generally more than 10 years but no more than 20 years old. However, the model is based on operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values is provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	The model characterizes variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	URS Corporation, (2015). Revised Strategic Toxic Air Reduction (STAR) environmental acceptability demonstration for 2013 and 2014.
HERO ID:	11273429
Conditions of Use:	Processing as a Reactant

EXTRACTION

Parameter	**Data**
Release quantity:	2006 TRI air release data provided in Appendix C, starting on page 58
Release or emission factors:	Release or emission factors
Comments:	There is a follow up study to this one: HEROID 11273446

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Model can be applied to Processing as a Reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	Low	Model approach and parameters described but the underlying equations and parameter values are not provided. Rationales for choice of approach and parameters are not provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	Medium	Uncertainty is addressed by discussion in Section 4.3 on the conservative nature of the results based on max emissions and overlapping layers of assumptions. Variability is not addressed.

Overall Quality Determination — High

Study Citation:	3E Company, (1992). Health risk assessment in fulfillment of requirements under the AB2588 Air Toxics Information and Assessment Act of 1987 (final report), Northrop B-2 Division, Pico Rivera, CA, with attachments and letter dated 02/14/1992.
HERO ID:	1356128
Conditions of Use:	Other - Combustion byproduct

EXTRACTION

Parameter	**Data**
Description of release source:	Exhaust stacks at an aerospace component manufacturing facility.
Release quantity:	"Stack 93332: 0.780 lbs/yr Stack 93333: 0.780 lbs/yr Stack 93385: 0.345 lbs/yr Stack 93386: 0.6824 lbs/yr Stack 93387: 1.289 lbs/yr Stack 93388: 0.7204 lbs/yr Stack 93505: 0.1323 lbs/yr"

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	EPA believes that 1,3-butadiene is being emitted as a fuel combustion byproduct, an occupational scenario that is not within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean and 1-hr maximum) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty

Overall Quality Determination Uninformative

Study Citation:	ATSDR, (2012). Toxicological profile for 1,3-butadiene.
HERO ID:	2991419
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	The dominant sources for the release of 1,3-butadiene to the atmosphere are fugitive or accidental emissions during its manufacture, use, transport, and storage. Low levels of 1,3-butadiene are continuously emitted to the atmosphere from many sources including exhaust from motor vehicle engines using petroleum-based fuels. (pg. 144/229)
Release quantity:	1.17 million pounds/year (see table 6-1, pg. 146/229)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	NIOSH and EPA methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Most data is from U.S, some supplemental studies are included from Canada.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of any study included in the report are fully characterized. Many studies are summarized, all of which are representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources are all documented and cited.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed throughout the report, and there is a section dedicated to it.

Overall Quality Determination High

Study Citation:	Choudhary, G. (1994). Environmental exposure to 1 3-butadiene: A human health perspective. Journal of Environmental Science and Health, Part C: Environmental Carcinogenesis & Ecotoxicology Reviews 12(1):23-61.
HERO ID:	5621174
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	automobile exhaust, gasoline fumes, cigarette smoke, smoke from wild fires

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	EC, (2000). Priority Substances List Assessment Report: 1,3-Butadiene.
HERO ID:	5160048
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Release quantity:	Total Canadian emissions in 1994 ranged between 12,917 and 41,622 tonnes... 3376-7401 tonnes from on-road motor vehicles; 150-258 tonnes from aircraft; 84-1689 tonnes from off-road motor vehicles; 84 tonnes from lawnmowers; 40 tonnes from the marine sector; 17 tonnes from the rail sector... total 270.4 tonnes from chemical and chemical product industries, only 0.058 tonnes of this released to water and 0.002 tonnes of this released to land; 17.5 tonnes form plastic products industries, 22.3 tonnes from refined petroleum and coal products industries; further breakdown of BD releases from industry and sources

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3: Applicability	High	Data are for manufacturing/processing/commercial use/vehicle emissions, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by limitations in data. Variability is not addressed.

Overall Quality Determination Medium

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

EXTRACTION

Parameter	**Data**
Description of release source:	tanks, wastewater treatment area, valves, and flanges in a California petrochemical refinery
Release quantity:	Tank emissions range from no emissions to 0.537 lb/yr. Valves and flanges range from no emissions to 529 lb/yr. Tank emissions range from no emissions to 6.13E-05 lb/hr. Valves and flanges range from no emissions to 6.00E-02 lb/hr. Wastewater treatment process emits 3.20E-06 lb/hr.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Sources of uncertainty in the risk assessment are discussed in detail. Variability addressed by considering alternate emission scenarios for the refinery.

Overall Quality Determination High

Study Citation:	ENSR, (1991). AB 2588 Health risk assessment for the Texaco refinery Area 3, Bakersfield, California.
HERO ID:	6339343
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	tanks, valves, and flanges in a California petrochemical refinery
Release quantity:	Storage tank emissions range from 2.29E-04 to 0.337 lb/yr. Valves and flanges range from no emissions to 2.60 lb/yr. Tank emissions range from 2.61E-08 to 4.30E-05 lb/hr. Valves and flanges range from no emissions to 2.96E-04 lb/hr.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Sources of uncertainty in the risk assessment are discussed in detail. Variability addressed by considering alternate emission scenarios for the refinery.

Overall Quality Determination High

Study Citation:	Envirologic Data, (1991). Supplemental information from Rohr Industries Inc to USEPA submitting enclosed health risk assessment draft report with attachments: Assessment of risks from potential exposure to airborne facility emissions under California AB 2588 for the Rohr Industries, Inc facility, Riverside, California.
HERO ID:	1874143
Conditions of Use:	Unknown

EXTRACTION

Parameter	**Data**
Description of release source:	Rohr Industries, Inc. is a manufacturer of military and commercial aircraft components. Processes which emit compounds include metal surface preparation, welding, large scale painting, adhesive bonding, composite bonding and layup, degreasing, solvent wipe down, natural gas combustion, perchloroethylene dry cleaning, and process water cooling.
Release quantity:	0.37 lb/yr of 1,3-butadiene

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The data are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	Low	It is not known why butadiene is being emitted from the facility and if it is the result of an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Medium	The release quantity is not characterized by statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty of the release quantity

Overall Quality Determination — Low

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
Conditions of Use:	Processing: lubricants, paints, and coatings for aircrafts

EXTRACTION

Parameter	**Data**
Release quantity:	0.0010 lbs/day, 0.37 lbs/yr

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for aircraft lubricants, coatings, and paints, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by selecting parameter values to reflect site conditions. Variability addressed by sampling at multiple sites.

Overall Quality Determination High

Study Citation:	Hallenbeck, W. H. (1992). Cancer risk assessment for the inhalation of 1,3-butadiene using physiologically based pharmacokinetic modeling. Bulletin of Environmental Contamination and Toxicology 49(1):66-70.
HERO ID:	820099
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Release quantity:	annual emissions of BD in the United States are 12 million pounds

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for generic occupational scenarios, which may include in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Hurst, H. E. (2007). Toxicology of 1,3-butadiene, chloroprene, and isoprene. Reviews of Environmental Contamination and Toxicology 189:131-179.
HERO ID:	646909
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Mobile sources, open burning, industrial releases; 2003 TRI showed BD releases were 60% point-source, 36% fugitive, and 3.7% underground injection
Release quantity:	mobile sources (primarily vehicles) and open burning (forest fires and prescribed burns) collectively emitted more than 61,707tons in 1990; comprise more than 90% of total BD environmental emissions in 1990... emissions from manufacturing processes in 1990 were about 5.8% of total (2,350tons)
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Medium	Data are for multiple occupational exposure scenarios, some of
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing specific release sources.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by change over time and differences between data sources, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions; TRI data for industrial air releases
Release quantity:	4,415 tonnes in 1987; 2,344 tonnes in 1990; and 1,321 tonnes in 1995 (TRI data, not evaluated)
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data include vehicle emissions, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (2008). 1,3-Butadiene, ethylene oxide and vinyl halides (vinyl fluoride, vinyl chloride and vinyl bromide). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 97 97:3-471.
HERO ID:	755320
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release quantity:	106,770 tonnes per yr based on estimation method
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by presence of catalyst, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation: Lawryk, N. J. (1994). Automobile commuter exposures to volatile organic compounds: Emissions, malfunctions, and policy.
HERO ID: 6025389
Conditions of Use: Disposal

EXTRACTION

Parameter	Data
Description of release source:	engine exhaust, crankcase, and evaporative emissions from gasoline-powered automobiles
Release quantity:	It is estimated that butadiene accounts for 0.35% of all vehicle hydrocarbon emissions per year.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by including a section of the report to discuss it. Variability addressed by sampling at different commute routes, and using different cars.

Overall Quality Determination High

Study Citation:	Melnick, R. L., Huff, J. E., Bird, M. G., Acquavella (1990). Symposium overview: Toxicology, carcinogenesis, and human health aspects of 1,3-butadiene. Environmental Health Perspectives 86:3-5.
HERO ID:	5554903
Conditions of Use:	Processing (synthetic rubber manufacture)

EXTRACTION

Parameter	**Data**
Release quantity:	"Annual atmospheric emissions of 1,3-butadiene from production or polymer manufacturing plants is approximately 10 million pounds, most of which is attributable to equipment leaks (J. A. Mullins, Shell Oil Co.)." (pg. 2/3)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing the limitations of the cohort study and where data is lacking. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Northrop Corporation, (1992). Northrop corporation aircraft division: Health risk assessment for west complex (final report) with attachments and cover letter dated 021492.
HERO ID:	1577139
Conditions of Use:	Unknown

EXTRACTION

Parameter	**Data**
Description of release source:	The source is a large manufacturing plant which produces major aircraft sub-assemblies and components. Toxic compounds are emitted by the following processes:• Degreasing activities to clean tools and parts. Emissions are due mostly to chemical solvents such as 1,1,1-trichloroethane.• Coating operations which perform spray application of paints and hand applications of adhesives and sealants. Emissions are primarily in the form of volatile organic compounds (VOCs) emitted during drying and particulate matter (PM) emitted during spraying.• Surface cleaning operations which most often use 1,1,1-trichloroethane.• Refrigerant recharge and purging of equipment lines. Emissions are fluorocarbons such as freon.• Combustion products from boilers, autoclaves, process heating ovens and space heaters.
Release quantity:	16.9 lbs/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The data are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	Low	It is not known why butadiene is being emitted from the facility and if it is the result of an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	Medium	The release quantity is not characterized by statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty of the release quantity

Overall Quality Determination — Low

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.
HERO ID:	3808976
Conditions of Use:	Use (paints and coatings)

EXTRACTION

Parameter	**Data**
Description of release source:	Container cleaning, equipment cleaning, coating application (overspray)
Release or emission factors:	nan
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario documents on coating industry (paints, lacquers and varnishes).
HERO ID:	3827298
Conditions of Use:	Processing and Use

EXTRACTION

Parameter	**Data**
Description of release source:	"PROC: material loading, heat-up, surface evaporation, filling, micellaneous operations, material storage, leaks, spills USE: Application losses, equipment residues, drum residues"
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions and coating types

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.
HERO ID:	3827299
Conditions of Use:	Processing: Adhesive Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Container cleaning, dusts and volatiles from unloading containers, vented losses during mixing, sampling, equipment cleaning, volatiles from loading containers, off-spec products
Release quantity:	Provides models for estimating various releases
Release or emission factors:	Release or emission factors
Release frequency:	days/yr equal to number of bt/yr
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are reasonably expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.

Overall Quality Determination High

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.
HERO ID:	3827300
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	container cleaning, unloading, equipment cleaning, application losses, curing/drying, trimming
Release or emission factors:	nan
Release frequency:	50-365 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2004). Emission scenario document on lubricants and lubricant additives.
HERO ID:	3827416
Conditions of Use:	Formulation and use of lubricants, hydraulic fluids, and metalworking fluids

EXTRACTION

Parameter	**Data**
Description of release source:	Release sources described in Section 5 (pg 56) for formulation of lubricants, Section 6 (pg 72) for use of lubricants, Section 7 (pg 81) for use of hydraulic fluids, Section 8 (pg 89) for metalworking fluids.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	From OECD countries. Data is mostly UK.
Metric 3:	Applicability	High	Formulation and use of lubricants is in scope.
Metric 4:	Temporal Representativeness	Medium	The ESD is from 2004, which is 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination High

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.
HERO ID:	3833136
Conditions of Use:	Adhesive Application

EXTRACTION

Parameter	**Data**
Description of release source:	container cleaning, unloading, equipment cleaning, application losses, curing/drying, trimming (page 61 of 189 and throughout)
Release or emission factors:	nan
Release frequency:	up to 365 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.
HERO ID:	3840003
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	Container cleaning, dusts and volatiles from unloading containers, vented losses during mixing, sampling, equipment cleaning, volatiles from loading containers, filter wastes
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	Release or emission factors
Release frequency:	250
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of UV curable products.

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario document on plastic additives.
HERO ID:	5079084
Conditions of Use:	Plastics Compounding and Converting

EXTRACTION

Parameter	**Data**
Description of release source:	Raw material handling, compounding, converting, service life, disposal.
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by presenting emission factors for multiple scenarios/additive types but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	OECD, (2011). Emission scenario document on the chemical industry.
HERO ID:	6306753
Conditions of Use:	Manufacture, processing, use

EXTRACTION

Parameter	**Data**
Description of release source:	”Stack Air: Reactor vents, distillation column vents, absorber units, strippers, sumps/decanters, dryers, cooling vents Fugitive Air: Valves, pump seals, compressor seals, pressure-relief valves, flanges/connections, open-ended lines, sampling connections Water: Drum cleaning, equipment cleaning, aqueous distillation streams, extraction, reaction water, absorption, solids-liquids separation, adsorption, condensation”
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by presenting emission factors for multiple scenarios but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.
HERO ID:	6385735
Conditions of Use:	Processing and Commercial Use: Lubricant additives

EXTRACTION

Parameter	**Data**
Description of release source:	"PROC: unloading, container cleaning, blending, sampling, equipment cleaning, loading USE: unloading, container cleaning, disposal of spent lube oil"
Release quantity:	Provides models for estimating various releases.
Release or emission factors:	nan
Release frequency:	"Processing: 256 Use: 253"
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination — High

Study Citation:	OECD, (2009). Emission scenario document on transport and storage of chemicals.
HERO ID:	6393282
Conditions of Use:	Transportation and Storage (Processing, distribution in commerce)

EXTRACTION

Parameter	**Data**
Description of release source:	filling and emptying of containers, storage, pipelines, washing and cleaning, recycling and disposal of packaging
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical forms, containers and storage system types.

Overall Quality Determination Medium

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.
HERO ID:	5184986
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Description of release source:	Process residue/unreacted precursor; container cleaning (at supplier site)
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple abatement technologies

Overall Quality Determination — High

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
Conditions of Use:	Other- Combustion byproduct

EXTRACTION

Parameter	**Data**
Description of release source:	Chevron Oil refinery in Richmond, California
Release quantity:	172.1 lbs/yr. Emission Rates in g/s given for 44 different sub-sites of the refinery, ranging from 7.27E-07g/s to 4.44E-04 g/s.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses sound methods and the associated information does not indicate flaws or quality issues
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the US
Metric 3:	Applicability	Uninformative	EPA believes that 1,3-butadiene is being emitted as a combustion byproduct, an occupational scenario that is not within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	the data are more than 20 years old
Metric 5:	Sample Size	Low	Data is not characterized by statistics
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.

Overall Quality Determination Uninformative

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
Conditions of Use:	Other-Combustion byproduct

EXTRACTION

Parameter	**Data**
Description of release source:	Shell Oil company refinery in Martinez California
Release quantity:	Total: 190 lbs/yr, "Source 30003: 1.93E-04 g/s Source 30004: 3.08E-04 g/s Source 30005: 3.08E-04 g/s Source 30010: 7.15E-04 g/s Source 30011: 1.04E-03 g/s Source 30013: 2.32E-05 g/s Source 30014: 2.32E-05 g/s Source 30015: 2.32E-05 g/s Source 30016: 2.32E-05 g/s Source 30017: 8.51E-05 g/s"
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses sound methods and the associated information does not indicate flaws or quality issues
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the U.S.
Metric 3:	Applicability	Uninformative	EPA believes that the 1,3-butadiene emissions are produced as a combustion byproduct, an occupational scenario that is not within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The data are more than 20 years old.
Metric 5:	Sample Size	Low	Distribution of samples is not characterized by statistics
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.

Overall Quality Determination Uninformative

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
Conditions of Use:	Other-Combustion byproduct

EXTRACTION

Parameter	**Data**
Description of release source:	Exxon Chemical's Benicia Refinery
Release quantity:	3.56E2 lb/yr

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The data are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Uninformative	EPA believes that the butadiene exposure is the result of its production as a byproduct of combustion, an occupational scenario that is not within scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Low	The release quantity is not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty of the release quantity

Overall Quality Determination Uninformative

Study Citation:	Science Applications International Corporation, (1996). Generic scenario for automobile spray coating: Draft report.
HERO ID:	6311222
Conditions of Use:	Paints and Coatings: Automobile Spray Painting

EXTRACTION

Parameter	**Data**
Description of release source:	In automotive OEM, the potential release points of a nonvolatile PMN are as follows:(1) water releases from blowdown (a purge stream of the circulating paint booth water, of continuous to intermittent frequency), (2) water releases from sludge processing (sludge may be removed continuously, or as infrequently as once/year which would correspond to the removal of the entire pit contents). The corresponding excess water from sludge processing is commonly returned to the pit for recirculation, but may potentially be released particularly if sludge is removed only once a year. A facility would either remove (skim) sludge continuously for processing, or let the sludge collect for a year and remove the sludge from the pit, but would not perform both operations. (3) The generated sludge, which may be collected in containers for disposal or dumped to the facility's onsite wastewater treatment plant (Patterson, 1996), (4) stack air releases, with the chemical entrained as an aerosol.Auto refinish: air filter waste from overspray, stack air"
Release or emission factors:	Release or emission factors
Release frequency:	"Auto OEM: sludge pit cleaning: 1 day/yr All other releases: 250 days/yrAuto refinish: 170 days/yr"
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The generic scenario document uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned.
Metric 4:	Temporal Representativeness	Low	Generic scenario was created over 20 years ago.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by investigating multiple scenarios, but uncertainty is not characterized.

Overall Quality Determination Medium

Study Citation:	Spitzer, H. L. (1997). An analysis of the health benefits associated with the use of MTBE reformulated gasoline and oxygenated fuels in reducing atmospheric concentrations of selected volatile organic compounds. Risk Analysis 17(6):683-691.
HERO ID:	80077
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Description of release source:	motor vehicles
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Uses EPA method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Medium	Similar to scope, but mainly focuses on health effects.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges and means are given with no other statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Report documents all sources and methods used.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed and explained.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).
HERO ID:	10480466
Conditions of Use:	Use - Laboratory Chemicals

EXTRACTION

Parameter	**Data**
Description of release source:	container unloading, container cleaning, labware equipment cleaning, during laboratory analyses, waste disposalMedia: Water, air, landfill (throughout document)
Release or emission factors:	Release or emission factors
Release frequency:	260 day/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	This is a generic scenario and not 1,3-butadiene-specific. Please refer to the generic scenario to determine the best values for this chemical's situation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	11182966
Conditions of Use:	Repackaging

EXTRACTION

Parameter	**Data**
Description of release source:	Transfer losses, container cleaning, equipment cleaning, transfer losses during loading.
Release quantity:	Provides methodology to estimate releases based on various parameters including: opening area of cleaning equipment, physical-chemical properties, air velocity, etc.
Release or emission factors:	Release or emission factors
Release frequency:	The number of operating days is given in a range of 174-260 days/yr with an EPA default of 260 days/yr.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Note that none of the above information is specific to 1,3-butadiene. The generic scenario itself should be consulted when determining values to use for 1,3-butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering emissions from multiple activities.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).
HERO ID:	11203977
Conditions of Use:	Fuels and Fuel Additives

EXTRACTION

Parameter	**Data**
Description of release source:	Unloading transport containers, cleaning transport containers, equipment cleaning, fuel combustion releases.
Release quantity:	Provides models for estimating various fugitive air releases. For combustion, 100% release is assumed and remaining chemical (minus upstream losses) is released.
Release or emission factors:	Release or emission factors
Release frequency:	365
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	This document is a generic scenario, not specific to 1,3-butadiene. When using the information please refer to the scenario itself to see the context of the above information and determine the relevancy to 1,3-butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple tank filling methods, and considering emissions from different activities.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene: Final report.
HERO ID:	1565
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	primarily an air contaminant in cigarette smoke, incineration products of fossil fuels, gasoline vapor, and automotive exhaust. (17 of 146)
Release quantity:	Up to 45 ppm have been reported in air samples and factory emissions at petrochemical plants (17 of 146)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1985
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.
HERO ID:	3827197
Conditions of Use:	Formulation of Coatings

EXTRACTION

Parameter	**Data**
Description of release source:	Fugitive air during unloading and transfer, Vented Dust During Unloading and Filter Replacement, Container Residue Cleaning and/or Disposal, Vented Air Releases During Operations, Product Sampling, Equipment Cleaning, Filter Waste, Off-Spec Product
Release quantity:	It is uncertain how much waterborne coatings attribute to the overall air, land, and water releases reported in TRI. Based on the 2008 EPA Sector Performance Report Supplement, the paints and coatings industry reported total TRI chemical releases amounting to 5.7 million pounds, of which 4 million pounds were emitted to air, 24,000 pounds to water discharges, and 1.6 million pounds to land or off-site waste disposal. Total air emissions declined by 56 percent between 1997 and 2006 due to the number of regulations limiting the emissions during formulation processes (see Table 1-1). These releases represent the industry as a whole and reflect releases reported during both solvent-borne and waterborne coatings formulation.
Release or emission factors:	nan
Release frequency:	Default values for ”frequency of release” are provided in the EPA/OPPT model default value tables in Section 4.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation. However, releases of 1,3-butadiene are not mentioned specifically.
Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by including releases from different processes but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID:	52153
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	Minor releases occur in production processes and vapors from the burning of plastics as well as rubber (page 18 of 435) 1,3-Butadiene may be released to the environment as an intentional or fugitive emission during its production, use, storage, transport, or disposal. 1.6% of sources and emissions are classified as industrial production and use. Industrial butadiene emissions arise from process vents, equipment leaks, and secondary sources such as wastewater treatment. Because butadiene released to aqueous systems or entering treatment plants is likely to evaporate completely, all emissions of butadiene can be considered air emissions. (page 27 of 435)
Release quantity:	See table 2-1 on page 28 for release quantities.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	report from 2002
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation: U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID: 52153
Conditions of Use: Fuels and Related Products

EXTRACTION

Parameter	Data
Description of release source:	The primary way the 1,3-butadiene is released into the environment is via emissions from gasoline- and diesel-powered vehicles and equipment. Lesser releases occur from the combustion of other fossil fuels and biomass. Minor releases come from tobacco smoke and gasoline vapors (page 18 of 435). 78.8% and 19.6% of sources and emissions to the environment can be classified as mobile sources and other miscellaneous combustion sources respectively (page 27 of 435). See section 2.3.1 and 2.3.2 on pages 27 to 32 for more detailed descriptions of mobile sources and miscellaneous combustion sources respectively, including emissions quantifies.
Release quantity:	See section 2.3.1 and 2.3.2 on pages 27 to 32 for more detailed descriptions of mobile sources and miscellaneous combustion sources respectively, including emissions quantities. Also see table 2-1 on page 28 for release quantities.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	United States
Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	report from 2002
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation: U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID: 52153
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Description of release source:	The relative contribution of butadiene production to the national butadiene emissions is 0.2% (page 27 of 435)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	report from 2002
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385719
Conditions of Use:	Paints and coatings: Furniture Industry

EXTRACTION

Parameter	**Data**
Description of release source:	container cleaning, equipment cleaning, coating application (overspray), volatile air emissions
Release or emission factors:	nan
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	The GS is based on data that is greater than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385741
Conditions of Use:	Fabric Finishing

EXTRACTION

Parameter	**Data**
Description of release source:	dumping finishing bath, drum residues
Release quantity:	Provides method for estimating release to water based on bath size, and on-weight-bath percentage

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Low	Data is general and not specific to the chemical. Also, fabric finishing is not in scope for the risk evaluation but the information extracted might be used for an in-scope scenario like Organic Fiber Manufacturing.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting into finished products) -generic scenario for estimating occupational exposures and environmental releases. Draft.
HERO ID:	6549571
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)

EXTRACTION

Parameter	**Data**
Description of release source:	1. Container residue from plastic resin transport container released to water, incineration, or landfill.2. Dust generation from forming processes released to water or landfill.3. Fugitive air emissions from forming and molding processes released to water or air.4. Equipment cleaning and cooling water from forming and molding processes released to water, incineration, or landfill.5. Solid waste from trimming operations released to water or landfill.
Release quantity:	Container Residue from Compounding Transport Container: Daily Release from Container Residue (kg/site-day) = Daily Use Rate (kg/site-day) x Loss FractionDust Generation from Converting Activities Released to Water or Landfill: Daily release of dust = daily use rate x loss fractionFugitive Air from Converting Activities Released to Water or Air: Daily release to water (or air) from volatilization = daily use rate x loss fractionResidual from Converting Equipment Cleaning: Daily release from equipment cleaning = daily use rate x loss fractionTrimming Waste: Daily release from trimmings = daily use rate x loss fraction
Release or emission factors:	Release or emission factors
Release frequency:	CEB standard assumption, 250 days per year based on 5 day work week and two weeks per year of operation shut down.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses high quality data and methods that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data are not chemical specific.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by evaluation of various sources of release, but uncertainty in release estimation is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Residual product from equipment cleaning and spillage
Release quantity:	58 kg/site/day to water7800 kg/yr to land
Release frequency:	350 days/year

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Processing as a reactant, Lubricants and lubricant additives in Petroleum lubricating oil and grease manufacturing.

EXTRACTION

Parameter	**Data**
Description of release source:	Spillage during transfer and sampling
Release quantity:	0.7 kg/site/day to water
Release frequency:	350 days/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5: Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Industrial and commercial use of Fuel and related products; Industrial and commercial use of Lubricants and greases

EXTRACTION

Parameter	**Data**
Description of release source:	Release from incineration (burning used oil), dumping, landfilling, and road oiling
Release quantity:	99,516 kg/yr from incineration9,257 kg/yr to land

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is greater than 20 years old.
	Metric 5:	Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Multiple

EXTRACTION

Parameter	**Data**
Description of release source:	The primary way the 1,3-butadiene is released in the environmentis via emissions from gasoline- and diesel-powered vehicles and equipment. Minor releases occur in production processes, tobacco smoke, gasoline vapors, and vapors from the burning of plasticsas well as rubber. pg. 16Industrial butadiene emissions arise from process vents, equipment leaks, and secondarysources such as waste water treatment. Since butadiene released to aqueous systems or enteringtreatment plants is likely to evaporate completely, all emissions of butadiene can be consideredair emissions. pg. 32
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	Release data is for both occupational and non-occupational scenarios but useful for occupational scenarios within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
Metric 5:	Sample Size	Medium	characterized by a one value with uncertain statistics
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions, but methods are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Processing- incorporation into an article- Rubber Products

EXTRACTION

Parameter	**Data**
Description of release source:	As stated previously, butadiene has a very low water solubility and high vapor pressure; thus, if it were released to an aqueous waste stream, it would immediately evaporate. It is then logical to assume, and the data confirms that, the amount of butadiene found in secondary sources such as waste water and solid waste is minimal or nonexistent. The majority of the butadiene releases during industrial production occurs via process vents; pg. 30
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, andassociated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The completed risk assessment is more than 20 years old.
Metric 5:	Sample Size	Medium	uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Description of release source:	process vent butadiene emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics. It is unclear ifanalysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Use in fuel and related products

EXTRACTION

Parameter	**Data**
Description of release source:	On-road mobile sources include the following classes of vehicles: light-duty gasoline vehicles (LDGV), light-duty gasoline trucks, heavy-duty gasoline trucks, light-duty diesel vehicles, light-duty diesel trucks, heavy-duty diesel trucks, and motorcycles. On-road mobile sources account for 37.7% national butadiene emissions; Nonroad mobile sources include mobile gasoline- and diesel-powered equipment and vehicles and other equipment types. Types of equipment included in this category range from construction, industrial, and agricultural equipment to small engines used in lawnmowers, chain saws, and other gasoline-powered equipment. Nonroad vehicles include motorcycles, snowmobiles, golf carts, and all-terrain vehicles (ATVs) used for off-road recreation and recreational and commercial marine vessels. Generally, most nonroad engines are in use for many years and are noncatalyst engines.The lack of a catalyst, in conjunction with the engine deterioration associated with increasedequipment age, may have profound effects on the amount of butadiene emitted.
Release quantity:	<0.0005% butadiene in gasoline vapor (pg. 32)
Release or emission factors:	Release or emission factors

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics. It is unclear ifanalysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Recycling/Reclamation

EXTRACTION

Parameter	**Data**
Description of release source:	Secondary lead smelting involves the reclamation of scrap automobile batteries to produce elemental and lead alloys. There are 23 such facilities in the United States, most of which are located near large population centers. The plastic and rubber components of the battery are the source of the butadiene emissions, contributing 0.4% of the national butadiene. pg. 34
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by one value with uncertain statistics. It is unclear ifanalysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Petroleum refining

EXTRACTION

Parameter	**Data**
Release quantity:	437,590 lb/year (1992, pg. 35)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by total and not individual volumes per site.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents its data sources, and assumptions. Methods and results are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The extracted data does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Disposal (Combustion Sources)

EXTRACTION

Parameter	**Data**
Description of release source:	Tire Burning, Biomass Burning-Biomass burning includes residential wood combustion in both fireplaces and woodstoves, open burning such as the backyard burning of yard waste, slash burning, land clearing/burning, agricultural burning, forest fires/prescribed burning, structural fires, and other wildfires.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The data is for an scenario not a condition of use of the risk evaluation, but may be useful for disposal COU.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Anttinen-Klemetti, T., Vaaranrinta, R., Mutanen, P., Peltonen, K. (2006). Inhalation exposure to 1,3-butadiene and styrene in styrene–butadiene copolymer production. International Journal of Hygiene and Environmental Health 209(2):151-158.
HERO ID:	5675367
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	butadiene manufacturing and processing facilities
Release quantity:	1380 tons/year in the USA, 10,600 tons/year in the UK.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included. (TRI data)
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 3 different sites and taking multiples samples per person.

Overall Quality Determination High

Study Citation:	ASRC, (2006). ASRC stack and fugitive emission release.
HERO ID:	11272629
Conditions of Use:	Processing as a reactant: Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Flare Control System, Flare Thermal Oxidizer (more information about the release point on page 12, 20-21 and page 29-30 of 32)
Release quantity:	volumetric fraction for TAC component - 13.60% (more information on pg 32 of 32)
Release frequency:	24 hours/day, 7 days/week, 52 weeks/year (pg 12 and 13 of 32)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation: ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID: 11273448
Conditions of Use: Import

EXTRACTION

Parameter	Data
Description of release source:	Process areas where 1,3-BD is used: tank farm unloading, tank farm storage, chemical manufacturing process, vapor/vent header, and a general category (page 9 of 239)Primary way 1,3-BD released into environment is via emissions from gasoline and diesel-powered vehicles and equipment. Lesser releases occur from combustion of other fossil fuels and biomass. Minor releases occur in production processes, tobacco smoke, gasoline vapors, and vapors from the burning of plastics as well as rubber (page 16 of 239)Summary of literature used and extracts of information from the used literature about emissions starts on page 34
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	From USA
Metric 3:	Applicability	High	Import and Processing COUs
Metric 4:	Temporal Representativeness	Low	From 2004
Metric 5:	Sample Size	N/A	Mostly descriptions
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release percentages described but not expanded on
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Release percentages described but not expanded on

Overall Quality Determination Medium

Study Citation: ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID: 11273448
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Description of release source:	Process areas where 1,3-BD is used: tank farm unloading, tank farm storage, chemical manufacturing process, vapor/vent header, and a general category (page 9 of 239)Primary way 1,3-BD released into environment is via emissions from gasoline and diesel-powered vehicles and equipment. Lesser releases occur from combustion of other fossil fuels and biomass. Minor releases occur in production processes, tobacco smoke, gasoline vapors, and vapors from the burning of plastics as well as rubber (page 16 of 239)Summary of literature used and extracts of information from the used literature about emissions starts on page 34
Release quantity:	0.03% of 1,3-butadiene consumed in manufacturing process on site is emitted (pg 5 of 239)Remaining 1,3-BD which isn't destroyed in a flare stack is emitted to air (~100,000 lbs/yr).
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	From USA
Metric 3:	Applicability	High	Import and Processing COUs
Metric 4:	Temporal Representativeness	Low	From 2004
Metric 5:	Sample Size	N/A	Mostly descriptions
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Release percentages described but not expanded on
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Release percentages described but not expanded on

Overall Quality Determination Medium

Study Citation:	Bikas, G., Zervas, E. (2007). Nonregulated pollutants emitted from Euro 3 diesel vehicles as a function of their mileage. Energy and Fuels 21(5):2731-2736.
HERO ID:	1956422
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from European cars, primarily OECD countries.
	Metric 3: Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by testing different cars and mileages, but uncertainty is not addressed.

Overall Quality Determination — Medium

Study Citation:	CEPE, (2020). SpERC fact sheet: Professional application of coatings and inks by spraying.
HERO ID:	10442902
Conditions of Use:	Application of coatings and inks by spraying

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors
Release frequency:	Indoor - CEPE SPERC 8a.3a.v2, CEPE SPERC 8c.3a.v2, 365 d/yOutdoor - CEPE SPERC 8d.3a.v2, CEPE SPERC 8f.3a.v2, 225 d/y
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Emission factors and release frequency come from emission scenario documents (ESDs) and expert information.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned.
Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
Metric 5:	Sample Size	Low	Distribution of samples used to determine emission factors and release frequency are not provided.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Chang, J. S., Chang, C. Y., Chen, A. C., Erdei, L., Vigneswaran, S. (2006). Long-term operation of submerged membrane bioreactor for the treatment of high strength acrylonitrile-butadiene-styrene (ABS) wastewater: effect of hydraulic retention time. Desalination 191(1-3):45-51.
HERO ID:	555064
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Description of release source:	Industrial wastewaters from ABS production; butadiene not explicitly mentioned but may be component of treated wastewater
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are for generic wastewater treatment from butadiene processing activities, which is similar to the the in-scope occupational scenario for butadiene processing releases to water.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (calculated results, individual data points shown graphically for each experiment) but discrete data points not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different retention times and starting influent concentrations, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Chin, J. Y. (2011). Characterization of biofuels blends: Emissions, permeation and apportionment of volatile organic compounds.
HERO ID:	6026451
Conditions of Use:	Use in Fuel/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle diesel emissions (page 108 of 204)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (single emission factor for each condition) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by use of Federal Test Procedure for testing fuel and likely included in referenced document. Variability addressed by testing different cars and fuel types.

Overall Quality Determination — High

Study Citation:	Chou, M. S., Lu, S. L. (1998). Treatment of 1,3-butadiene in an air stream by a biotrickling filter and a biofilter. Journal of the Air and Waste Management Association 48(8):711-720.
HERO ID:	5645750
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Processing equipment and ducts release butadiene in the manufacturing of synthetic rubber and resins.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by mentioning what may have caused unstable filter performance. Variability addressed by using different packing heights, types of filters, inlet concentration, and loading rates.

Overall Quality Determination Medium

Study Citation:	Di, Y., Cheung, C. S., Huang, Z. (2009). Experimental investigation on regulated and unregulated emissions of a diesel engine fueled with ultra-low sulfur diesel fuel blended with biodiesel from waste cooking oil. Science of the Total Environment 407(2):835-846.
HERO ID:	857752
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	diesel vehicle emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by test methods and measurement. Variability addressed by various testing parameters.

Overall Quality Determination — High

Study Citation:	Dodbiba, G., Shibayama, A., Sadaki, J., Fujita, T. (2003). Combination of triboelectrostatic separation and air tabling for sorting plastics from a multi-component plastic mixture. Materials Transactions 44(12):2427-2435.
HERO ID:	5585989
Conditions of Use:	Dispoal

EXTRACTION

Parameter	**Data**
Description of release source:	A plastic mixture of ABS, PP and PVC, which are used in the manufacture of automotive interior and exterior trim, packaging, and medical electrical or electronic applications.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by the conclusion, where it states causes where a better separation wasn't obtained. Variability addressed by using different separation methods with the same plastics.

Overall Quality Determination High

Study Citation:	Dold, P. L. (1989). Current practice for treatment of petroleum refinery wastewater and toxics removal. Water Pollution Research Journal of Canada 24(3):363-390.
HERO ID:	1924634
Conditions of Use:	Disposal (refinery water treatment)

EXTRACTION

Parameter	**Data**
Description of release source:	Petroleum refineries
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses Ontario department sources and the American Petroleum Institute as references.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	Medium	Waste treatment method is in scope, but butadiene is never explicitly mentioned (only VOC's as a whole).
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Low	Report is mainly qualitative and includes no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Report clearly documents the sources used.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Report includes an "experienced problems" section, but there are no statistics to be uncertain about.

Overall Quality Determination Medium

Study Citation:	Duffy, B. L., Nelson, P. F., Ye, Y., Weeks, I. A. (1999). Speciated hydrocarbon profiles and calculated reactivities of exhaust and evaporative emissions from 82 in-use light-duty Australian vehicles. Atmospheric Environment 33(2):291-307.
HERO ID:	1952206
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release or emission factors:	Release or emission factors
Comments:	See Tables 1-9 for data.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD, and number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by methods. Variability addressed by car model year, engine type, and fuel cycle.

Overall Quality Determination High

Study Citation:	García, C. A., Manzini, F., Islas, J. (2010). Air emissions scenarios from ethanol as a gasoline oxygenate in Mexico City Metropolitan Area. Renewable and Sustainable Energy Reviews 14(9):3032-3040.
HERO ID:	919969
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Release quantity:	tonnes of BD emissions from vehicles given graphically and cumulative amount modeled 2002 to 2030 for different fuel types; applies to the Mexico City Metropolitan Area. Figure 5.
Release or emission factors:	Release or emission factors
Comments:	Accumulated air pollutant emissions subdivided in criteria and toxic pollutants and CO2 from 2002 to 2030 of the gasoline on-road motor vehicle fleet in the MAMC in fourdifferent fuel scenarios. Accumulated emissions thousand tonnes (MTBE5=30, E6=28, E10=27 and ETBE13.7=25). See table 5

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Mexico, an OECD country.
Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of results from models used. Variability addressed by changing vehicle emission standards and fuel additives.

Overall Quality Determination — High

Study Citation:	Ghadikolaei, M. A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines - A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by different fuel additives, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Ghadikolaei, M. A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines - A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	diesel vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different fuel additives and engine cycle, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Ghadikolaei, M. A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines - A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	diesel vehicle emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Europe, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different fuel additives, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Ghadikolaei, M. A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines - A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	diesel vehicle emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Europe, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different fuel additives and engine loads, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Ghadikolaei, M. A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines - A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	diesel vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different fuel additives and engine types, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Hart, J. R. (1994). Comparison of emissions from burning hazardous waste in a dry-process cement kiln with emission from burning conventional fossil fuels. Hazardous Waste and Hazardous Materials 11(1):193-199.
HERO ID:	658817
Conditions of Use:	Emissions from Hazardous Waste Incineration

EXTRACTION

Parameter	**Data**
Description of release source:	Combustion in dry-process cement kiln
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Medium	Data are for incineration of hazardous waste, which is similar to the in-scope occupational scenario for industrial emissions to air.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of limitations. Variability addressed by different incinerator operating scenarios.

Overall Quality Determination — High

Study Citation:	Heseltine, E., Peltonen, K., Sorsa, M., Vainio, H. (1993). Assessment of the health hazards of 1,3-butadiene and styrene. Meeting report. Journal of Occupational Medicine 35(11):1089-1095.
HERO ID:	200013
Conditions of Use:	Manufacturing, Processing, Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Various industrial, vehicle emissions; estimate that 90% of all butadiene emissions in the US are from mobile sources
Release frequency:	In survey of 32 facilities, release frequency ranged from one to 700 release events/year with more than 75% of facilities having < 5 release events/year

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for generic factory releases, which are similar to the in-scope occupational scenarios for manufacturing and processing.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Hesterberg, T. W., Lapin, C. A., Bunn, W. B. (2008). A comparison of emissions from vehicles fueled with diesel or compressed natural gas. Environmental Science & Technology 42(17):6437-6445.
HERO ID:	106731
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Vehicle emissions (transit and school buses)
Release or emission factors:	nan
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	See Table 5

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided). Provided in supplemental information documents.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by varying vehicles and catalysts.

Overall Quality Determination High

Study Citation:	Kulich, D. M., Gaggar, S. K., Lowry, V., Stepien, R. (2003). Acrylonitrile–butadiene–styrene (ABS) polymers. :414-438.
HERO ID:	9493543
Conditions of Use:	Manufacture of ABS

EXTRACTION

Parameter	**Data**
Description of release source:	Emulsion process of ABS manufacturing
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data that are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Most references in data source are greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size is not applicable to data extracted.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty are not applicable to data extracted.

Overall Quality Determination High

Study Citation:	Lee, S., Kim, J., Hwang, Y., Kim, J., Kim, Y., Chen, S.,ha (2019). Butadiene substance flow analysis and management in South Korea. Journal of Cleaner Production 220:331-339.
HERO ID:	5670940
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Release quantity:	56.7 tons/year

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from South Korea, a non-OECD country.
	Metric 3:	Applicability	High	Data are for butadiene processing and use an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (regression statistics and means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty addressed in the regression analysis. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Malin, N. (1994). Carpeting, Indoor Air Quality, and the Environment. Environmental Building News 3(6):1.
HERO ID:	5708617
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	BD as a monomer in SB latex used extensively in carpeting;carpet disposal in landfill; recycling methods for carpets involve extracting useful materials and/or incinerating. See page 11 to 16 for more detailed information on carpet disposal and recycling methods.
Release quantity:	about 3.5 billion pounds of carpeting disposed each year (page 12 of 21)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for disposal of solid wastes, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Mehlman, M. A. (1992). Dangerous and cancer-causing properties of products and chemicals in the oil refining and petrochemical industry. VIII. Health effects of motor fuels: Carcinogenicity of gasoline–scientific update. Environmental Research 59(1):238-249.
HERO ID:	598259
Conditions of Use:	Petroleum refining, Consumer fuel use

EXTRACTION

Parameter	**Data**
Description of release source:	Gasoline; hydrocarbons in liquid gasoline are 5-10% olefins (includes butadiene)... 360million lbs of gasoline vapors emitted in 1982; 40% of emissions from retail service stations
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petroleum refining, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Processing and Use

EXTRACTION

Parameter	**Data**
Description of release source:	1,3-Butadiene's production and use in the manufacture of polymers such as synthetic rubber, plastics and resins and as chemical intermediate may result in its release to the environment through various waste streams. Emissions from motor vehicles, tobacco smoke, the thermal breakdown or burning of plastics and by volatilization from gasoline will result in its direct release to the environment. 1,3-Butadiene is released directly to the environment in emissions from combustion of wood and smoke of bush fires (page 19 of 52)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	From US
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	Nelson, P. F., Tibbett, A. R., Day, S. J. (2008). Effects of vehicle type and fuel quality on real world toxic emissions from diesel vehicles. Atmospheric Environment 42(21):5291-5303.
HERO ID:	965984
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Release or emission factors:	Release or emission factors
Comments:	see Table 4.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	OAQPS, (1982). Compilation of air pollutant emission factors, third edition, supplement 13 (including supplements 1-7).
HERO ID:	5707820
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	describes processes and relevant environmental releases
Release or emission factors:	Release or emission factors
Comments:	Early version of EPA AP-42 document

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data include internal combustion emissions, storage and transport of petroleum liquids, synthetic rubber, and petroleum refining, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different parameters applicable to each emission factor, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Oestermark, U., Petersson, G. (1993). Volatile hydrocarbons in exhaust from alkylate-based petrol. Chemosphere 27(9):1719-1728.
HERO ID:	5697579
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	Engine emissions - mopeds and walk-behind lawn mowers
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	Medium	Data are for non-road combustion engine emissions, which is similar to the in-scope occupational scenario vehicle emissions.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percent of NMHC as butadiene and exhaust concentration averages and stadard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion of external factors that may have affected data and some consideration of analytical uncertainty in standard deviations. Variability addressed by different fuel and engine types.

Overall Quality Determination Medium

Study Citation:	Puškár, M., Jahnátek, A., Kuric, I., Kádárová, J., Melichar, K., Šoltésová, M. (2019). Complex analysis focused on influence of biodiesel and its mixture on regulated and unregulated emissions of motor vehicles with the aim to protect air quality and environment. Air Quality, Atmosphere and Health 12(7):1-10.
HERO ID:	5707806
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions - diesel
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Slovak Republic, an OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emisisons, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average emission concentration, graph of data) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by measurement standard error and uncertainty percentage. Variability addressed by different fuels and engine modes.

Overall Quality Determination — High

Study Citation:	Qiu, K., Yang, L., Lin, J., Wang, P., Yang, Y.,i, Ye, D., Wang, L. (2014). Historical industrial emissions of non-methane volatile organic compounds in China for the period of 1980-2010. Atmospheric Environment 86:102-112.
HERO ID:	2373425
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	Various/life cycle; shown in source-tracing diagram (Figure 1)
Release or emission factors:	Release or emission factors
Comments:	Non-methane VOCs (not BD-specific) in Chinaemission factors provided in Tables for various sectors within 4 source categories: NMVOC production, NMVOC storage and transport, industrial processes using NMVOCs as raw material, and processes using NMVOC-containing products

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	Medium	Data are for release of NMVOCs, which is similar to the in-scope occupational scenario for releases of butadiene.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by emission estimation. Variability addressed by different industrial sectors and temporal changes.

Overall Quality Determination Medium

Study Citation:	Ray, R., Thorpe, R. B. (2007). A comparison of gasification with pyrolysis for the recycling of plastic containing wastes.
HERO ID:	5720319
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3:	Applicability	High	Data are for the disposal and recycling of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Schifter, I., Diaz, L., Lopez-Salinas, E., Ramos, F., Avalos, S., Lopez-Vidal, G., Castillo, M. (2000). Estimation of motor vehicle toxic emissions in the metropolitan area of Mexico City. Environmental Science & Technology 34(17):3606-3610.
HERO ID:	4087479
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release quantity:	Estimation of total emissions per year based on emissions factors – Vehicles 1984-1990: 374.2 ton/yr... Vehicles 1991-1996: 30.6 ton/yr... Vehicles 1997-1999: 2.3 ton/yr... Taxis 1984-1990: 252.8 ton/yr... Minibus before 1996: 75.8 ton/yr... TOTAL: 735.6 ton/yr
Release or emission factors:	Release or emission factors
Comments:	Please check table 3-11 for relevant data on the chemical.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Mexico, an OECD country.
Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by changes over time and different vehicles but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Stump, F. D., Knapp, K. T., Ray, W. D. (1996). Influence of ethanol-blended fuels on the emissions from three pre-1985 light-duty passenger vehicles. Journal of the Air and Waste Management Association 46(12):1149-1161.
HERO ID:	42346
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Vehicle emissions
Release or emission factors:	nan
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by different vehicles, varying temperatures, and varying engine cycles, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Stump, F. D., Knapp, K. T., Ray, W. D., Snow, R., Burton, C. (1992). The composition of motor vehicle organic emissions under elevated temperature summer driving conditions (75 to 105°F). Journal of the Air and Waste Management Association 42(2):152-158.
HERO ID:	43449
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Vehicle emissions
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing several different vehicles at different temperatures, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 2 - Solid Waste Disposal.
HERO ID:	10180485
Conditions of Use:	Disposal - Open Burning of Tires

EXTRACTION

Parameter	**Data**
Description of release source:	Open Burning
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Data are from EPA's Air and Energy Engineering Research Laboratory (AEERL).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by weighted averages only. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by measuring emissions from both chunk and shredded tires, but measurement uncertainty is not characterized.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (n.d.). AP-42: Chapter 2 - Solid Waste Disposal.
HERO ID: 10180485
Conditions of Use: Disposal - Landfills

EXTRACTION

Parameter	Data
Description of release source:	Release from landfills. Table 2-8 Landfill Gas Constituents, presents the default emission factor information for the speciated organic compounds and reduced sulfur compounds that were corrected for air infiltration. Forty-seven test reports contained speciated organic and reduced sulfur compound data that could be corrected for air infiltration. An additional 20 test reports contained data that were not able to be corrected. For the speciated organic data, EPA Method 25C was used to obtain the majority of the data. Other methods used to determine speciated organic concentrations were EPA Methods TO-14 and TO-15, and South Coast Air Quality Management District's (SCAQMD) Method 25.2. For reduced sulfur measurements, EPA Method 18 and SCAQMD Method 307 were used.
Release or emission factors:	Release or emission factors
Release frequency:	Continuous

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and techniques that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Air monitoring data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variability is addressed by evaluation of various landfills, and uncertainty is addressed by the emission factor ratings within the study.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2019). Synthetic turf field recycled tire crumb rubber research under the Federal Research Action Plan, Final report part 1: Tire crumb rubber characterization, volume 1.
HERO ID:	11803647
Conditions of Use:	Rubber products

EXTRACTION

Parameter	**Data**
Release or emission factors:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for rubber products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentiles and max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by testing methods. Variability addressed by sampling crumb rubber from both a recycling facility and a synthetic turf field.

Overall Quality Determination High

Study Citation: U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.
HERO ID: 8726953
Conditions of Use: Drum cleaning

EXTRACTION

Parameter	**Data**
Description of release source:	This model estimates a loss fraction of a liquid that may remain in a drum after use that may be released during container cleaning (aqueous rinse to water, solvent rinse to incineration, drum reclamation furnace to incineration) or direct disposal (landfill). This model only applies to liquids shipped in drums ranging from 20 to 100 gallons. The default drum size for this model will be 55 gallons. This model can be applied to all liquids shipped in drums regardless of unloading technique (e.g., pumping, pouring); however, it only addresses potential releases from container residue, and does not account for potential release from spills or other wastes during container unloading. Additionally, this model does not assess potential releases to air of volatile chemicals (i.e., chemicals with a vapor pressure greater than 0.001 torr) during container cleaning or unloading.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned specifically.
Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by including estimates from different literature sources but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Wilkins, E. S., Wilkins, M. G. (1985). Review of toxicity of gases emitted from combustion, pyrolysis of municipal and industrial wastes. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 20(2):149-175.
HERO ID:	58470
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	waste incineration; pyrolysis of various plastic and rubber materials; states pyrolysis of polyurethane foam yielded 1,3-BD; pyrolysis mixture of PE, PS , and tires yielded 1,3-BD... presents various pyrolysis processes
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for emissions to air from disposal, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Wong, J. M. (1998). Petrochemicals. Water Environment Research 70(4):658-664.
HERO ID:	1010105
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Water
Description of release source:	Petrochemical wastewater
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses data from journal articles and NPDES reports.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data is pulled from many countries, some are in the OECD.
	Metric 3: Applicability	High	Data is within scope.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Medium	Mostly ranges and percent reductions given.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment documents all sources and appropriately references them.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	Wright, S. L., Kelly, F. J. (2017). Plastic and Human Health: A Micro Issue?. Environmental Science & Technology 51(12):6634-6647.
HERO ID:	3862800
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Substantial amount of plastic is lost to marine environment as microplastics; lost as WWTP effluent and land application of WWTP sludge as fertilizer... Tire particulates released to air considered as microplastics source
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from United Kingdom, an OECD country.
Metric 3:	Applicability	Medium	Data are for generic release of plastics to the environment, which is similar to the the in-scope occupational scenario for release of plastics containing butadiene as a monomer.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Yang, X., Sun, L., Xiang, J., Hu, S., Su, S. (2013). Pyrolysis and dehalogenation of plastics from waste electrical and electronic equipment (WEEE): A review. Waste Management 33:462-473.
HERO ID:	5519320
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	At present, there are four options available in the management of WEEE plastics: landfilling, mechanical recycling, energy recycling and feedstock recycling
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for Emissions to Air and Land, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, percentages, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by studying different methods of pyrolisis, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Ye, Y., Galbally, I. E., Weeks, I. A. (1997). Emission of 1,3-butadiene from petrol-driven motor vehicles. Atmospheric Environment 31(8):1157-1165.
HERO ID:	5742105
Conditions of Use:	Disposal/emissions to air

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan
Comments:	See Table 4 for the emission data.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (final calculated emission rates for each car) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by various cars tested, different fuels, and comparison to roadside emissions, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Ying, L., Min, S., Jing, Z., Linlin, F., Sihua, L. (2005). Distributions and source apportionment of ambient volatile organic compounds in Beijing City, China. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 40(10):1843-1860.
HERO ID:	623828
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	various; vehicle exhaust contributed 57.7% of VOC emissions followed by painting (12.4%), gas vapor (11.3%), and LPG (5.8%)
Release or emission factors:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Some data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by discussion of limitations. Variability addressed by various sources of VOC emissions.

Overall Quality Determination Medium

Study Citation:	Yoon, S. H. (2007). Comparisons of mobile source air toxics risks associated with using conventional and reformulated gasoline. Doctoral Dissertation(3305345):167.
HERO ID:	5707798
Conditions of Use:	Commercial Use - Fuels and related products

EXTRACTION

Parameter	**Data**
Description of release source:	vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fuels, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by EPA MOBILE model. Variability addressed by seasonal variation, vehicle speed, vehicle type, fuel composition, vehicle age.

Overall Quality Determination High

Study Citation:	Zhang, Z. H., Cheung, C. S., Chan, T. L., Yao, C. D. (2010). Experimental investigation of regulated and unregulated emissions from a diesel engine fueled with Euro V diesel fuel and fumigation methanol. Atmospheric Environment 44(8):1054-1061.
HERO ID:	388167
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Diesel vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for vehicle emissions, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by measurement uncertainty. Variability addressed by different levels of methanol and engine loads tested.

Overall Quality Determination — High

Study Citation: Zhu, J., Cao, X. L., Pigeon, R., Mitchell, K. (2003). Comparison of vehicle exhaust emissions from modified diesel fuels. Journal of the Air and Waste Management Association 53(1):67-76.
HERO ID: 39179
Conditions of Use: Disposal

EXTRACTION

Parameter	Data
Description of release source:	Vehicle emissions
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by limitations of results. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Bressa, S. P., Ardiaca, N. O., Martinez, O. M., Barreto, G. F. (1998). Analysis of operating variables in the catalytic purification of butene-1 in a trickle bed. Chinese Journal of Chemical Engineering 6(2):103-115.
HERO ID:	5575329
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Monomer used in polymer production
Process description:	Selective hydrogenation is industrially employed in the preparation of high purity butene-1 for co-monomer use in the production of linear low density polyethylene. Impurities of acetylenic compounds and 1,3-butadiene are selectively hydrogenated to reach concentrations of about 10 ppm in the final products.
Chemical concentration:	10 ppm in the final products
Comments:	See Table 1 for reaction network and kinetic expression used for the modeling.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Argentina, a non-OECD country.
	Metric 3:	Applicability	High	Model can be applied to monomer and polymer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Model is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	Low	Variability and uncertainty are not addressed

Overall Quality Determination Medium

Study Citation:	Albertini, R. J., Sram, J., Vacek, P. M., Lynch, J., Nicklas, J. A., Sittert, Van, N. J., Boogaard, P. J., Henderson, R. F., Swenberg, J. A., Tates, A. D., Ward, J. B., Jr, Wright, M. (2003). Biomarkers in Czech workers exposed to 1,3-butadiene: a transitional epidemiologic study. Research Reports (Health Effects Institute) (116):1-141; discussion 143-62.
HERO ID:	94288
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Annual industrial production is approximately 12 billion pounds, of which 3 billion are produced in the United States alone
Life cycle description:	synthetic rubber manufacturing
Process description:	BD is an important industrial chemical used as an intermediate in the production of polymers, elastomers, and other chemicals. Although its major uses are in the manufacture of styrene-BD rubber (SBR) and thermoplastic resins, it is present in many products including the fungicides captain and captfol.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	NIOSH method used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Research was conducted in many different countries, but worker data is from an OECD country.
	Metric 3: Applicability	High	Report is within scope.
	Metric 4: Temporal Representativeness	Medium	Data is more than 10 years old, but less than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Data sources, assessment methods, and results are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainties are explained and put into context of the study.

Overall Quality Determination High

Study Citation:	Albertini, R., Clewell, H., Himmelstein, M. W., Morinello, E., Olin, S., Preston, J., Scarano, L., Smith, M. T., Swenberg, J., Tice, R., Travis, C. (2003). The use of non-tumor data in cancer risk assessment: reflections on butadiene, vinyl chloride, and benzene. Regulatory Toxicology and Pharmacology 37(1):105-132.
HERO ID:	1328548
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Worldwide, annual butadiene production is approximately 12 billion pounds, with 3 billion pounds produced in the U.S., making it the 36th highest volume chemical produced in the United States. About 75% of the manufactured 1,3-butadiene is used to make synthetic rubber.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of butadiene in polymerization, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussion limitations of animal vs human studies, and current available data. Variability is addressed by including multiple studies in the report.

Overall Quality Determination High

Study Citation:	ATSDR, (2012). Toxicological profile for 1,3-butadiene.
HERO ID:	2991419
Conditions of Use:	Manufacture and Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Annual U.S. production capacity is 6 billion pounds in 2008. 600 million pounds imported in 2005. (pg. 135/229)
Life cycle description:	synthetic rubber, plastic, and resin manufacturing
Number of sites:	11 sites that produce butadiene, 847 facilities that produce, process, or use butadiene. (site info starts on pg.136/229)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	NIOSH and EPA methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Most data is from U.S, some supplemental studies are included from Canada.
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Data sources are all documented and cited.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed throughout the report, and there is a section dedicated to it.

Overall Quality Determination High

Study Citation:	Bolognesi, C., Kirsch-Volders, M. (2016). The ex vivo L-CBMN assay detects significant human exposure to butadiene. Mutation Research 770(Pt A):73-83.
HERO ID:	4656923
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic rubber and polymer manufacturing, petrochemical manufacturing.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is pulled from three countries, two of three are in the OECD.
	Metric 3:	Applicability	High	Data are for synthetic rubber and polymer manufacturing, petrochemical manufacturing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Some data included in the review is over 20 years old, some is between 10 and 20 years old, and some is less than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by using a quality score for included sources. Variability addressed by using various different sources in the literature review.

Overall Quality Determination Medium

Study Citation:	Choudhary, G. (1994). Environmental exposure to 1 3-butadiene: A human health perspective. Journal of Environmental Science and Health, Part C: Environmental Carcinogenesis & Ecotoxicology Reviews 12(1):23-61.
HERO ID:	5621174
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The annual production of 1,3- butadiene is approximately 12 billion pounds worldwide, and 3 billion pounds in the United States
Life cycle description:	synthetic rubber manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production data is well cited.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by stating that there are gaps in the data, and suggesting where more research needs to be conducted. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Downs, T. D., Crane, M. M., Kim, K. W. (1987). Mortality among workers at a butadiene facility. American Journal of Industrial Medicine 12(3):311-329.
HERO ID:	94761
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Butadiene was manufactured by the catalytic dehydrogenation of n-butene using a process described in the Appendix. Since butadiene is a gas, the process was designed to operate in an entirely enclosed system, and has done so since the plantwas first opened. The few process changes that have been introduced are also outlined in the Appendix.
Comments:	See Appendix Table 1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Social Security Administration records used and Texas state records used. NIOSH reports are referenced.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources, assessment methods, and results are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainties are addressed and explained in the report.

Overall Quality Determination High

Study Citation:	EC, (2000). Priority Substances List Assessment Report: 1,3-Butadiene.
HERO ID:	5160048
Conditions of Use:	Domestic manufacturing, Plastic material manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1994 data: single Canadian producer with capacity of 120kilotonnes, actual production 103.7kilotonnes; Canada inported 1.7kilotonnes from USA; Canadian domestic use was 98.3kilotonnes and 7.1kilotonnes were for export sales... Consumption breakdown: 52.3% towards PB rubber, 31.5% towards styrene-butadiene latexes; 10.2% towards nitrile-butadiene rubbers; 3.5% towards ABS; 2.5% towards specialty SBR
Number of sites:	one Canadian producer in 1994

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing and plastic materials manufacturing, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Production information.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by changes from 1994 to 1996, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Fink, J. K. (2010). Acrylonitrile-butadiene-styrene polymers. :211-267.
HERO ID:	9493525
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Process description:	From articles used in electronics, high value precious metals, electronic components and glass electronic components are separated from the plastic housings, which have been generally sent to landfill because there was no economical process to separate the plastics to sufficient purity to enable the plastics to be recycled. The housings are generally made of mixed plastics such as ABS and PC (118). Methods suitable for the recycling of ABS resins have been developed (81,118-120). Full description on recycling of ABS on pdf pgs. 37-48

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Book chapter, is not a frequently used source, but uses sound methods and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	Information is applicable to occupational scenarios but is not the recycling of 1,3-butadiene but of a reaction product, which is not within the scope of the risk evaluation. This information may be useful information.
	Metric 4:	Temporal Representativeness	Medium	Chapter was published in 2010, more than 10 years ago but less than 20 years old.
	Metric 5:	Sample Size	N/A	N/A-qualitative information
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The assessment addresses variability by covering different processes and uncertainty is not applicable as only extracted data was different process descriptions.

Overall Quality Determination Medium

Study Citation:	Fink, J. K. (2010). Acrylonitrile-butadiene-styrene polymers. :211-267.
HERO ID:	9493525
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Process description:	1,3-butadiene with acrylonitrile, styrene and other monomers produce ABS polymers. Continuous mass polymerization occurs using poly-butadiene with acrylonitrile, styrene and other reactants through a cascade of reactors which after the first stage additional monomers are added. (pdf pg. 7) Emulsion polymerization: ABS products with high impact strengths and relatively high surface gloss may be produced by using traditional emulsion polymerization techniques...In the agglomeration step, the latexes are partially agglomerated using a core/shell agglomerating agent latex, which consists ofan elastomeric 1,3-butadiene/styrene copolymer core and an ethylacrylate/methacrylic acid copolymer shell. (full description starts on pg. 8)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Book chapter, is not a frequently used source, but uses sound methods and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario (Processing as a reactant) within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Chapter was published in 2010, more than 10 years ago but less than 20 years old.
	Metric 5:	Sample Size	N/A	N/A-qualitative information
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The assessment addresses variability by covering different processes and uncertainty is not applicable as only extracted data was different process descriptions.

Overall Quality Determination High

Study Citation:	Hallenbeck, W. H. (1992). Cancer risk assessment for the inhalation of 1,3-butadiene using physiologically based pharmacokinetic modeling. Bulletin of Environmental Contamination and Toxicology 49(1):66-70.
HERO ID:	820099
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BD production is 12 billion pounds worldwide and 3 billion pounds in the United States; based on another source

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	facility/production data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Hurst, H. E. (2007). Toxicology of 1,3-butadiene, chloroprene, and isoprene. Reviews of Environmental Contamination and Toxicology 189:131-179.
HERO ID:	646909
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	More than 5,000,000 tons produced worldwide in 2004; approximately 43% produced in the United States
Process description:	butadiene produced during ethylene production by steam cracking petroleum (petroleum distillates combined with steam at high temperature)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	Process/facility data
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	Huy, L. N., Lee, S. C., Zhang, Z. (2018). Human cancer risk estimation for 1,3-butadiene: An assessment of personal exposure and different microenvironments. Science of the Total Environment 616-617:1599-1611.
HERO ID:	4283815
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2013, the global BD market volume was 10,500 kt and is projected to be 14,180 kt by 2020 with the annual growth rate of 4.4% from 2014 to 2020
Life cycle description:	Polymer in rubber manufacturing, platic and resin manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is pulled from many countries, some are in the OECD.
	Metric 3: Applicability	Low	Data are for personal exposures within cities, which is similar to the in-scope occupational scenario of emissions to air.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by mentioning unavailability of data in most countries. Variability addressed by including studies for different microenvironments and age groups.

Overall Quality Determination High

Study Citation:	Huy, L. N., Lee, S. C., Zhang, Z. (2018). Human cancer risk estimation for 1,3-butadiene: An assessment of personal exposure and different microenvironments. Science of the Total Environment 616-617:1599-1611.
HERO ID:	4283815
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Number of sites:	175

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is pulled from many countries, some are in the OECD.
	Metric 3:	Applicability	Low	Data are for personal exposures within cities, which is similar to the in-scope occupational scenario of emissions to air.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	life cycle description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning unavailability of data in most countries. Variability addressed by including studies for different microenvironments and age groups.

Overall Quality Determination High

Study Citation: IARC, (1992). Occupational exposures to mists and vapours from strong inorganic acids; and other industrial chemicals.
HERO ID: 1104546
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Pg. 241/345:ln 1987, worldwide production of 1,3-butadiene was approximately 5.5 million tons. U.S. production was 1,329,000 tons.
Life cycle description:	pg 242/345ln 1990, 1,3-butadiene was used in the USA for: styene-butadiene rubber (30%), polybutadiene rubber (20%), adiponitrile/hexamethylenediamine (15%), styene-butadiene latex (10%), neoprene rubber (5%), acrylonitrile-butadiene-styene resins (5%), exports (4%), nitrile rubber (3%) and other (including specialty polymers) (8%) (Anon., 1991a).(For more detailed discussions of the production and use of 1,3-butadiene, see Miler, 1978; Leviton, 1983; Greek, 1984.)
Process description:	Pg. 240/345: "The production of 1,3-butadiene is thus a two-stage process: (i) production of a e4 coproduct during ethylene manufacture and (ii) recovery of 1,3-butadiene from the co-product. The first stage consists of cracking a hydrocarbon such as naphtha to produce ethylene as the primary product and a co-product stream composed of e4 hydrocarbons. The amount of 1,3- butadiene in the co-product depends on the feedstock used and the severity of the cracking process: the heavier the feedstock and the more severe the cracking, the more 1,3-butadiene is produced. The 1,3-butadiene content of the co-product C4 stream is 20-70%; the C4 feed streams are usually blended with a feed stream containing 40-50% 1,3-butadiene for processing. ln the extraction plants, solvents such as dimethylformamide, acetonitrile, furfural, dimethylacetamide and methyl pyrrolidone are used to alter the volatility of components in a fractional distillation selectively and to produce a high purity (> 99.0%) 1,3-butadiene monomer."
Number of sites:	Pg. 241/345See Table 2 for trends by country: Information available in 1988 indicated that 1,3-butadiene was produced by nine companies in Germany, eight in Japan, four in the United Kingdom and in Brazil, three in France, two in Australia, Belgium, Canada, the Netherlands and Spain, and one each in Argentina, Austria, Bulgaria, China, Czechoslovakia, Finland, India, Italy, Mexico, Poland, Saudi Arabia, Singapore, Taiwan and Yugoslavia. It was produced by eight companies in the USA in 1991.
Chemical concentration:	pg 239/345There is an instrument grade of 99.4-99.5 mol% purity, a research grade of 99.86 mol% purity, a technical-commercial grade of 98 mol% purity and a rubber grade of 99.0-99.5%. Crude 1,3-butadiene is also available from many producers for use as a feedstock. Such grades contain a minimum of 36-65%

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Most data is from the US, but other countries are included, and the report was published in France.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by the statistics presented in the report. Variability addressed by including many data sources from different sectors of production.

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Study Citation:	IARC, (1992). Occupational exposures to mists and vapours from strong inorganic acids; and other industrial chemicals.
HERO ID:	1104546
Conditions of Use:	Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	IARC, (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide.
HERO ID:	201838
Conditions of Use:	Domestic Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Shows butadiene US production once every three years from 1981-1996; 1996 production was 1,744,000 tonnes... Use pattern in US in 1995: 31% for SBR, 24% for butadiene rubber, 13% for styrene-butadiene latex, 4% for chloroprene rubber, 5% for ABS, 2% for nitrile rubber, 12% for adiponitrile, and 9% other
Process description:	Steam cracking: hydrocarbons heated to 800 C and 34kPa for <1sec; separated by extractive distillation, also may use cuprous ammonium acetate for separation which complexes butadiene... May also use dehydrogenation of n-butane
Number of sites:	Seven major producers in United States with 10 plant locations in 1996
Chemical concentration:	polymerization grade has min. 99% w/ acetylene impurity; other grades sold with minute impurities... stabilized with hydroquinone, catechol, and aliphatic mercaptans"
Physical form:	liquefied gas under pressure

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by change over time and across countries but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	IARC, (1986). Some chemicals used in plastics and elastomers.
HERO ID:	5549343
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1.04 million tons produced in 1983. 400,000 tons imported in 1983.
Life cycle description:	Plastic and Resin Manufacturing, synthetic rubber manufacturing
Process description:	"1,3-Butadiene is manufactured either as a co-product of the steam cracking of naphtha to yield ethylene or through the catalytic dehydrogenation of n-butane or n-butene."
Number of sites:	11 major U.S. producers have 16 plant locations.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data & techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from many countries, most of which are in the OECD.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing and synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty addressed by stating where data is lacking, or there are too few samples. Variability addressed by referencing many studies done in different countries and work-place environments.

Overall Quality Determination High

Study Citation:	IARC, (2008). 1,3-Butadiene, ethylene oxide and vinyl halides (vinyl fluoride, vinyl chloride and vinyl bromide). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 97 97:3-471.
HERO ID:	755320
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	North America capacity... 2006 - 2,878 tonnes 2004 - 2,862 tonnes 1996 - 1,956 tonnes 1990 - 1,593 tonnes 1981 - 1,480 tonnes Also shows butadiene production in other regions of the world (Table 2)
Process description:	steam cracking: accounts for over 95% of global BD production; hydrocarbons heated to 800 C and 34kPa for <1sec, collected as C4 fraction; separated by extractive distillation, most common solvents used are acetonitrile and DMF w/ DMAc, furfural, and NMP also used... Dehydrogenation of n-butane by Houdry process or by oxidative dehydrogenation Alternative ethanol-based production in India 7 different processes exist for extraction of butadiene
Chemical concentration:	butadiene used for polymerization is 99.9% pure with up to 22 different light volatile impurities

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S. and North American countries
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	IISRP, (1982). Mortality of workers in the styrene-butadiene rubber polymer manufacturing industry (final report) with attached status report, cover sheets and letter dated 120282.
HERO ID:	5372807
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	polymerizaation for synthetic rubber manufacturing
Process description:	The basic method of production of synthetic rubber in these plants was through the reaction of an aqueous emulsion of butadiene and styrene in the presence of a soap solution, polymerization indicators, and regulators to form a high molecular weight polymer with elastic properties. Initially, this reaction was carried out at high temperatures, about 50 degrees centigrade, and a pressure of about 60-50 psi. The reaction is usually carried to partial completion at which point it is terminated by the addition of a chemical called ”shortstop.” Any unreacted monomers of both styrene and butadiene are recovered or ”stripped” from the latex. The latex is then coagulated, washed, dried, and packaged.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data and methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S., and one site in Canada.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by stating unknown values and population statistics in the sampling process. Variability addressed by running statistics with and without certain groups to see the sensitivity.

Overall Quality Determination High

Study Citation:	IISRP, (1986). Mortality of a cohort of workers in the styrene-butadiene polymer manufacturing industry 1943-1982 (final report) with cover letter dated 040888.
HERO ID:	5555546
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing
Process description:	The basic method of producing synthetic rubber is throigh an emulsion polymeriation process. The basic reaction involves the poly merization of aqueous monomers of butadiene and styrene in the presence of a soap solution and an initiator system such as p-Menthane hydroperoxide and sodium formaldehyde sulfoxylate in combination with a mercaptan. When the appropriate level of polymerization is reached a ”shortstop” such as sodium dimethyldithiocarbamate is added to end the reaction. The ”shortstop” reacts with free radicals and oxidizing agents destroying the initiator system and presenting further polymerization. The unreacted monomer of butadiene is recovered through distillation and the styrene monomer is stripped by steam. The recovered monomers are recycled into the reactor stream. Antioxidants such as diphenylamine are 3 added to extend the ”life” of the product. The latex is coagulated using salt and sulfuric acid. The coagulate is then washed, dried and the crumb is prepared for shipment.
Number of sites:	10

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data and methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study, and where more research needs to occur. Variability addressed by sampling sites more than once, sampling different sites, and dividing the study into subgroups.

Overall Quality Determination High

Study Citation:	Johns Hopkins University, (1992). Initial submission: mortality of workers in the styrene-butadiene rubber polymer manufacturing industry with cover letter dated 082492.
HERO ID:	5790933
Conditions of Use:	Processing as a Reactant: Synthetic Rubber Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	See page 13-14 of 55 for a process description for synthetic rubber as of the writing of this paper. See page 12 for a process description for synthetic rubber from plants in the past.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S., and one site in Canada.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Meinhardt, T. J., Lemen, R. A., Crandall, M. S., Young, R. J. (1982). Environmental epidemiologic investigation of the styrene-butadiene rubber industry: Mortality patterns with discussion of the hematopoietic and lymphatic malignancies. Scandinavian Journal of Work, Environment and Health 86(4):250-259.
HERO ID:	62365
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	40642 tons/yr (26.2% of which is butadiene)
Life cycle description:	Synthetic Rubber Manufacturing
Process description:	Cold temperature continuous polymerization process.
Number of sites:	15 SBR plants, 2 butyl rubber plants, 16 butadiene plants, 5 styrene plants

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	NIOSH method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	High	Report is within scope.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	N/A	Background process information
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Sources are cited and referenced.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is mentioned, but not spoken about in detail.

Overall Quality Determination High

Study Citation:	Melnick, R. L., Huff, J. E., Bird, M. G., Acquavella (1990). Symposium overview: Toxicology, carcinogenesis, and human health aspects of 1,3-butadiene. Environmental Health Perspectives 86:3-5.
HERO ID:	5554903
Conditions of Use:	Processing (synthetic rubber manufacturing)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	3 billion lbs/yr in the US, 12 billion lbs/yr worldwide (2nd paragraph, pg. 2/3)
Life cycle description:	synthetic rubber manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing the limitations of the cohort study and where data is lacking. Variability is not addressed.

Overall Quality Determination High

Study Citation:	NIOSH, (1994). Initial submission: Mortality study of workers employed in 1,3-butadiene refining units identified from a large chemical workers cohort with cover letter dated 062094.
HERO ID:	5790851
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Approximately 2500 million pounds of butadiene are produced in the United States each year.
Process description:	The Rubber Reserve process produced butadiene indirectly from ethanol. To better understand the process the plant may be considered u being composed of four major divisions: 1) an Acetaldehyde conversion system, 2) a butadiene conversion system, 3) a butadiene purification system. and 4) a recovery distil1ation system.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study. Variability addressed by sampling different sites.

Overall Quality Determination High

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.
HERO ID:	3808976
Conditions of Use:	Use (paints and coatings)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"54,633,000 total gallons automotive refinish coatings/yr 99,747 - 1,097,457 gallons coating/yr (depending on coating type, from Table 1-1)"
Life cycle description:	Automotive Coating Application
Process description:	Repair/replace automotive surface, initial wash (water/detergent and/or solvent), sanding (dry or wet), mixing of primer coatings, spray paint (multiple layers of primer), curing/drying each layer, sanding (dry or wet), solvent wipe-down, mixing of each coating (basecoat and clearcoat), spray paint (multiple layes of basecoat and clearcoat), curing/drying each layer
Throughput:	"0.25-12 gal coating/site-day, depending on number of jobs Also provides method for adjsuting the use rate based on the type of coating product used" (Table 3-2)
Number of sites:	32,296 (pg. 41/152)
Chemical concentration:	15-25% (not specific to BD)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario documents on coating industry (paints, lacquers and varnishes).
HERO ID:	3827298
Conditions of Use:	Processing and Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	3.2 million tonnes coating/yr
Life cycle description:	Formulation of Coatings and Use of Coatings
Process description:	”PROC: Dispersion, milling, finishing, filling USE: Application via roller/brush, air spray systems, airless and air-assissted airless spray systems, electrostatic spray, electrodeposition/electrocoating and autodeposition, dip coating, flow and curtain coating, roll coating, and supercritical carbon dioxide coating systems”
Throughput:	0.62-9.0 l/vehicle (auto refinishing); 1.1-5.1 g coating/can (metal can coating sites)
Number of sites:	60,330 automotive application sites; 33 metal coating application sites
Chemical concentration:	Provides conc. estimates based on the chemical function, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions and coating types

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.
HERO ID:	3827299
Conditions of Use:	Processing: Adhesive Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	15.8-4,990 million kg adhesive/yr
Life cycle description:	Formulation of Adhesives
Process description:	Unloading raw materials from containers into mixing vessel, mixing, packaging/on-site storage
Throughput:	Provides methodology for estimating throughput based on the amount of adhesive produced, and the concentration of the chemical in the adhesive
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the adhesive use rate, and the concentration of the chemical in the adhesive formulation
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are reasonably expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.

Overall Quality Determination High

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.
HERO ID:	3827300
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1,500 - 9,100,000 kg adhesive/site-yr
Life cycle description:	Adhesive Application
Process description:	unloading, dilute and mix (optional), application (roll, spray, curtain, bead/syringe), drying/curing, product finishing
Throughput:	Provides methodology for estimating throughput based on the amount of adhesived used, and the concentration of the chemical in the formulation
Number of sites:	541-22,294
Chemical concentration:	Provides conc. estimates based on chemical function and adhesive type, not chemical specific.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2004). Emission scenario document on lubricants and lubricant additives.
HERO ID:	3827416
Conditions of Use:	Formulation and use of lubricants, hydraulic fluids, and metalworking fluids

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 1.1 (pg 13) has UK lubricant production. Table 1.2 (pg 14), Figure 1 (pg 15-18), Table 4.2 (pg 45), Table 4.3 (pg 47), Table 4.4 (pg 48), Table 4.5 (pg 49), Table 4.7 (pg 50), Table 4.13 (pg 55) has consumption by sector.
Process description:	Section 2 (pg 19) provides process overview.
Throughput:	Oil use per car provided in Table 6.1 (pg 73)
Number of sites:	Page 47 states 50,000+ businesses use metalworking lubricants.
Chemical concentration:	Table 4.1, Table 4.2 (pg 45), Table 4.3 (pg 47), Table 4.6 (pg 50), Table 4.7 (pg 50), Table 4.9 (pg 52), Table 4.10 (pg 53), Table 4.11 (pg 53), Table 4.12 (pg 54), Table 4.13 (pg 55), Table 4.14 (pg 55) has concentrations by additive type.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	From OECD countries. Data is mostly UK.
	Metric 3: Applicability	High	Formulation and use of lubricants is in scope.
	Metric 4: Temporal Representativeness	Medium	The ESD is from 2004, which is 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination — High

Study Citation: OECD, (2015). Emission scenario document on use of adhesives.
HERO ID: 3833136
Conditions of Use: Adhesive Application

EXTRACTION

Parameter	Data
Production, import, or use volume:	1,500 - 9,100,000 kg adhesive/site-yr (Table 3-2 on page 46 of 189)
Process description:	unloading, dilute and mix (optional), application (roll, spray, curtain, bead/syringe), drying/curing, product finishing (page 33 of 189)
Throughput:	Provides methodology for estimating throughput based on the amount of adhesive used, and the concentration of the chemical in the formulation.
Number of sites:	541-22,294
Chemical concentration:	Provides conc. estimates based on chemical function and adhesive type, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.

Overall Quality Determination High

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.
HERO ID:	3840003
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	0.7-69.84 million kg coating/ink/adhesive/yr
Life cycle description:	Formulation of Coatings, inks, and adhesives
Process description:	Preheating (optional), Unloading raw materials from containers into mixing kettle, mixing, filtering, packaging
Throughput:	Provides methodology for estimating throughput based on the amount of product produced, and the concentration of the chemical in the formulation
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the use rate, and the concentration of the chemical in the formulation
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of UV curable products.

Overall Quality Determination Medium

Study Citation:	OECD, (2009). Emission scenario document on plastic additives.
HERO ID:	5079084
Conditions of Use:	Plastics Compounding and Converting

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Provides % of polymers used for various end-use applications
Process description:	Provides descriptions for a variety of closed, partially open, and open compounding and converting processing. Including the following compounding processes: tumbling, ball blending, gravity mixers, paddle mixers, intensive vortex mixers, banbury mixers, two roll mills, and extruder mixing. And the following converting processes: extrusion, injection molding, compression molding, extrusion blow molding, injection blow molding, film extrusion, extrusion coating, thermoforming, calendering, hand lay up, spray techniques, and filament winding.ESD also provides a break down of the % and volume of polymers used in each process in the UK.
Throughput:	Provides methodology for estimating throughput of polymers and additives.
Number of sites:	4000 sites in UK
Chemical concentration:	Provides conc. estimates based on additive function in various plastics, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment from 2009 but is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering prevalence of various processing methods, additive functions, and plastics.

Overall Quality Determination Medium

Study Citation:	OECD, (2011). Emission scenario document on the chemical industry.
HERO ID:	6306753
Conditions of Use:	Manufacture, processing, use

EXTRACTION

Parameter	**Data**
Life cycle description:	Manufacture, Formulation of processing aids, processing as a reactant, use of processing aids
Process description:	General synthesis process consists of reaction, handling/transportation, isolation, handling/transportation, purification, handling/transportation, then either reaction to make another chemical or on to the next life cycle stage

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
	Metric 5: Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Process description and life cycle description.

Overall Quality Determination Medium

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.
HERO ID:	6385735
Conditions of Use:	Processing and Commercial Use: Lubricant additives

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	8.5 billion kg lubricants/yr
Life cycle description:	Formulation and Use of Automotive Lubricants
Process description:	”Processing: Unloading raw materials, blending, intermediate storage Use: Unloading lube oil, removing spent oil and replacing with new oil, disposing/recycling of used oil”
Throughput:	Provides methodology for estimating throughput based on the amount of lubricant produced, and the concentration of the chemical in the lube oil
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the use rate, and the concentration of the chemical in the lubricant
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination High

Study Citation:	OECD, (2009). Emission scenario document on transport and storage of chemicals.
HERO ID:	6393282
Conditions of Use:	Transportation and Storage (Processing, distribution in commerce)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”11 million tonnes shipped via rail tankers 30 million tonnes shipped via pipelines ”
Life cycle description:	Transportation and Storage
Process description:	On-site storage of chemicals, filling of containers, transport to distributors/downstream users/consumers, containers with residual chemical transported to recylcing/cleaning or disporal site, empty/cleaned containers returned to distributor or production site
Throughput:	”Road tankers: 18-25 tonnes Rail tankers: 130,000 L IBCs: 400-2,000 L or 225-2,270 kg Steel Drums: 49-416 L Steel Pails: </= 45 L Plastic drums: 9.5-208 L Fibre drums: 4-450 L or up to 400 kg Bags/sacks: 25-1000 kg Carboys: 10-50 L Glass bottles </=2.5 L ”
Number of sites:	Container cleaning sites in UK: 40 for road tankers; 8 for steel drums; 8 for plastics drums; 6 for fibre drums; 13 for IBCs; 7 for hazardous waste containers

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical forms, containers and storage system types.

Overall Quality Determination Medium

Study Citation:	OECD, (1996). SIDS initial assessment profile: 1,3-Butadiene.
HERO ID:	7330348
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Global production: 1,202,000-4,960,000 tonnes/yr. No US specific info. (pg 1)
Life cycle description:	Monomer in manufacture of rubbers and plastics (96%). Intermediate to produce other compounds (4%) (pg 1)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3:	Applicability	Medium	Data are for worldwide manufacturing, which is similar to the in-scope occupational scenario Manufacturing.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Omenn, G. S. (1996). Risk assessment for butadiene: Introductory and summary comments. Toxicology 113(1-3):5-11.
HERO ID:	5620716
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	6 million tons produced per year.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene monomer production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	production information.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing discrepancies in different literature reports. Variability addressed by including different report from different sectors and time periods.

Overall Quality Determination High

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.
HERO ID:	5184986
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	25-1,000 kg precursor/site-yr
Life cycle description:	Semiconductors (Chemical Vapor Deposition)
Process description:	CVD precursors shipped to end users in cylinder, bubbler/canister, or isotrailer, container attached to gas delivery system, deposition/reaction, unreacte precursors to abatement systems
Throughput:	Provides methodology for estimating throughput based on the precusor use rate and operating days/yr
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, precursor use rate, and operating days
Chemical concentration:	100%

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple site sizes

Overall Quality Determination High

Study Citation:	Penn, A., Snyder, C. A. (2018). 13.26 - 1,3-butadiene and cardiovascular disease. :538-544.
HERO ID:	5727580
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2000, its peak production year in the United States, >2.0E09 kg of this volatile compound were produced. (page 2 of 7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by including multiple studies in the report but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Penn, A., Snyder, C. A. (2018). 13.26 - 1,3-butadiene and cardiovascular disease. :538-544.
HERO ID:	5727580
Conditions of Use:	Importing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Although the US output represents 1/4 of the world's total yearly industrial BD production, around 90E06 additional kg of BD must be imported yearly to satisfy US industrial needs (as of 2001)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by including multiple studies in the report but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Research Statistics Inc, (1992). Initial submission: Mortality among workers at a butadiene production facility with cover letter dated 051492.
HERO ID:	5665284
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	Both catalytic and oxidative dehydrogenation of n-butane required three separate steps. The feedstock, a mixture of butenes. butylene and other light hydrocarbons. was first run through a series of extractive distillations to Isolate n-butene. Next. n-butene was passed over a fixed bed catalyst In a reactor, the butadiene was absorbed from the product stream. and unreacted n-butene was recycled to the reactor. Finally. the butadiene product was Isolated and purified through further extractions. and oxygen-scavengers, defoilers and polymer Inhibitors were added.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by mentioning shortcomings of the study, like incorrect race classifications. Variability addressed by sampling many different types of workers.

Overall Quality Determination High

Study Citation:	Research Statistics Inc, (1985). Report - mortality among workers at a butadiene production facility - with cover letter dated 051586.
HERO ID:	5665530
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Between 2.1 billion and 7.3 billion lbs maufactured/imported in 1977.
Life cycle description:	Domestic Manufacturing
Process description:	Both catalytic and oxidative dehydrogenation of n-butane required three separate steps. The feedstock, a mixture of butenes. butylene and other light hydrocarbons. was first run through a series of extractive distillations to Isolate n-butene. Next. n-butene was passed over a fixed bed catalyst In a reactor, the butadiene was absorbed from the product stream. and unreacted n-butene was recycled to the reactor. Finally. the butadiene product was Isolated and purified through further extractions. and oxygen-scavengers, defoilers and polymer Inhibitors were added.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning shortcomings of the study, like incorrect race classifications.. Variability addressed by sampling many different types of workers.

Overall Quality Determination High

Study Citation:	Rooij, De, B. M., J, Commandeur, N. M., N, Vermeulen, P. E. (1998). Mercapturic acids as biomarkers of exposure to electrophilic chemicals: Applications to environmental and industrial chemicals. Biomarkers 3(4-5):239-303.
HERO ID:	1010100
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Rubber manufacturing, cigarette smoke
Chemical concentration:	Air concentrations of 1,3-butadiene ranging between 0.044 mg/m–3 and 800 mg/m–3 have been determined in different industrial settings. Also low levels (< 1 microgram/m–3) in outdoor air.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Many journal articles and studies are referenced as data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Report includes occupational scenarios in the rubber industry.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data sources and studies included are all clearly documented and referenced.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation in the studies is mentioned and summarized.

Overall Quality Determination High

Study Citation:	Science Applications International Corporation, (1996). Generic scenario for automobile spray coating: Draft report.
HERO ID:	6311222
Conditions of Use:	Paints and Coatings: Automobile Spray Painting

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”Auto OEM: 166,00 cars painted/yrAuto refinish: 70-2,000 L paints/yr”
Process description:	In automobile original equipment manufacturing (OEM), several layers of paint are applied to the car alternated with heating to cure the paint or drive off moisture. Oven temperatures are as high as 450 F to cure the paint. Although lower temperatures are used to simply remove water. Individual sites may add additional painting steps to achieve protection in certain areas and may modify the drying/curing steps.Automobile OEM painting is conducted by robots and overspray is collected in water wash booths of downdraft or crossdraft design. Water is used almost exclusively to collect overspray in new automobile manufacture. During assembly line activities following painting. the paint may be scratched or damaged and necessitate touchup repair. In these cases, the paint is applied manually and cured at temperatures up to 180’F, which is lower than the curing temperature used upstream to avoid damaging the other components. A generic process flow diagram of an automotive assembly plant paint booth is presented in Figure 3.In automobile refinishing, almost all spray coating operations are expected to involve a worker spraying the vehicle, typically in a ventilated spray booth with dry filters to collect overspray. The car can dry at atmospheric conditions, or at elevated temperatures through the use of heated paint booth air or portable heat sources. The curing temperature is likely to be comparable to that used in OEM ”touch-up” activities (i.e., up to 180F).
Throughput:	”Auto OEM: 250 days/yrAuto refinish: 170 days/yr”
Number of sites:	”Auto OEM: 61 sitesAuto refinish: 1000’s of sites”

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The generic scenario document uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned.
Metric 4:	Temporal Representativeness	Low	Generic scenario was created over 20 years ago.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability in throughput is described, but uncertainty is not characterized.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).
HERO ID:	10480466
Conditions of Use:	Use - Laboratory Chemicals

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Provides methodology to estimate annual use rate. Provides some use rate quantities for the first 10 chemicals in table 1-2 (page 1-3)
Life cycle description:	Use - Laboratory Chemicals
Process description:	Receive chemicals, weigh or measure chemical, add chemical to labware, dilute/add other laboratory chemicals, add sample, run analytical testing, dispose of sample and laboratory chemical waste (starting on page 2-1)
Throughput:	260 days/yr 255 grams reagent/site-day (average); 2,000 mL reagent/site-day (average); Table 3-2 gives daily throughput for laboratory stock solutions (page 3-3)
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, annual throughput - 40,639 total establishments (page 3-5)
Chemical concentration:	Provides conc. estimates based on the chemical function, not chemical specific. (page 3-2)
Comments:	This is a generic scenario and not 1,3-butadiene-specific. Please refer to the generic scenario to determine the best values for this chemical's situation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering different chemical functions

Overall Quality Determination High

Study Citation: U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID: 11182966
Conditions of Use: Repackaging

EXTRACTION

Parameter	Data
Production, import, or use volume:	Table B-1 presents PMN data on repackaging rate in kg chemical/site-yr.
Process description:	Pre-manufacture notices (PMN) submitted from 2010 to 2020 under EPA's New Chemicals Program indicated imported and repackaged chemicals can be solids or liquids and may be neat or in solutions/mixtures and contained in various packaging types. After they arrive at the repackaging site, repackaging operations occur where the chemical is transferred from the transport container it was imported in to a new one of a different size in order to meet the customer's needs (JACO, 2021). Chemicals may also be transferred from original containers to intermediate storage containers before packaging into smaller containers (Cooke, 2013; NIOSH, 2009). Chemicals are expected to be received at repackaging sites in drums or larger bulk containers (supersacks, totes, tank trucks, etc.) (Cooke, 2013; NIOSH, 2009). The chemical of interest may be received in its final formulation and transferred directly from these large containers into smaller containers, charged to a temporary storage tank, or it may be charged to a mixing tank and diluted or mixed with other chemicals before it is repackaged. Once the chemical has been formulated to desired specifications, it can be repackaged. Workers may be potentially exposed during the unloading of chemicals from the original transport containers into temporary storage or new transport containers. Releases of chemicals may also occur during this stage, from open container surfaces (e.g., if the chemical is volatile), transfer operations (e.g., if the chemical is volatile or a powder), and original transport container disposal.Repackaging operations for liquid chemicals typically involve pouring or pumping the product from the original containers or mixing /storage tanks into the new containers. A study conducted by the Health and Safety Laboratory in the U.K. investigated two chemical repackaging sites (Cooke, 2013). At both of these sites the chemical was delivered to the site by road tanker and pumped into dedicated storage tanks. One of the sites, a hydrazine supplier, pumped the hydrazine into a mixing vessel where it was diluted with water and packaged into smaller containers for sale to customers. At the other site, trichloroethylene was pumped from storage tanks into a closed loop system where workers using a hydraulic lance connected to a semi-automated filling system transferred the chemical into new containers (Cooke, 2013). The usual process for repackaging solid chemicals differs from the processes for liquids. A NIOSH Health Hazard Evaluation Report (HHE) from 2009 investigated a repackaging facility that was transferring bulk shipments of silane-coated glass beads ranging between 0.2 – 1.2mm in diameter. At this facility, 2,200 lb supersacks of the product are lifted with a forklift over a metal bin, then cutting the bottom of the container with a knife to empty the beads into the bin. The metal bin is then lifted by a forklift, and the glass beads are poured into hoppers. From the hoppers the beads are gravity fed into smaller cardboard boxes or paper sacks that are shipped to customers (NIOSH, 2009). Workers may be potentially exposed during the transfer of chemicals from temporary storage into new transport containers. Releases of chemicals may also occur during this stage from open container surfaces (e.g., if the chemical is volatile), transfer operations (e.g., if the chemical is volatile or a powder), and cleaning any equipment that was used in during the process.
Number of sites:	Table 1-2 presents the number of repackaging sites based on 2019 U.S. Census data.
Chemical concentration:	A fraction of completed IRERs from 2010-2020 were reviewed, 21 submissions contained information on chemical repackaging. In these submissions, chemicals were repackaged at concentrations ranging from 1% to 100%, with a 50th percentile of 93%, a 95th percentile of 100%, and a mode of 100%.
Comments:	Note that none of the above information is specific to 1,3-butadiene. The generic scenario itself should be consulted when determining values to use for 1,3-butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.

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Study Citation: U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID: 11182966
Conditions of Use: Repackaging

Domain		Metric	EVALUATION Rating	Comments
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple repackaging facilities.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).
HERO ID:	11203977
Conditions of Use:	Fuels and Fuel Additives

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	95.3 billion gallons of gasoline were sold in 2018.
Process description:	Chemicals in fuels and related products are expected to be received at use sites (i.e., fueling stations) via tank trucks, rail cars, tankers, barges, and pipelines. The fuels are then transferred from these transport containers to on-site storage tanks, typically through pipes and hoses. At the use site, fuels are dispensed from storage tanks to vehicles or other equipment. Storage tanks for fuel are typically underground, and fuel is pumped upwards through tubes and nozzles. During combustion, fuel is burned to provide energy to an engine. In a typical internal combustion engine, fuel is mixed with air in a chamber. This mixture is ignited with a spark and energy from the burning fuel is used to power the vehicle or machine. Exhaust gases leave through a tailpipe or vent.
Throughput:	Provides methodology for estimating throughput based on use rates and operating days/yr.
Number of sites:	Up to 505,698 sites (Table 1-2).
Chemical concentration:	Table 1-1 provides concentration ranges (with example chemicals) of typical fuel additives.
Comments:	This document is a generic scenario, not specific to 1,3-butadiene. When using the information please refer to the scenario itself to see the context of the above information and determine the relevancy to 1,3-butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple fuel and additive types.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene: Final report.
HERO ID:	1565
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1977 between 2.1 and 7.3 billion pound were produced or imported. (17 of 146)
Process description:	Produced as an ethylene co-product, by oxidative dehydrogenation of n-butenes, or by dehydrogenation of n-butanes (17 of 146)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1985
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene: Final report.
HERO ID:	1565
Conditions of Use:	Processing, processing as a reactant

EXTRACTION

Parameter	**Data**
Life cycle description:	1,3-Butadiene is mainly used by the styrene-butadiene rubber and polybutadiene rubber industries. (11 of 146). Used as an intermediate in the production of polymers, elastomers, and other chemicals. The major use is in the manufacture of styrene-butadiene rubber (synthetic rubber). In addition, it is used as an intermediate to produce a variety of industrial chemicals, including the fungicides, captan and captofol. It is also FDA approved for use in adhesives used in certain types of food containers. (page 17 of 146)
Process description:	Produced as an ethylene co-product, by oxidative dehydrogenation of n-butenes, or by dehydrogenation of n-butanes (17 of 146)
Number of sites:	eight plants included in one of the cohort studies (13 of 146).
Chemical concentration:	In a typical recipe for the production of SBR butadiene accounts for 26% of total ingredients (79 of 146)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1985
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

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

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	2.3 billion pounds of rubber-grade 1,3-butadiene in 1985. Production of all grades in 1985 and 1986 is ~25 billion pounds (10 and 22 of 92). See page 22 for a list of manufacturers that produce 1,3-butadiene; they have a combined annual capacity of 3.755 billion.
Life cycle description:	used predominantly in the production of synthetic rubber s and elastomers (page 10 and 23 of 92) The use pattern as of 1985 is as follows: styrene-butadiene rubber (37%), polybutadiene rubber (22%), and adiponitrile/HMDA (11%), styrene-butadiene latexes (9%), neoprene (7%), ABS resin (5%), exports (4%), nitrile rubber (3%), other (2%). Also chemical intermediate for production of 1,4-hexadiene and 1,5,9-cyclodecatriene (page 23 of 92)
Process description:	1,3-butadiene is manufactured by steam cracking of naphtha and gas oil fractions, which produce butadiene and ethylene as co-products, or by the catalytic dehydrogenation of n-butene and n-butane. The steam cracking process is the predominant U.S. production process. The isomeric 1,2-butadiene is sometimes found as a contaminant of 1,3-butadiene (page 23 of 92)
Number of sites:	10 US manufacturing sites in 1985 (page 10 of 92)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	from EPA
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US
Metric 3:	Applicability	High	within scope
Metric 4:	Temporal Representativeness	Low	1989
Metric 5:	Sample Size	N/A	The extracted data do not constitute data that are a sample from a population.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	The sources of the extracted data are cited but the methods of deriving these data are not mentioned.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The data source does not include information about uncertainty in the extracted data. Information about variability (e.g., across time) is lacking.

Overall Quality Determination Medium

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

EXTRACTION

Parameter	Data
Production, import, or use volume:	~500 million pounds/year imported, and ~125 million pounds/year exported. (22 of 92)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	from EPA
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	within scope
	Metric 4:	Temporal Representativeness	Low	1989
	Metric 5:	Sample Size	N/A	Import volume data do not constitute a population that is sampled.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	The sources of the extracted data are cited but the methods of deriving these data are not mentioned.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty in the extracted data is not mentioned and variability in the extracted data (e.g., variability across time) is not mentioned.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.
HERO ID:	3827197
Conditions of Use:	Formulation of Coatings

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	As outlined in Table 1-6, out of the 1,142 million gallons of paint produced in the U.S. in 2010, 602.5 million gallons are estimated to be waterborne coatings (or 52.8 percent of the industry's production). Equation 1-1 was used to calculate the estimated production volume shown in Table 1-6 for OEM coatings.
Life cycle description:	This Generic Scenario presents a standard approach for estimating the environmental releases and associated occupational exposures to different functional chemical components (both volatile and nonvolatile) used during the formulation of waterborne coatings. Releases and exposures from the manufacture or import of the chemicals and the subsequent blending of the chemicals into components for use in waterborne coating formulations are beyond the scope of this scenario, and therefore not addressed. Additionally, the scenario does not cover the application of the coating onto a substrate or article or the use of the substrate once the coating has been applied and cured.
Process description:	Traditional paint manufacturing processes consist of the following unit operations (KO, 2005; OECD, 2006): Pre-assembly or pre-mixing (of the pigment dispersion); Grinding or milling (of the pigment dispersion); Blending of the final formulation; and Filtration and packaging. Bulk solvents and resins are normally delivered in road tankers and unloaded by pipes and pipelines into bulk storage tanks. Other liquid materials are delivered in 55-gallon drums or 1 tonne Intermediate Bulk Containers (IBCs). Powder pigments and extenders are delivered in 25 kilogram bags on 1 tonne pallets, in 1 tonne big bags, or occasionally in bulk road tankers from which they are unloaded by compressed air into bulk silos (OECD, 2006). See Figure 2-1.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation, but data is not chemical-specific.
	Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID:	52153
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	1,3-butadiene is used as an intermediate in the production of polymers, elastomers, and other chemicals. Its major uses are in the manufacture of styrene-butadiene rubber (SBR) (synthetic rubber) and of thermoplastic resins. Elastomers of butadiene are used in the manufacture of tires, footwear, sponges, hoses and piping, luggage, packaging, and a variety of other molded products. In addition, 1,3-butadiene is used as an intermediate to produce a variety of industrial chemicals, including the fungicides captan and captfol. (page 18 of 435) In 1990, 1,3-butadiene was used in the United States for SB rubber (30%), polybutadiene rubber (20%), adiponitrile/hexamethylenediamine (15%), SB latex (10%), neoprene rubber (5%), acrylonitrile-butadienestyrene resins (5%), exports (4%), nitrile rubber (3%), and other (including specialty polymers) (8%) (page 25 of 435). See sections 2.2.1 through 2.2.6 on pages 25 through 26 of 435 for more specific production information for several butadiene products.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	report from 2002
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sources of information are cited but the underlaying methods are not described.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Various types of end-use products are mentioned.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (2002). Health assessment of 1,3-butadiene.
HERO ID: 52153
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Approximately 12 billion pounds of 1,3-butadiene are produced annually worldwide, including 3 billion pounds produced in the United States (page 18 and 25 of 435)
Process description:	produced by three different processes: (1) oxidative dehydrogenation of n-butene (the Oxo-D or O-X-D process), (2) catalytic dehydrogenation of n-butane and n-butene (the Houdry process), and (3) recovery from the C4 coproduct (by-product) stream from the steam-cracking process used to manufacture ethylene (the ethylene coproduct process). The ethylene coproduct processaccounts for approximately 95% of U.S. and 85% of worldwide production (page 18 and 25 of 435)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	EPA assessment
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	United States
Metric 3:	Applicability	High	Manufacture is a COU
Metric 4:	Temporal Representativeness	Low	The date of the extracted data is 1990.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Data sources are cited but the underlying methods are not described.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Different processes for manufacture are mentioned. PV is mentioned but variability of PV across time is not described.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385719
Conditions of Use:	Paints and coatings: Furniture Industry

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Metal: 5,000-446,600 L coating/yrWood: 4,326-4,372 L coating/yr
Process description:	Metal furniture: Metal cleaning, coating unloaded, coating mixing, coating application (spray booth, manual or automatic), flash-off, drying oven Wood furniture: coating unloaded, coating mixing, coating application (spray booth, manual or automatic), flash-off, drying oven, sanding and other finishing operations
Throughput:	Metal: 20-1,786 L coating/dayWood: 17.3-17.4 L coating/day
Number of sites:	152-8,176
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	The GS is based on data that is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385741
Conditions of Use:	Fabric Finishing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	73 million kg finishing agents/yr
Process description:	Fabric immersed in an aqueous finishing formulation then squeezed between metal rolls to remove excess padding solution and to aid in the even distribution of the finishing agent, fabric dried by passing over a series of heated metal rolls, fabric cured by passing through a long oven.
Throughput:	3,520-50,000 kg cloth/site-day
Number of sites:	1,100 total finishing plants
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Low	Data is general and not specific to the chemical. Also, fabric finishing is not in scope for the risk evaluation but the information extracted might be used for an in-scope scenario like Organic Fiber Manufacturing.
Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting into finished products) -generic scenario for estimating occupational exposures and environmental releases. Draft.
HERO ID:	6549571
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 2 presents the types of thermoplastic resins, common uses, and 2003 production volume.
Life cycle description:	The plastic manufacturing industry can be divided into four sections: polymer manufacturing, compounding, converting, and "in-house" manufacturing. This generic scenario will address converting operations. Polymer manufacturing will not be included in this scenario. Compounders produce masterbatches of plastic resins with specific properties by blending the polymer (resin), additives, fillers, and reinforcements. Converters receive the masterbatch of plastic resin from compounders and form finished plastic products. Compounding and converting may take place as the same facility ("in-house" manufacturing) or at separate facilities. This scenario assumes that compounding and converting take place at separate facilities; therefore, in-house manufacturing is not covered in this scenario.
Process description:	Various plastic processing operation descriptions are provided in Table 5, and a Process Diagram is provided on PDF pg. 10. More generally, polymer resin is received at the compounding sites from the resin manufacturer in the form of pellets. A compounding site blends the resin and additives to produce a masterbatch. The converting site then processes the masterbatch by shaping the plastic into the desired form for the final plastic product. The blending and forming may take place at the same facility ("in house" manufacturing) or separate facilities. As a conservative estimate, it is assumed that the compounding of the plastic resin and the converting of the resin into plastic products take place at separate facilities. Therefore, in-house manufacturing is not covered in this scenario. After shaping, finishing operations such as filing, grinding, sanding, polishing, painting, bonding, coating, engraving etc. are performed to complete the finished plastic product. This scenario covers the converting of plastic resins into finished products.
Throughput:	Daily use rate = amount of resin / # converting sites / days of operation x fraction of additive x fraction of chemical in additive
Number of sites:	Overall, there were 12,191 Plastic Product Manufacturing establishments in 2001. Table 1 provides Number of Establishments for subcategories of NAICS 3261 Plastic Product Manufacturing.
Chemical concentration:	Default values used to represent the weight fraction of various additives in plastic resin range from 0.001 - 0.5. These values are provided in Table 2 and Table 3.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data that are from a frequently used source are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				

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Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting into finished products) -generic scenario for estimating occupational exposures and environmental releases. Draft.
HERO ID:	6549571
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)

			EVALUATION	
Domain		Metric	Rating	Comments
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by evaluation of various plastic processing operations, as well as various additive fractions. However, uncertainty associated with data are not characterized.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (2016). Chemical Data Reporting (CDR): Complete 2016 submissions.
HERO ID: 7315471
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Out of the 27 sites that have data for butadiene in CDR, one site reported using 187637001 lbs of butadiene, one site reported using 755338710 lbs, one site reported using 22809033 lbs, 9 sites reported using 0 lbs, and 15 sites claimed CBI/withheld.
Number of sites:	27 sites in the US reported data for butadiene to CDR.
Chemical concentration:	Out of the 27 sites that reported data to CDR for butadiene, 1 site reported concentrations less than 1% by weight, 1 site reported concentrations at least 60% but less than 90% by weight, 18 sites reported concentrations of at least 90% by weight, and 7 sites claimed CBI/withheld.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided)
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by listing ranges for reported values. Variability isn't addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1,000,000 kg additive/year
Process description:	The nature of the production process varies among additives. PMN produced at 100% concentration then diluted to between 90 - 50% in mineral oil to facilitate handling. More detailed description on page 8
Number of sites:	2
Chemical concentration:	PMN produced at 100% concentration then diluted to between 90 - 50% in mineral oil

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Processing as a reactant, Lubricants and lubricant additives in Petroleum lubricating oil and grease manufacturing.

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1,000,000 kg additive/year
Process description:	unloading additive, blending additive with base stock to 1%, package product in cans or drums. More detailed description on page 8
Number of sites:	2 blending sites
Chemical concentration:	additive manufactured and diluted to 50-90% in mineral oil. 1% additive in lube oil product

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Industrial and commercial use of Fuel and related products; Industrial and commercial use of Lubricants and greases

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	29.3 mm gal/yr lube
Process description:	Workers drain out oil from automobiles and add fresh oil containing 1% fuel additive. Used oil is collected and recycled.
Number of sites:	Pure lube: 4,000 sites, 20,000 workersGeneral Automotive: 57,629 sites, 222,720 workers
Chemical concentration:	1% additive in lube oil product

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Approximately 12 billion pounds of 1,3-butadiene are produced annually worldwide and 3 billion pounds in the United States. pg. 16; In 1990, 1,3-butadiene was used in the United States for styrene-butadiene rubber (30%), polybutadiene rubber (20%), adiponitrile/ hexamethylenediamine (15%), styrene-butadiene latex (10%), neoprene rubber (5%), acrylonitrile-butadiene-styrene resins (5%), exports (4%), nitrile rubber (3%), and other(including specialty polymers) (8%) (Anon., 1991). pg. 30
Life cycle description:	It is used as an intermediate in the production of polymers, elastomers, and other chemicals. The major uses of 1,3-butadieneare in the manufacture of styrene-butadiene rubber (SBR) (synthetic rubber) and of thermoplastic resins. Elastomers of butadiene are used in the manufacture of tires, footwear, sponges, hoses and piping, luggage, packaging, and a variety of other molded products. In addition, 1,3- butadiene is used as an intermediate to produce a variety of industrial chemicals, including the fungicides captan and captfol. pg. 16
Process description:	1,3-Butadiene is a colorless gas produced by three different processes: (1) oxidative dehydrogenation of n-butene (the Oxo-D or O-X-D process), (2) catalytic dehydrogenation of n-butane and n-butene (the Houdry process), and (3) recovery from the C4 coproduct (by-product) stream from the steam cracking process used to manufacture ethylene (the ethylene coproduct process). pg. 16

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, andassociated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
Metric 5:	Sample Size	N/A	N/A- no sampling data
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID:	9493517
Conditions of Use:	Processing- incorporation into an article- Rubber Products

EXTRACTION

Parameter	**Data**
Life cycle description:	SB latex and rubber are used for a variety ofproducts, including automobile tires, textiles, paper, and adhesives. pg. 30
Number of sites:	26 facilities in the United States that produce SB latex and rubber. pg. 30

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, andassociated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed risk assessment is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

Study Citation: U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID: 9493517
Conditions of Use: Processing as a reactant

EXTRACTION

Parameter	Data
Number of sites:	Four companies at five locations in the United States currentlyproduce polybutadiene; Three facilities currently produce neoprene, though only two use butadiene as a raw material and the other starts with chloroprene; Currently, there are 10 facilities that produce ABS resin, only 6 of which use butadiene as a raw material; Nitrile elastomer is produced at nine facilities in theUnited States and accounts for about 5% of total butadiene consumption. Three facilities produce adiponitrile, but only two of these facilities use butadiene inproduction.Nitrile elastomer is produced at nine facilities in theUnited States pg. 31-32

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.

Overall Quality Determination High

Study Citation: U.S. EPA, (1998). Health risk assessment of 1,3-butadiene. External review draft.
HERO ID: 9493517
Conditions of Use: Recycling/Reclamation

EXTRACTION

Parameter	Data
Number of sites:	Secondary lead smelting involves the reclamation of scrap automobile batteries to produce elemental and lead alloys. There are 23 such facilities in the United States, most of which are located near large population centers.pg. 34

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability is not applicable. Uncertainty in estimate of number of facilities is not addressed.

Overall Quality Determination Medium

Study Citation:	UAB, (2007). A follow-up study of women in the synthetic rubber industry.
HERO ID:	6544020
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Plants 3,5, and 6 in this study produce over 200 million pounds of SBR per year.
Process description:	All plants in the study originally used a batch emulsion process to make SBR. After 1950, the production process switched from a hot process to a cold process, and from a batch to a continuous process.
Number of sites:	8

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling at 8 different plants. Uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	USTMA, (2019). U.S. Tire Manufacturers Association: Tire manufacturing and tire materials overview slides.
HERO ID:	10370205
Conditions of Use:	Processing –incorporation into article: Other: Polymer in: Rubber and plastic product manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Pg. 14 & 17/38: raw material used in tires include synthetic elastomers, which include Polybutadiene rubber (BR) and Styrene butadiene rubber (SBR) which are made with 1,3-butadiene. 1,3-butadiene in finished tires is generally not detectable.
Process description:	Pg. 10-12/38: The tire manufacturing process consists of the following steps: mixing, calendering, extruding, tire building, tire curing, inspection. Rubber vulcanization is explained. Rubber vulcanization occurs during tire curing.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Industry information
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	Use in tires is a COU
Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
Metric 5:	Sample Size	High	The trade association represents all major manufacturers
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	How the information was obtained is not clearly stated.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	[Anonymous] (2018). First commercial application of technology for manufacture of butadiene via oxydehydrogenation of butene. China Petroleum Processing and Petrochemical Technology 20(1):66.
HERO ID:	4723653
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	The first-stage isothermal reactor has shown that the temperature of hot spots is lower than 400 ℃, which can protect catalyst from coke buildup at high temperature to extend its cycle length to more than three years and to double its spacetime yield. The two-stage syngas methanation process features shorter process flow scheme, less equipment needed, lower reaction temperature, longer cycle length of catalysts, higher space-time yield, and higher output of co-produced steam, which can reduce the investment in the operating equipment and decrease the operating cost
Throughput:	100 m3/hr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	[Anonymous] (2015). Sustainable chemicals: Global Bioenergies develops production process for green butadiene. Focus on Catalysts 2015(1):7.
HERO ID:	5562649
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Butadiene is an essential intermediate in the petrochemicals industry. It represents a world market of 10 million tons/year.
Process description:	In 2012 Global Bioenergies developed a new metabolic process involving a series of synthetic enzyme reactions. The following stage consisted of improving the performance of these enzymes and using them in making a bacterial strain for production. This strain was placed in a laboratory fermenter and, after the addition of glucose, butadiene was detected in the resulting fermentation gases.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and information which doesn't indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	[Anonymous] (2012). Asahi Kasei develops new butadiene process. Focus on Catalysts 2012(2):7.
HERO ID:	5674412
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Asahi Kasei Chemicals was looking into setting up a 50,000 tonne/y plant based on the BBFLEX process in Mizushima, Okayama Prefecture, Japan, around 2014.
Process description:	Asahi Kasei Chemicals' newly developed butadiene process, called BB-FLEX, involves the use of butene to produce butadiene. The Japanese company's existing butadiene process entails the production of butadiene using the C4 fraction generated by the naphtha cracking process.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are for Japan, an OECD country.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production volumes) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation: [Anonymous] (2018). Butadiene markets: volatility here to stay. Focus on Catalysts 2018(9):2.
HERO ID: 5674718
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	"The international butadiene extraction capacity stood at nearly 14.8 M tonnes/y in 2016, 50% of which came from Asia-Pacific. US production of butadiene dropped from around 2.0 M tonnes in 2006 to nearly 1.3 M tonnes in 2016, with imports filling the deficit. "

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for the whole world.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total production) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	[Anonymous] (2001). Butadiene - Demand decline raises inventories. Chemical Week 163(29):38.
HERO ID:	5708400
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2001, Texas Petrochemicals Corps added 300 million lbs of butadiene capacity.
Throughput:	Poor demand pulled down year-to-date butadiene production to 2.05 million lbs, down 7% from the previous year. May 2001 inventory at the Houston site was 228 million lbs.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	Process and throughput description
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by discussing changes in production and market conditions from year to year, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Abdel-Rahman, S. Z., Ammenheuser, M. M., Ward, J. B. (2001). Human sensitivity to 1,3-butadiene: role of microsomal epoxide hydrolase polymorphisms. Carcinogenesis 22(3):415-423.
HERO ID:	782889
Conditions of Use:	Domestic Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Global consumption of BD was 6.1 million metric tons in 1995, expected to be 7.5 million metric tons in 2000... US produced over 3.6 billion pounds of BD in 1995 which was equivalent to approximately one-fourth of the global BD output

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparison to global production, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Abdel-Rahman, S. Z., El-Zein, R. A., Ammenheuser, M. M., Yang, Z., Stock, T. H., Morandi, M., Ward, J. B. (2003). Variability in human sensitivity to 1,3-butadiene: Influence of the allelic variants of the microsomal epoxide hydrolase gene. Environmental and Molecular Mutagenesis 41(2):140-146.
HERO ID:	782890
Conditions of Use:	Synthetic rubber manufacturing, monomer used in polymerization

EXTRACTION

Parameter	**Data**
Number of sites:	two SBR plants in southeast Texas
Comments:	same information as HERO ID 782889 (duplicate)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	N/A	Facility data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Abduli, M. A., Abbasi, M., Nasrabadi, T., Hoveldi, H., Razmkhah, N. (2006). Solid waste management in tabriz petrochemical complex. Iranian Journal of Environmental Health Science & Engineering 3(3 (2006)):185-192.
HERO ID:	1159262
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Process description:	Various hazardous solid waste treatments are described on page 6 of 8, including incineration which is indicated earlier in the paper as a common treatment for the butadiene waste streams.
Throughput:	2443 tons/year of generated butadiene waste, and 2785 tons/year of Acrylonitril Butadiene Styrene (ABS) waste. (Table 1, Page 3 of 8)See Table 2 on page 4 of 8 for effluent flow in tons/yr of waste produced by the Styrene Butadiene Rubber unit. Wastes generated from this unit are the most significant suppliers of the incinerator (page 4 of 8)See Table 3 on page 5 of 8 for effluent flow in tons/yr of waste produced by graded ABS and 1,3 Butadiene, and see the bottom of page 4 of 8 for discussion.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (throughputs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	ACA, (2019). Comment submitted by Raleigh Davis, Assistant Director and Riaz Zaman, Counsel, Government Affairs, American Coatings Association (ACA) regarding the proposed 20 high priority candidates for chemical risk evaluation.
HERO ID:	10369850
Conditions of Use:	Processing – incorporation into formulation, mixture, or reaction product - (1) paints and coatings Manufacturing, (2) Adhesives Manufacturing.

EXTRACTION

Parameter	**Data**
Chemical concentration:	Pg. 5/7: "Manufacturers note residual amounts of the chemical in aerosol propellants and in architectural paints and coatings. The chemical is also in resins, incorporated for their tensile and elastomeric properties. Formulators are uncertain how muchremains in the end product from this residual in raw materials"
Comments:	The data source is a public comment by the American Coatings Association (ACA) on the scope documents. The ACA "represents 90% of the paint and coatings industry, including downstream users (or processors) of chemicals, as well as chemical manufacturers. Our membership includes companies that manufacture paints, coatings, sealants and adhesives" according to pg. 2/7 of the data source. According to the extracted information which is stated above, there is residual amounts of 1,3-butadiene in aerosol propellants and in resins. The association of these propellants and resins with one or more of the industries that the ACA is associated with is not stated.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Data source is industry
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	data pertains to COUs
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	The underlying methods, sources, ..etc. are not stated.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	Ammenheuser, M. M., Bechtold, W. E., Abdel-Rahman, S. Z., Rosenblatt, J. I., Hastings-Smith, D. A., Ward, J. B. (2001). Assessment of 1,3-butadiene exposure in polymer production workers using HPRT mutations in lymphocytes as a biomarker. Environmental Health Perspectives 109(12):1249-1255.
HERO ID:	2959573
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1995, 3.68 billion lbs produced in U.S.
Life cycle description:	Polymer production for synthetic rubber manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Well-described method by a national laboratory was used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	In-scope report.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	N/A	Production and life cycle description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	Angelici, C., Weckhuysen, B. M., Bruijnincx, A., P.C. (2013). Chemocatalytic conversion of ethanol into butadiene and other bulk chemicals. ChemSusChem 6(9):1595-1614.
HERO ID:	4687724
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	9 x10^6 ton/year in 2005 and and estimated to grow considerably (page 5 of 20)
Process description:	Two ways are mainly pursued for its industrial synthesis: isolation from naphtha steam cracker fractions of paraffinic hydrocarbons for the manufacture of ethylene and its higher homologues, or the catalytic and oxidative dehydrogenation of n-butane and n-butene. The first route is undoubtedly the most important, accounting for over 95% of worldwide butadiene production. (see page 10-18 of 20 for a long and in-depth description of the manufacturing processes)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	from Germany, an OECD country
	Metric 3: Applicability	High	manufacturing of 1,3-butadiene
	Metric 4: Temporal Representativeness	High	Report is from 2013
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized

Overall Quality Determination High

Study Citation:	Anonymous, (2013). Global Bioeneregies makes a breakthrough in the production of biobased butadiene. International Sugar Journal 115(1369):18.
HERO ID:	4723631
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2013, 10 million tonnes of butadiene were produced from oil. 7 million tonnes are used to manufacture rubbers and 3 million tonnes goes into the production of nylon, plastics and latexes. (Page 2 of 2)
Process description:	A new process by Global Bioenergies and Synthos coverts renewable feedstock to butadiene through direct gaseous fermentation. (Page 2 of 2)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from a ”European company” which is likely an OECD country.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (total production) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Anonymous, (2014). Global Bioenergies secures a USTPO patent for its butadiene process. International Sugar Journal 116(1386):408.
HERO ID:	4723644
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	As of 2014, approximately 10 million tons of butadiene are produced annually from oil (page 3 of 3)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from the U.K., an OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Anonymous, (1996). Butadiene/styrene Q3 prices fall. European Chemical News 66(1725):9.
HERO ID:	5651515
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The report mentions that 3000 tons of butadiene were imported to Turley. Also, the report lists the European stock of butadiene at 602 DM/tonne.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are worldwide.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (production factors) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Low

Study Citation:	Anonymous, (1996). Olefins supply - Production problems tighten butadiene. European Chemical News 66(1741):10.
HERO ID:	5651529
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996, Occidental owned a 95,000 ton/year butadiene unit in Corpus Christi. Lyondell owned a 272,000 ton/year butadiene unit in Channelview. Texas Petrochemicals owned a 350,000 ton/year butadiene unit in Houston. In Europe, DSM owned a 130,000 ton/year unit in Geleen.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are for the U.S. and Europe.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production volumes) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Low

Study Citation:	Anonymous, (2009). An additional 100 kt/a butadiene production line constructed by yangzi petrochemical company. China Petroleum Processing and Petrochemical Technology 4:62.
HERO ID:	5660504
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Throughput:	0.1 Mt/yr at SINOPEC Yangzi Petrochemical Company

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Production description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (2007). Yangzi petrochemical utilizes the pyrolysis C-4 resources to expand butene-1 and butadiene production capacity. China Petroleum Processing and Petrochemical Technology 2007(1):55.
HERO ID:	5662686
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Throughput:	A 100 kt/yr unit was set up, and is expected to reach 200 kt/yr after the expansion of an ethylene unit.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	lifecycle description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (2009). Shaw to design ABS plant in Saudi Arabia. Pump Industry Analyst 2009(5):4.
HERO ID:	5665737
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The Shaw Group's Energy & Chemicals Group was expected to provide front end engineering design services for a grassroots 200 kilo tons per annum acrylonitrile butadiene styrene (ABS) plant for Arabian Petrochemical Co in 2009.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data is from Saudi Arabia, a non-OECD country.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Anonymous, (2005). Butadiene rubber production in Russia. Focus on Catalysts 2005(4):6.
HERO ID:	5676477
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2003, Russia produced 141,000 tons of butadiene-containing rubber. During 2004, it is predicted that production will rise to 169,000 tons.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Russia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	production information.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1974). Computer control-system increases throughput and operating cost savings in Texas butadiene plant. Rubber Age 106(10):50.
HERO ID:	5707200
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Annual production for the Phillip's Petroleum plant in Texas is 158,000 short tons/year.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the U.S.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total production) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1999). Shell, BASF, Fina to add butadiene plant. Chemical & Engineering News 77(29):16.
HERO ID:	5708111
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	New joint venture plant under BASF, Shell, and Fina begin production in 2002 in Port Arthur, Texas with projected capacity of 900million lbs/yr
Process description:	Butadiene plant uses feedstock from steam cracker

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Anonymous, (2000). Butadiene extraction plant planned. Chemical Engineering Progress 96(2):13.
HERO ID:	5708118
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	New joint venture plant under BASF, Shell, and Fina begin production in 2002 in Port Arthur, Texas with projected capacity of 900million lbs/yr
Process description:	Develop BD distribution system to pipe product directly to customers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Production/process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Anonymous, (1998). Olefins - Asia leads butadiene growth. European Chemical News 69(1797):10.
HERO ID:	5708401
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1997, 1998, and 2002, global butadiene capacity was 8.856 million, 9.257 million, and 10.207 million tons respectively. Global butadiene demand was 7.223 million, 7.567 million, and 8.839 million tons respectively. North American demand was 2.343 million, 2.4 million, and 2.56 million, respectively.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is global, but the report was published in a European journal.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (capacities) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1985). Study indicates OSHA butadiene limit too lax. Chemical & Engineering News 63(4):7-8.
HERO ID:	5708547
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	More than 2.3 billion lb of butadiene were produced in the U.S. in 1984.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are worldwide.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1987). Not to worry about butadiene shortage. Chemical Engineering 94(14):30.
HERO ID:	5708557
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1987, Chem Systems used 100,000 tons of butadiene for co-cracking.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation: Anonymous, (1996). US players perplexed by low butadiene nomination. European Chemical News 66(1730):10.
HERO ID: 5708607
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Inventory of BD in August 1990 was 63,000 tons, which was 7,000 tons more than July of that year.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Anonymous, (1997). Butadiene - Tight markets in US and Europe force up prices. European Chemical News 68(1773):11.
HERO ID:	5708615
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In July 1997, Shell's Deer Park plant included a 130,000 tonne/year butadiene extraction unit.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from a European journal which is likely encompasses OECD countries.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (production data) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1996). US major agrees price dip to cut butadiene imports. European Chemical News 65(1705):10.
HERO ID:	5708618
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996, Chevron owned a 450,000 ton/year ethylene cracker, which produced butadiene as a byproduct. Also, the report says that at this time, butadiene imports from Europe typically average 25,000 tons/month

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are for the U.S. and Europe.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production volume, import averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1979). Canadian petroleum guide to canadian petrochemical plants. Canadian Petroleum 20(4):21.
HERO ID:	5708674
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”Monsanto, La Salle, Quebec: 34,000 tons/year of ABS Monsanto, Sarnia, Ontario: 25,000 tons/year of ABS Petrosar, Sarnia, Ontario: 225,000 tons/year of butadiene Polysar, Sarnia, Ontario: 135,000 tons/year of butadiene Union Carbide, Montreal, Quebec: 7,000 tons/year of butadiene”

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3: Applicability	High	Data are for production of butadiene and synthetic rubber, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Anonymous, (1974). Butadiene faces shift in feedstocks. Chemical & Engineering News 52(37):8.
HERO ID:	5708753
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1974 the U.S. imported an estimated 450 million to 500 million pounds of butadiene. The report predicted that by 1984 in the US, primary dehydrogenation units and heavy liquids crackers each will be producing just over 3 billion pounds of butadiene annually (with a maximum output of 3.7 billion pounds), but demand will exceed this combined production by 350 million to 500 million pounds per year and imports will still be required to fill the gap.
Process description:	"Virtually all of the butadiene produced in Europe and Japan comes from cracking naphtha and heavier feedstocks In the US, 68% of butadiene produced in 1972 was from primary plants and only 32% was coproduct from ethylene units. In 1973 ethylene producers shifted significantly toward lighter feedstocks. Crackers with the flexibility to do so reduced naphtha input and substituted ethane-propane as much as they could."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are mainly for the U.S., but worldwide data are also included.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production volume, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in the predictions given in the report. Variability isn't addressed.

Overall Quality Determination Medium

Study Citation:	Anttinen-Klemetti, T., Vaaranrinta, R., Mutanen, P., Peltonen, K. (2004). Personal exposure to 1,3-butadiene in a petrochemical plant, assessed by use of diffusive samplers. International Archives of Occupational and Environmental Health 77(4):288-292.
HERO ID:	5584146
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996 BD was one of the forty most widely produced chemicals in the USA, with a total production weight of 3.8 billion. The global production in 2001 was estimated to be 18.5 billion lb, with North American production being 5.5 billion lb
Life cycle description:	Petrochemical manufacturing
Process description:	BD is manufactured as a co-product of the steam cracking of hydrocarbon streams to produce ethylene. Typically, butadiene is recovered from the C4 hydrocarbon stream by solvent extraction utilising acetonitrile. The BD is then isolated by extractive distillation from the solvent. After a drying process, BD is stored as a liquid at a temperature of -4C to -5C, which prevents dimerisation, an irreversible reaction that produces vinylcyclohexene. BD is transported to customers usually by railroad or in tankers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling participants multiple times.

Overall Quality Determination High

Study Citation:	Anttinen-Klemetti, T., Vaaranrinta, R., Mutanen, P., Peltonen, K. (2006). Inhalation exposure to 1,3-butadiene and styrene in styrene–butadiene copolymer production. International Journal of Hygiene and Environmental Health 209(2):151-158.
HERO ID:	5675367
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1.7 million tons in the USA, 8.4 million tons globally.
Life cycle description:	Monomer used in polymerization process
Process description:	The manufacturing process of the latex begins with the addition of modifiers into the cooled water followed by the addition of BD and styrene monomers. Polymerization will take place in an exothermic reaction driven by a catalyst. The reaction mixture is stripped and unreacted monomers are distilled and recycled. At the end of the manufacturing process, SB latex is fractionated and transported to the end users by ship, train or truck.
Comments:	The main components in the manufacturing process of SB-latexes are styrene and BD, with styrenecomprising about 40–60% of the monomers. The proportion of BD monomer varies from about 20% to50% depending on the intended use of the latex.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
Metric 3:	Applicability	High	Data are for polymerization for synthetic rubber, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 3 different sites and taking multiples samples per person.

Overall Quality Determination High

Study Citation:	ASRC, (2007). Request for modification of the EA goal applicable to a single process for a single TAC: Flare and plant-wide fugitive emissions.
HERO ID:	11273427
Conditions of Use:	Processing as a reactant: Rubber manufacturing

EXTRACTION

Parameter	**Data**
Process description:	ASRC produces three types of synthetic rubber at its Louisville facility: PBR, SSBR, and PBAN (page 6 of 28)
Throughput:	Request a permit condition to limit max potential amount of 1,3-butadiene to the vent header to no more than 9,500,000 lbs/yr, and min required destruction efficiency for the Flare Thermal Oxidizer to be increased from 99.5% to 99.99% (page 4 of 28)
Number of sites:	1

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The report used site specific data
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	High	Tire Manufacture of rubber
	Metric 4:	Temporal Representativeness	Medium	2007 (16 years ago)
	Metric 5:	Sample Size	N/A	single site and descriptions
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	single site and descriptions
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Single site and descriptions

Overall Quality Determination — High

Study Citation:	ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID:	11273448
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Approximately 3 billion lbs of 1,3-BD produced annually in US as of 1990 (page 16 of 239)ASRC purchases ~300 million lbs of 1,3-BD each year. (page 17 of 239)
Life cycle description:	1,3-butadiene is used as an intermediate in production of polymers, elastomers, and other chemicals. Major use is manufacture of styrene-butadiene rubber and thermoplastic resins (page 16 of 239)ASRC (the facility this report is about) manufactures three products, polybutadiene rubber, styrene butadiene rubber (used in the manufacture of tires), and a small amount of PBAN (used as a fuel binder in solid rocket fuel applications), a liquid synthetic rubber product. 1,3-butadiene is major raw material component in all their production (page 16 of 239). 1,3-butadiene product stewardship guidance manual from 2002 starts on page 164 of 239
Process description:	Process descriptions included for all of the 1,3-BD systems on site (Tank Farm Unloading on page 18, Tank Farm Storage on page 20 with excerpt below, 1,3-Butadiene Purification on page 23 with excerpt below, Polymerization on page 26, Concentration/Blending on page 28, Stripping/Finishing on page 30, and lastly Liquid Polymer Operations on page 30)
Throughput:	of the 300 million lbs of 1,3-BD purchased each year, 98.5% is transformed into products. Of remaining 1.5%, 1.47% is destroyed in flare stack and remaining (0.03% or 100,000lbs is emitted to air). (Page 16-7)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for Import, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID: 11273448
Conditions of Use: Import

EXTRACTION

Parameter	Data
Production, import, or use volume:	Approximately 3 billion lbs of 1,3-BD produced annually in US as of 1990 (page 16 of 239)ASRC purchases ~300 million lbs of 1,3-BD each year. (page 17 of 239)
Life cycle description:	1,3-butadiene is used as an intermediate in production of polymers, elastomers, and other chemicals. Major use is manufacture of styrene-butadiene rubber and thermoplastic resins (page 16 of 239)ASRC (the facility this report is about) manufactures three products, polybutadiene rubber, styrene butadiene rubber (used in the manufacture of tires), and a small amount of PBAN (used as a fuel binder in solid rocket fuel applications), a liquid synthetic rubber product. 1,3-butadiene is major raw material component in all their production (page 16 of 239). 1,3-butadiene product stewardship guidance manual from 2002 starts on page 164 of 239
Process description:	Process descriptions included for all of the 1,3-BD systems on site (Tank Farm Unloading on page 18, Tank Farm Storage on page 20 with excerpt below, 1,3-Butadiene Purification on page 23 with excerpt below, Polymerization on page 26, Concentration/Blending on page 28, Stripping/Finishing on page 30, and lastly Liquid Polymer Operations on page 30)[All of the plant's large 1,3-butadiene storage tanks are located in the Tank Farm for safety reasons, since this is a remote and isolated area with few employees working nearby. These tanks are grouped together according to the moisture content of the 1,3-butadiene stored and also according to the process the 1,3- butadiene will eventually be supplied to. As 1,3-butadiene is shipped to the plant, it is wet with moisture. This moisture must be removed before the 1,3-butadiene can be used to make rubber. Some of the storage tanks hold wet 1,3-butadiene. Others hold dry 1,3-butadiene which has been processed in other areas of the plant to remove moisture. As wet 1,3-butadiene is unloaded from railroad tank cars, it is pumped by pressure to two large round storage tanks called spheres. The spheres are the largest tanks in the plant and hold most of the plant's 1,3-butadiene supply. Butadiene is pumped from the spheres to smaller horizontal day tanks that function as feed tanks or intermediate storage tanks for other processes in the plant. Some of the water present in wet 1,3-butadiene collects in the bottom of the storage tanks and is drained away as a first step in drying the 1,3-butadiene. The system used to drain water from the storage tanks is designed to contain any 1,3-butadiene that may accompany the water so that little or none is emitted to the air.] from page 20 of 239[A butadiene purification system is used to remove traces of water from the fresh 1,3-BD received from the supplier. The 1,3-butadiene is then sent to the purification system where it is "dried" by distillation. The 1,3-butadiene passes through a packed distillation column. The distillation process separates the 1,3-butadiene and water. 1,3-Butadiene and water form an azeotrope, and thus the vaporized mixture exits the top of the distillation column and the "dry" liquid 1,3-butadiene is removed at the bottom of the column. The dried 1,3-butadiene then goes to the "Dry BD" Day Tanks for storage before being used in the polymerization process. The moisture content must be nearly zero in . order to be used in the polymerization process. The 1,3-butadiene/water vapor mixture, which exits the top of the column, is cooled and condensed using a heat exchanger and is returned to the column feed drum. The small amount of water removed is decanted into a closed system, and steam stripped to remove any traces of 1,3-butadiene. The traces of 1,3-butadiene are steamed-stripped from the water vented to the flare stack.Located in the purification area is a system to recover unreacted 1,3-butadiene from the polymerization process, as well as 1,3-butadiene vented from the purification process. This system compresses gases containing toluene and 1 ,3- butadiene. The gas is compressed and then goes through a series of condensers to separate the toluene and 1,3-butadiene. The recovered toluene is sent directly back to the toluene purification system for re-use in the polymerization process. The recovered 1,3-butadiene is not acceptable for reuse in the polymerization process due to impurities. However, this material is recovered and is currently accepted by the 1,3-butadiene supplier for further treatment and eventually becomes usable 1,3-butadiene.] from page 23-4 of 239
Throughput:	of the 300 million lbs of 1,3-BD purchased each year, 98.5% is transformed into products. Of remaining 1.5%, 1.47% is destroyed in flare stack and remaining (0.03% or 100,000lbs is emitted to air). (Page 16-7)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for Import, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old

Continued on next page . . .

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Study Citation: ASRC, (2004). Study of the 1,3-butadiene processes for American Synthetic Rubber Company.
HERO ID: 11273448
Conditions of Use: Import

			EVALUATION	
Domain		Metric	Rating	Comments
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Athaley, A., Saha, B., Ierapetritou, M. (2019). Biomass-based chemical production using techno-economic and life cycle analysis.
HERO ID:	5710041
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Roughly 12 million tons of butadiene are produced worldwide. Page 2.
Life cycle description:	Domestic Manufacturing
Process description:	Butadiene production starts from furfural as the main raw material obtained from p-xylene process. Furfural and pressurized hydrogen at 5 bar (stream 1) is fed to reactor (B-R1) containing catalyst at 250 degrees C. Decarbonylation takes place of furfural to produce furan and syngas (stream 2), and is introduced into a flash drum (B-V1) at −30 degrees C. Syngas is separated which is used for the electricity generation. The liquid stream (stream 3) is fed to another flash drum (B-V2) and then introduced to column (B-C1) to purify furan from water and other by-products (furfuryl alcohol and methylfuran). Furan is then pressurized to 55 bar and is hydrogenated to form tetrahydrofuran (THF) (stream 8) in reactor (B-R2) at 100 degrees C with the help of Pd/C catalyst. Product stream is then introduced to another flash drum (B-V3) to separate the gas from liquid phase. THF is then heated in a heater (B-H1) to 400 degrees C and fed to reactor (B-R3) where decyclization and dehydration reaction takes place at atmospheric pressure. Water is separated in flash drum (B-V4). The gaseous phase (stream 11) as well as liquid phase (stream 12) is then pressurized, mixed with each other in a flash drum (B-V5) and send to a distillation column (B-C2) where butadiene is separated from the unreacted components (stream 16) which is recycled back to increase the overall yield of the reaction. The purity of butadiene is ~99%.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for butadiene production from furfural, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by explaining where further research needs to be done and what the study could improve on. Variability addressed by comparing butadiene production to jet fuel and surfactant production

Overall Quality Determination High

Study Citation:	Au, W. W., Bechtold, W. E., B, W.E., , J. R., Legator, M. S. (1995). Chromosome aberrations and response to gamma-ray challenge in lymphocytes of workers exposed to 1,3-butadiene. Mutation Research 334(2):125-130.
HERO ID:	5663108
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Approximately 3 billion lbs of butadiene is made per year in the USA.
Life cycle description:	Synthetic rubber and resin manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different age groups and races of workers.

Overall Quality Determination High

Study Citation:	Author], [No (2018). Sinopec chooses Topsoe CATOX catalyst for Asia's largest styrene butadiene rubber emissions control project. Focus on Catalysts 2018(12):4.
HERO ID:	5677048
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Throughput:	The emission control facility has a capacity of 240,000 Nm3 /h.
Comments:	Data is for styrene butadiene rubber (SBR).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (throughput) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Author], [No (1998). Butadiene demand set to accelerate. Oil and Gas Journal 96(5):32-32.
HERO ID:	5708411
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996, world butadiene demand was almost 7 million metric tons. The report forecasted that by 2002, demand would rise to over 8.5 million metric tons (increasing at an average rate of 4.2% per year). The report includes a bar graph that breaks down the yearly predicted growth as well as total demand by product. See article text for context of the growth and demand. (Page 1 of 1)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues (from Chemical Market Associates Inc).
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are worldwide.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Becker, D. L. (1974). Development document for effluent limitations guidelines and new source performance standards for the synthetic resins segment of the plastics and synthetic materials manufacturing point source category.
HERO ID:	1159276
Conditions of Use:	Processing (polymers)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	431,000 kkg of ABS produced annually.
Life cycle description:	Polymerization of plastic resins
Throughput:	5,000 to 30,000 gal for each emulsion polymerization batch. 42.4 million gallons of ABS per day for all sites.
Number of sites:	8 sites producing ABS

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Data comes from the EPA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sources are cited at the end of the report but specific data isn't cited within the body.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variability is addressed multiple times throughout the report.

Overall Quality Determination High

Study Citation:	BMI Research, (2016). Netherlands petrochemicals report 2016.
HERO ID:	5584682
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2015, the Netherlands produced 425,000 tons of butadiene. 90,000 tons of this were used for styrene-butadiene monomer, and 200,000 tons were used for acrylonitrile butadiene styrene.
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from the Netherlands, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI Research, (2017). Egypt petrochemicals report Q1 2017.
HERO ID:	5706195
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	By 2020, Egypt predicted to add 210,000 tpa to their butadiene capacity (page 7 and 36 of 70), and another 214,000 tpa butadiene for export (page 37 of 70)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Egypt, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2012). Egypt petrochemicals report Q4 2012.
HERO ID:	1445925
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	A 20,000 tpa butadiene extraction plant was planned to be built starting in 2015.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Egypt, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation: BMI, (2012). India petrochemicals report Q3 2012.
HERO ID: 1446132
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	India's Butadiene capacity in Table on Page 58 from 280,000 tpa in 2009 to 730,000 tpa in 2016.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: BMI, (2012). Germany petrochemicals report Q3 2012.
HERO ID: 1448004
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Production, import, or use volume:	In 2012, Germany had a butadiene capacity of 850,000 tpa, ABS capacity of 80,000 tpa, and SBR capacity of 240,000 tpa.
Throughput:	The BP Cologne Plant produces 250,000 tpa of butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Turkey petrochemicals report Q3 2012.
HERO ID:	1448261
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	A site in Yarimca produced 288,000 tpa of total petrochemicals (including styrene-butadiene-rubber, butadiene, carbon black, and polystyrene) in 1995. In 2001, this site was transferred to another company (page 30 of 55).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Turkey, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: BMI, (2013). Singapore petrochemicals report 2013.
HERO ID: 1448844
Conditions of Use: Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Japan company in Singapore to add 100,000tonnes per annum of solution-polymerized styrene-butadiene rubber (SSBR) capacity from 2013 to 2015 (page 6 of 55). Three collective chemical complexes in Singapore add an additional 155,000 tonnes per annum of butadiene capacity (page 29 and 45 of 55). Shell Eastern Petrochemicals Complex (one of the three companies from precious sentences) has had a capacity of 175,000 tpa since 2010 (page 31 of 55). A Japanese company in Singapore will soon produce 50,000 tpa of SSBR upon first phase of plant completion in 2013, which will increase to a total of 100,000 tpa total upon completion of the second phase in early 2015 (Page 32 and 38 of 55).Singapore total capacity is 215,000 tonnes per annum and this is expected to remain consistent from 2010 to 2017 (page 39 of 55)
Life cycle description:	SSBR is used in the production of high performance tyres that can improve fuel efficiency (page 32 of 55)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Singapore, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). France petrochemicals report Q4 2012.
HERO ID:	1449147
Conditions of Use:	Domestic manufacturing, synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	French company Naphthachimie has capacity to produce 140,000 tonnes per annum of butadiene (Page 25 of 50). France estimated to have 445,000 tonnes per annum butadiene production capacity in 2011 and styrene butadiene rubber capacity of 160,000 tonnes per annum (Page 31 of 50); and the table on page 31-32 shows that capacity will likely stay consistent from 2008 to 2016.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Spain petrochemicals report Q3 2012.
HERO ID:	1449554
Conditions of Use:	Domestic manufacturing, Synthetic rubber manufacturing, Plastic material manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Spain estimated to have a capacity of 165,000 tonnes per annum for acrylonitrile-butadiene-styrene (ABS) copolymer and 60,000 tonne per annum styrene-butadiene rubber (SBR) capacity (Page 34 of 57). Also has 160,000 tonnes per annum butadiene capacity, and capacity for all three products remains and is predicted to remain consistent from 2009 to 2016 (page 36 of 57)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Spain, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing and plastic/synthetic rubber manufacturing, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Qatar petrochemicals report Q4 2012.
HERO ID:	1449631
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Qapco joint venture with Total set to complete in 2018 will add 83,000 tonnes per annum of butadiene capacity in Qatar

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Qatar, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Poland petrochemicals report Q4 2012.
HERO ID:	1450054
Conditions of Use:	Domestic manufacturing, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Poland has 60,000 tonnes per annum butadiene capacity in 2012; 90,000 tonnes per annum SBR capacity... does not show capacity changing from 2009 to 2016

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing and synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Saudi Arabia petrochemicals report Q1 2012.
HERO ID:	4945548
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Projecting capacity of ABS in Saudi Arabia from 2011 to 2016 is 200,000 tpa (page 54 of 70)
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Saudi Arabia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). Spain petrochemicals report Q2 2010.
HERO ID:	5436142
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Global production of butadiene in 2009 was 12,620,000 tons (page 12 of 62). In Spain, annual production of butadiene was 160,000 tons per year from 2008-2014. (Page 39 of 62)
Life cycle description:	Petrochemical manufacturing (6 of 62)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Spain, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation: BMI, (2011). Thailand petrochemicals report Q2 2011.
HERO ID: 5436166
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	In 2011, Thailand produced 295,000 tons of butadiene (page 41 of 64)According to the table on page 42 Thailand's yearly production is 295,000 tons in 2007-2010 but in future from 2011 to 2015 yearly capacity will increase to 430,000 tons.Beginning operations in 2011 are the expansion ofIRPC's acrylonitrile butadiene styrene (ABS) unit from 117,000tpa to 200,000tpa (page 40 of 64)
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Thailand, a non-OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation: BMI, (2011). Belgium petrochemicals report 2011.
HERO ID: 5436168
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Production, import, or use volume:	200,000 tpa of ABS produced in Belgium from 2007-2015
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Belgium, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). Thailand petrochemicals report Q4 2010.
HERO ID:	5451601
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2008 and 2009 and projected in 2010, Thailand produced 295,000 tons of butadiene per year. (page 40 of 67). It was projected that from 2011 to 2014, 430,000 tons per year will be produced. (page 41 of 67)
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Thailand, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). Thailand petrochemicals report Q2 2010. :1-64.
HERO ID:	5451603
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009, Thailand produced 295,000 tons of butadiene (page 40 of 65). World capacity for butadiene in 2009 was 12,620,000 tons (page 15 of 65). Report projects that the capacity per year for 2008 - 2010 is/will be 295,000 tons and from 2011-2014 it will be 430,000 tons (page 41)
Life cycle description:	Petrochemical manufacturing
Process description:	Ethylbenzene (EB), the feedstock for styrene monomer (SM) which produces polystyrene (PS), acylonitrile-butadiene-styrene (ABS) and styrene butadiene rubber (SBR) is manufactured by reacting ethylene with benzene. (Page 15 of 65)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Thailand, a non-OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2012). Belgium petrochemicals report 2012.
HERO ID:	5451626
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	200,000 tpa of ABS produced in Belgium from 2008-2016 (page 26 of 40)
Life cycle description:	Fina Antwerp Olefins, a part of Total's petrochemical plants in Belgium, is a JV with ExxonMobil Chemical. It processes naphtha, butane and propane from the Total refinery into base chemicals: ethylene, propylene, butadiene and benzene. (page 31 of 40)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Belgium, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). Singapore petrochemicals report 2010.
HERO ID:	5582324
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The worldwide butadiene production capacity is estimated at 12,620,000 tons per year. In 2009, Singapore produced 60,000 tons of butadiene. By 2014, annual production is expected to be 215,000 tons.
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Singapore, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	process and production description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2010). Malaysia petrochemicals report 2010.
HERO ID:	5585435
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009, Malaysia produced 100,000 tons of butadiene, but produced 350,000 tons of ABS. The worldwide butadiene production capacity was estimated at 12,620,000 tons per year.
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2010). Japan petrochemicals report 2010.
HERO ID:	5585660
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"In 2008, Japan has a production capacity of 1.12 million tons of butadiene. In 2004, Japan produced 1,040,724 tons of BD. In 2005, 1,039,878 tons of BD. In 2006, 1,002,143 tons of BD. In 2007, 1,023,542 tons of BD. In 2008, 953,023 tons of BD. In 2004, Japan produced 711,465 tons of SBR. In 2005, 727,090 tons os SBR. In 2006, 709,903 tons of SBR. In 2007, 727,299 tons of SBR. In 2008, 705,524 tons of SBR. In 2004, Japan produced 283,090 tons of butadiene rubber. In 2005, 289,066 tons of BR. In 2006, 288,863 tons of BR. In 2007, 293,872 tons of BR. In 2008, 290,397 tons of BR. In 2004, Japan produced 105,103 tons of acrylonitrile butadiene rubber. In 2005, 105,552 tons of ABR. In 2006, 99,411 tons of ABR. In 2007, 109,139 tons of ABR. In 2008, 108,972 tons of ABR."
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2010). France petrochemicals report Q3 2010.
HERO ID:	5586838
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009, France had a production capacity of 445,000 tons per year of butadiene and 160,000 tons per year of styrene-butadiene rubber.
Life cycle description:	Petrochemical manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). United Kingdom petrochemicals report Q2 2010.
HERO ID:	5697839
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	World capacity of BD in 2009: 12,620,000 tons per annum (page 14/60)... BP in the UK has capacity to produce 80,000 tons/yr of BD (page 29/60)... UK had combined BD capacity of 180,000 tons/yr in 2009 (page 41/60); 150,000 tons/yr for SBR; and 60,000 tons/yr for ABS plastic

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from United Kingdom, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). United Kingdom petrochemicals report Q1 2010.
HERO ID:	5697844
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	World capacity of BD in 2009: 12,620,000 tons per annum (page 14 of 57)BP in the UK has capacity to produce 80,000 tons/yr of BD (page 28 of 57)UK had combined BD capacity of 180,000 tons/yr in 2009; 150,000 tons/yr for SBR; and 60,000 tons/yr for ABS plastic. (page 6 and 38 of 57). These capacities are written for 2008 and predicted to remain constant to 2014 (page 39 of 57)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from United Kingdom, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: BMI, (2012). Taiwan petrochemicals report 2012. :1-68.
HERO ID: 5698248
Conditions of Use: Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Taiwan is the leading producer of ABS plastic with output of 1,545,000 tons/yr capacity... Produce 15,600 tons/yr of methylmethacrylate-BD-styrene (MBS) by Formosa... Taiwan had production capacity of 625,000 tons/yr of BD in 2010; six facilities had capacities ranging from 35,000 to 180,000 tons/yr; plans to expand Formosa Corp. operations will increase overall Taiwan capacity to 755,000 tons/yr in 2013 Indonesian company PT Chandra Asri Petrochemical plans to build a 100,000 tons/yr BD extraction facility
Process description:	solution-polymerized SBR
Number of sites:	Six facilities in Taiwan; 3 owned by CPC Corporation and 3 owned by Formosa Petrochemical Corp.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production data is well characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Taiwan petrochemicals report 2011. :1-70.
HERO ID:	5698251
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2010, Taiwan had a production capacity of 625,000 tpa of butadiene. (Page 26 of 71).The capacities of six companies/sites individually are listed on page 29 of 71.The capacities of three future butadiene manufacturing sites as well as hopeful date of completion are listed on page 35 of 71.Butadiene capacity is listed as 615,000 in 2007-2008, 625,000 from 2009 to 2012, and finally 755,000 from 2013-2014, and 955,000 in 2015 (page 54 of 71)ABS capacity is predicted to stay the same at 1,545,000 tpa from 2008 to 2015. (page 54 of 71).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2012). South Korea petrochemicals report 2012.
HERO ID:	5698816
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009 and 2011, South Korea had a production capacity of 1.25 million tpa butadiene, 565,000 tpa SBR, and 1.48 million tpa ABS (page 26 and 39 of 62). These capacities remain the same/are predicted to remain the same from 2008 to 2016, except ABS which expects an increase in capacity to 1.725 million tpa in 2013 (page 41-42 of 62). The butadiene capacity of individual companies can be found on the Company Profiles section of the document on pages 47, 49 and 53.
Number of sites:	7 sites in South Korea (page 28-29 of 62)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from South Korea, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2011). South Korea petrochemicals report 2011.
HERO ID:	5698818
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2007-2010, South Korea had a production capacity of 1.25 million tpa butadiene, and this capacity is predicted to remain constant up until 2015.In 2007-2010 South Korea had a production capacity of 565,000 tpa SBR and this capacity is predicted to remain constant up until 2015. In 2007-2010 South Korea had a production capacity of 1.48 million tpa ABS and this capacity is predicted to remain constant up until 2015. (page 38 of 53)Individual company capacities of butadiene can be found on pages 25-26 and on the table on page 27-28 and in the Company Monitor section of the report on pages 42, 44, and 46.
Number of sites:	7 sites in South Korea (page 27-28 of 53)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from South Korea, a non-OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2010). South Korea petrochemicals report 2010.
HERO ID:	5698820
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009, the world production capacity of butadiene was 12.62 million tpa (page 15 of 61)In 2008-2009, South Korea had a production capacity of 1.25 million tpa butadiene, and this capacity is predicted to remain constant up until 2014.In 2008-2009 South Korea had a production capacity of 565,000 tpa SBR and this capacity is predicted to remain constant up until 2014. In 2007-2009 South Korea had a production capacity of 1.48 million tpa ABS and this capacity is predicted to remain constant up until 2013. (page 41 of 61)Individual company capacities of butadiene can be found on pages 28-29 and on the table on page 30-31 and in the Company Monitor section of the report on pages 46, 48, and 50.
Number of sites:	7 sites in South Korea (page 30-31).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from South Korea, a non-OECD country.
Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	BMI, (2011). Singapore petrochemicals report 2011.
HERO ID:	5698943
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2008-2009, Singapore had a production capacity of 60,000 tpa butadiene. It is predicted than from 2010 to 2015 the production will increase to 215,000 tpa (page 33 of 54) due to a second site being constructed (page 32 of 54).
Number of sites:	1 site in Singapore (page 25 of 54)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Singapore, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2012). Singapore petrochemicals report 2012.
HERO ID:	5698956
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2008 and 2009 Singapore had a production capacity of 60,000 tpa butadiene. From 2010 to 2016 production is predicted to increase to 215,000 tpa. (page 37 of 53)
Number of sites:	1 site in Singapore. (Page 27 of 53)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Singapore, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2010). Russia petrochemicals report Q3 2010.
HERO ID:	5699403
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2009, Russia had a production capacity of 710,000 tpa butadiene, 335,000 tpa SBR, and 20,000 tpa ABS (page 47 of 70). From 2013 onward, ABS capacity was predicted to increase to 90,000 tpa, while butadiene and SBR capacities remain the same. (page 48-49 of 70).The Sibur Holding plant at Tobolsk-Neftekhim produces about 200,000tpa of butadiene, about half of Russia's annual output (page 58 of 70).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Russia, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2011). Malaysia petrochemicals report 2011.
HERO ID:	5703347
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Malaysia BD capacity in 2010 was 100,000 tons/yr... ABS capacity at 350,000 tons/yr
Number of sites:	Single Malaysian facility, Titan Petchem

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production data over the years provided.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Malaysia petrochemicals report 2012.
HERO ID:	5703364
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Malaysia BD capacity in 2011 was 100,000 tons/yr and this has been/is expected to remain constant from 2008 to 2016 (page 27, 41, 43 of 60)ABS capacity was/is predicted to be 350,000 tons/yr from 2008-2016 (page 43 of 60)Indonesia company plans a 100,000 ton/yr extraction facility to start in 2013 (page 23 of 60)
Number of sites:	Single Malaysian facility, Titan Petchem (page 27 of 60)Sumitomo planning solution-polymerized SBR plant to start in 2013 for Singapore (page 22 of 60)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation: BMI, (2011). Iran petrochemicals report Q3 2011.
HERO ID: 5703869
Conditions of Use: Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	The table on page 47 shows estimated/predicted capacities from 2008 to 2015. BD capacity was 125,000 tons/yr in 2008 and grew to 240,000 tons/yr in 2009 and is expected to remain steady from there. ABS capacity is 90,000 tons/yr and expected to grow to 290,000 tons/yr in 2012. SBR capacity is 90,000 tons/yr and is expected to stay at that quantity.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Iran petrochemicals report Q3 2010.
HERO ID:	5703873
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The table on page 43 to 44 shows capacities between 2008 and 2014. BD capacity was 125,000 tons/yr in 2008 then grew to 240,000 tons/yr in 2009. ABS capacity was 90,000 tons/yr in 2008 and remains steady until 2012 when it is expected to grow to 290,000 tons/yr. SBR capacity is steady at 90,000 tons/yr.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Iran petrochemicals report Q2 2011.
HERO ID:	5703877
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Iran BD unit constructed in 2011 with capacity of 245,000 tons/yr... Iran BD capacity in 2009 estimated at 240,000 tons/yr; ABS capcity at 90,000 tons/yr; SBR capacity at 90,000 tons/yr (pg 48/62, also includes forecasts)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Iran petrochemicals report Q4 2011. :1-54.
HERO ID:	5703886
Conditions of Use:	manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Iran BD unit constructed in 2011 with capacity of 245,000 tons/yr... Iran BD capacity in 2009 estimated at 240,000 tons/yr; ABS capcity at 90,000 tons/yr; SBR capacity at 90,000 tons/yr (pg 45/63)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Iran petrochemicals report Q4 2010. :1-62.
HERO ID:	5703889
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Iran BD unit constructed in 2011 with capacity of 245,000 tons/yr... Iran BD capacity in 2009 estimated at 240,000 tons/yr; ABS capcity at 90,000 tons/yr; SBR capacity at 90,000 tons/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). India petrochemicals report Q1 2010.
HERO ID:	5704266
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	World BD capacity of Butadiene in 2009 was 12,620,000 tons/yr (page 16 of 72)Table on pages 54 and 55 shows India petrochemical capacities/predicted capacities from 2008 to 2014. ABS is predicted to grow from 175,000 to 230,000 tons/yr. Butadiene is predicted to grow from 280,000 to 730,000 tons/yr. SBR is predicted to grow from 10,000 to 130,000 tons/yr.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). India petrochemicals report Q2 2011. :1-70.
HERO ID:	5704268
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	India BD capacity in 2010 was 485,000 tons/yr... Plan to establish SBR unit with 120,000 tons/yr capacity to complete in 2012; currently imports up to 130,000 tons/yr... New cracker planned to finish in 2012 with 115,000 tons/yr BD capacity... India ABS capacity in 2009 of 230,000 tons/yr; SBR capacity of 10,000 tons/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). India petrochemicals report Q2 2010.
HERO ID:	5704270
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	India BD capacity in 2009 was 280,000 tons/yr (page 53 and 56 of 75. See page 56 for estimated capacities from 2008 to 2014); world BD capacity was 12,620,000 tons/yr in 2009 (page 16 of 75). New cracker planned to finish in 2012 with 115,000 tons/yr BD capacity (page 39 to 75). India ABS capacity in 2009 of 230,000 tons/yr (see page 56 of 75 for estimated capacities from 2008 to 2014); SBR capacity of 10,000 tons/yr (See page 56 of 75 for estimated capacities from 2008 to 2014)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on current industry conditions and data between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). India petrochemicals report Q1 2011.
HERO ID:	5704271
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	India BD capacity in 2010 was 485,000 tons/yr... Plan to establish SBR unit with 120,000 tons/yr capacity to complete in 2012... New cracker planned to finish in 2012 with 115,000 tons/yr BD capacity... Investing in 40,000 tons/yr polyBD rubber plant and 75,000 tons/yr SBR plant... India ABS capacity in 2009 of 230,000 tons/yr; SBR capacity of 10,000 tons/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on current industry conditions and data that are more than 10 years old, but no more than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). India petrochemicals report Q3 2010.
HERO ID:	5704282
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	India BD capacity in 2009 was 280,000 tons/yr (page 47 of 74, see page 53 of 74 for estimates between 2007 to 2013). Plan to establish SBR unit with 120,000 tons/yr capacity to complete in 2012 (page 33 of 74). New cracker planned to finish in 2012 with 115,000 tons/yr BD capacity (page 34 of 74). India ABS capacity in 2009 of 230,000 tons/yr (see page 53 of 74 for estimates between 2007 to 2013); SBR capacity of 10,000 tons/yr (see page 53 of 74 for estimates between 2007 to 2013).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on current industry conditions and data between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Indonesia petrochemicals report Q3 2010.
HERO ID:	5704339
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	GT Petrochemicals in Indonesia produces 60,000 tons/yr of SBR; no other SBR operations in Indonesia... Indonesia has capacity of 40,000 tons/yr of ABS... Projections for BD plants to be built in coming years

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Indonesia, a non-OECD country.
	Metric 3: Applicability	High	Data are for processing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Indonesia petrochemicals report Q1 2012. :1-55.
HERO ID:	5704340
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Chandra Asri Petrochemical to build 100,000 tons/yr BD extraction facility to be completed in 2013... Sumitomo plans to build solution-polymerized SBR plant... GT Petrochemicals in Indonesia produces 60,000 tons/yr of SBR; no other SBR operations in Indonesia... Indonesia has capacity of 40,000 tons/yr of ABS

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Indonesia, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Indonesia petrochemicals report Q1 2010. :1-58.
HERO ID:	5704341
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	GT Petrochemicals in Indonesia produces 60,000 tons/yr of SBR; no other SBR operations in Indonesia... Indonesia has capacity of 40,000 tons/yr of ABS... World BD capacity in 2009 was 12,620,000 tons/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Indonesia, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Indonesia petrochemicals report Q2 2012.
HERO ID:	5704342
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Honam Petrochemical plans to complete plant in 2016 with BD capacity of 140,000 tons/yr (page 33 and 42 of 56)... Chandra Asri Petrochemical to build 100,000 tons/yr BD extraction facility to be completed in 2013 (page 26, 33, and 42 of 56)... Sumitomo plans to build solution-polymerized SBR plant (page 26 of 56)... GT Petrochemicals in Indonesia produces 60,000 tons/yr of SBR (page 29 and 40 of 56, see page 44 for the yearly outlook from 2008 to 2016); no other SBR operations in Indonesia... Indonesia has capacity of 40,000 tons/yr of ABS (page 40 of 56, see page 43 for the yearly outlook from 2008 to 2016)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Indonesia, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on industry conditions between 10 and 20 years old
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination — Medium

Study Citation:	BMI, (2011). India petrochemicals report Q3 2011.
HERO ID:	5704343
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The table on page 53-54 shows the estimated or predicted capacities for each year between 2008 and 2015. For ABS the capacities grew from 175,000 tpa to 230,000 tpa. For butadiene the capacities grew from 280,000 tpa to 730,000 tpa. For SBR the capacities grew from 10,000 tpa to 130,000 tpa.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Indonesia petrochemicals report Q2 2010.
HERO ID:	5704344
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In In 2010, Indonesia had a production capacity of 60,000 tpa SBR and 40,000 tpa ABS.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Indonesia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	BMI, (2011). India petrochemicals report Q4 2011. :1-72.
HERO ID:	5704350
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The table on page 53-54 shows estimated or predicted production capacities for each year from 2008 to 2015. The ABS capacity grew from 175,000 tpa to 230,000 tpa. Butadiene capacity grew from 280,000 tpa to 730,000 tpa. SBR capacity grew from 10,000 tpa to 130,000 tpa.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). India petrochemicals report Q4 2010.
HERO ID:	5704352
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	See the table on page 51-52 of 73 for past and predicted production capacities between 2007 and 2014 of butadiene, ABS, and SBR as expected in 2010. For ABS the capacities grew from 175,000 tpa to 230,000 tpa within the timespan. For butadiene the capacities grew 280,000 tpa to 730,000 tpa. For SBR the capacities grew from 10,000 tpa to 130,000 tpa.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2014). Hungary petrochemicals report Q1 2014. :1-89.
HERO ID:	5704788
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	MOL is investing in a new BD production plant of 130,000 tons/yr scheduled for completion in 2015

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Hungary, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Production information.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2013). Hungary petrochemicals report Q3 2013. :1-69.
HERO ID:	5704793
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	forms the basis for tyre production, and synthetic rubberproduction (page 14 of 70)
Number of sites:	Hungarian petrochemicals producer MOL is investing in a new BD production plant scheduled for completion in 2015 (page 27 and 32). There is no mention of how many other butadiene sites there are in the country.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Hungary, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2014). Hungary petrochemicals report Q2 2014.
HERO ID:	5704796
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Hungarian petrochemicals producer MOL is investing in a new BD production plant of 130,000 tons/yr scheduled for completion in 2015 (page 15, 34, and 41 of 96).
Life cycle description:	Growth in butadiene output will help secure feedstock supplies for synthetic rubber used in the country's growing automotive industry. (page 19 of 96)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Hungary, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Germany petrochemicals report Q4 2010. :1-55.
HERO ID:	5705137
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BP Koln manufactures 250,000 tons/yr of BD (page 27 of 56).Germany has 850,000 tons/yr BD capacity, 240,000 tons/yr of SBR, and 80,000 tons/yr of ABS plastic as of 2009 and predicts this to remain constant for all three through 2014 at least (in table on page 34 of 56, in text on page 36 to 37 of 56).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on industry conditions between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Germany petrochemicals report Q1 2011.
HERO ID:	5705138
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BP Koln manufactures 250,000 tons/yr of BD (page 27 of 51)Germany has 850,000 tons/yr BD capacity, 240,000 tons/yr of SBR, and 80,000 tons/yr of ABS plastic as of 2009 and predicts these three capacities will remain constant through 2015 (table on page 34 of 51 and in text on page 36-37 of 51).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Germany petrochemicals report Q3 2011.
HERO ID:	5705151
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BP Koln manufactures 250,000 tons/yr of BD (Page 28 of 52)Lanxess expansion of hydrogenated nitrile-BD rubber capacity announced for 2012 (page 30 of 52)Styron plans to expand existing solution styrene-BD rubber production by 50,000 tons/yr with start in 2012 (page 31 of 52)Germany has 850,000 tons/yr BD capacity, 240,000 tons/yr of SBR, and 80,000 tons/yr of ABS plastic as of 2009 and these capacities are predicted to remain constant through at least 2015. (table on page 34 of 52, within the text on page 36 of 52)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). France petrochemicals report Q1 2010. :1-49.
HERO ID:	5705312
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	France BD capacity in 2009 was 445,000 tons/yr and SBR capacity was 160,000 tons/yr. These values were/are predicted to be consistent from 2008 to 2014. (page 32 of 50)World BD capacity in 2009 was 12,620,000 tons/yr (page 13 of 60)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on industry conditions between 10 and 20 years old
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). France petrochemicals report Q2 2010.
HERO ID:	5705333
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	World BD capacity in 2009 was 12,620,000 tons/yr (page 13 of 51)France BD capacity in 2009 was 445,000 tons/yr and SBR capacity was 160,000 tons/yr. These values remained/are predicted to remain the same from 2008 to 2014. (Page 33 of 51)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is between 10 and 20 years old
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation: BMI, (2010). China petrochemicals report Q3 2010.
HERO ID: 5708213
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	In 2010, China's production capacity was 3.495 billion tpa of ABS. By 2013 and through 2014, the production capacity was expected to be 4.735 billion tpa ABS. Predicted values grew between 2008 and 2014, see the table on page 63 of 81 for all values.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2014). Belgium petrochemicals report 2014.
HERO ID:	5708989
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Evonik increase in BD capacity by 100,000 tons/yr at Antwerp plant to start in 2015... Belgium ABS copolymer production in 2012 at 200,000 tons/yr... West European BD output at 966,000 tonnes in 2013

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Belgium, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2010). Australia petrochemicals report 2010.
HERO ID:	5708996
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	World BD capacity in 2009 was 12,620,000 tons/yr... 23,000 tons/yr BD facility in Australia operated by Qenos

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Germany petrochemicals report Q2 2012. BMI's Industry Survey & Forecasts Series :1-54.
HERO ID:	5728905
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2012, Germany had a butadiene capacity of 850,000 tpa, ABS capacity of 80,000 tpa, and SBR capacity of 240,000 tpa.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Production information.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Medium

Study Citation:	BMI, (2011). Iran petrochemicals report Q1 2011. :1-61.
HERO ID:	5741683
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BD plant with 245,000 tonnes/yr capacity commissioned in 2010 by NPC and operated by Jam Petrochemical (page 33 of 62) ... Iran 2009 BD capacity at 240,000 tonnes/yr (page 44 of 62); ABS capacity 290,000 tonnes/yr; SBR capacity 90,000 tonnes/yr (page 49 of 62)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on current industry conditions more than 10 but less than 20 years old
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Iran petrochemicals report Q1 2012. :1-57.
HERO ID:	5741695
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BD plant with 245,000 tonnes/yr capacity commissioned in 2010 by NPC and operated by Jam Petrochemical... Iran 2012 BD capacity at 240,000 tonnes/yr; ABS capacity 290,000 (increase from 2011) tonnes/yr; SBR capacity 90,000 tonnes/yr

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2012). Germany petrochemicals report Q1 2012. BMI's Industry Survey & Forecasts Series :1-50.
HERO ID:	5741929
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BP Koln manufactures 250,000 tons/yr of BD... Lanxess expansion of hydrogenated nitrile-BD rubber capacity announced for 2012... Evonik to build polyBD plant for completion in 2012.... Germany has 850,000 tons/yr BD capacity as of 2009; 240,000 tons/yr of SBR; 80,000 tons/yr of ABS plastic

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	BMI, (2011). Germany petrochemicals report Q2 2011.
HERO ID:	5870253
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Styron constucting 50,000 tonnes/yr production line of solution SBR due to start in 2012... BP Koln manufactures 250,000 tons/yr of BD... Germany has 850,000 tons/yr BD capacity as of 2009; 240,000 tons/yr of SBR; 80,000 tons/yr of ABS plastic

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Bo, C., Zhang, S.,hi, Lin, J., Bo, C., Wang, Z., IEEE (2006). Design & application of the automatic load control system of butadiene product equipment.
HERO ID:	5641153
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	The solvent DMF is used to distil high purity of butadiene-1,3 from raw material C4. The technology uses two section of extracting distillation and two section of normal distillation, which includes 9 distillation columns, several circumfluence jars, condensers, reboilers and compressors.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by using different parameters or loop structures based on process input, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Borg-Warner, (2006). Resins (acrylonitrile-butadiene-styrene) (ABS).
HERO ID:	10187099
Conditions of Use:	Manufacturing/processing

EXTRACTION

Parameter	**Data**
Process description:	In most ABS polymerization approaches, a rubber substrate is manufactured in an initial stage, with the styrene/acrylonitrile copolymer matrix being generated in one or more subsequent stages. An example of one approach is shown in block diagram format in Fig. 1.Step 1Polybutadiene rubber is formulated by feeding butadiene, water,an emulsifier, and catalyst into a glass-lined reactor. This is anexothermic reaction. About 80% conversion is achieved in a periodof about 50 hours. The residual butadiene monomer is recovered by steamstripping and recycled.Step 2Polybutadiene rubber is further polymerized, but in the presence ofstyrene and acrylonitrile monomers. This is done in low-pressure reactors under a nitrogen atmosphere. In this operation, the monomers are grafted onto the rubber backbone through the residual desaturation remaining from the first step.Step 3In a separate step, styrene-acrylonitrile (SAN) resin [CAS: 9003-54-7] is prepared by emulsion, suspension, or mass polymerizationby free-radical techniques. The operation is carried out in stainless steel reactors operated at about 75°C (167,°F) and 5 psig for about 7 hours. The final chemical operation is the blending of the ABS graft phase with the SAN resin, plus adding various antioxidants, lubricants, stabilizers, and pigments. Final operations involve preparation of a slurry of fine resin particles (via chemical flocculation), filtering, and drying in a standard fluid-bed dryer at 121-132,°C (250-270,°F)inlet air temperature.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Van Nostrand's Scientific Encyclopedia
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Borio, D. O., Schbib, N. S., Gatica, J. E. (1999). Effect of catalyst deactivation on the dynamics of cyclic reactive processes. Studies in surface science and catalysis 122:117-124.
HERO ID:	5589803
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	"The catalytic dehydrogenation of 1-butene into 1-3-butadiene is commonly carried out under adiabatic conditions, at high temperatures, and low reactants partial pressures. The operation is cyclic, with the feed being periodically switched between beds. For continuous effluent flow and concentration, at least three reactors in parallel must be used. The process is started-up with the butene being fed to the first reactor. A fast catalyst deactivation by coke deposition occurs. Thus, after a short operation time, the feed is switched to a second catalytic bed. The first bed is then purged with steam, and the coke deposited on the catalyst is burned off by combustion in air or mixtures with low oxygen concentration. When the regeneration has been completed, the air stream is shut off and a fuel gas mixture is admitted to burn off the residual oxygen and pre-treat the catalyst under reducing conditions. After a purge stage, restarting the dehydrogenation stage completes the cycle."
Throughput:	Typical industrial operation conditions require 15-20 minutes cycles .

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from both the U.S., and Argentina, a non-OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by testing different catalyst cycles and temperatures, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Burgess, W. A. (1991). Potential exposures in the manufacturing industry—Their recognition and control. :595-674.
HERO ID:	1267867
Conditions of Use:	Processing (synthetic rubber)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	More than 3 million metric tons of natural and synthetic rubber are used annually . Half of this is SBR, and half of this SBR is used to make tires.
Process description:	A schematic of the production of tire rubber is shown in Figure 28. During compounding, the rubber is received at the workstation and cut into pieces with a guillotine. The additives are weighed out and added to the rubber. The mixture is heated and mixed, then used as a masterbatch for all applications. After molding into the desired products, all rubbers must be cured with heat.
Number of sites:	1,500 plants in the U.S.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability in types rubber production processes is discussed. Uncertainty isn't addressed.

Overall Quality Determination High

Study Citation:	CEPE, (2020). SpERC fact sheet: Industrial application of coatings by spraying.
HERO ID:	10442901
Conditions of Use:	Paints and coatings

EXTRACTION

Parameter	**Data**
Throughput:	Typical maximum daily usage, based on sector knowledge,1000 kg product/day at any one locationPigment/extender/filler - 100 kg/dayBinder - 100 kg/dayOrganic solvent/coalescent - 450 kg/dayAdditives - 5 kg/day

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but data is general and not chemical specific.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including throughput for different substance functions but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	CEPE, (2020). SpERC fact sheet: Professional application of coatings and inks by spraying.
HERO ID:	10442902
Conditions of Use:	Application of coatings and inks by spraying

EXTRACTION

Parameter	**Data**
Throughput:	Typical maximum daily usage, for any one substance, based on sector knowledge 100 kg product/day at any one location.Pigment/extender/filler: 10 kg/dayBinder: 10 kg/dayWater: 35 kg/dayOrganic solvent/coalescent: 45 kg/dayAdditives: 0.5 kg/day

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Data is from CEPE SpERC 8.3. The report uses high quality data and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	No distribution of samples provided for throughput.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Chauvel, A., Delmon, B., Hölderich, W. F. (1994). New catalytic processes developed in Europe during the 1980s. Applied Catalysis A: General 115(2):173-217.
HERO ID:	5640288
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Process description:	Butadiene from steam cracking and CO used as reactant to form adipic acid: reacted with CO and pyridine at 130 Celsius and 600 bar to form dimethyl adipate followed by hydrolysis at 170 Celsius and 150 bar to get adipic acid (Table-6, pg.16/45)Butadiene forms as side product/impurity in production of 1-butene from ethylene; reacts immediately upon formation to create hexadienes. (pg. 29/45)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Germany, France, and Belgium which are OECD countries.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Cornell, P. W. (1989). Butadiene for synthetic rubber - A wartime challenge. Chemical Engineering Communications 82:1-19.
HERO ID:	5640331
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Port Neches alone, with a plant rated at 100,000 tonsper year could produce enough butadiene to provide synthetic rubber equal to 20% of the previous year's consumption of natural rubber or about one seventh of that projected for wartime needs.
Process description:	A feed preparation unit would recover normal butylenes from the feedstock supplied by pipeline from the five participating refineries. This unit would return to the refineries isobutylene, primarily as dimer, as well as separated streams of isobutane, normal butane and pentanes and heavier. Each would be returned in the quantities in which they were delivered to the butadiene plant. A butylene dehydrogenation unit would produce 1,3 butadiene ready for purification. A butadiene recovery and purification plant is next. The butadiene so produced would be separated from the unconverted butylenes and inhibited. The unconverted butylenes would be recycled to the process and the product delivered to the adjacent copolymer plants by pipeline or to other plants in the Government program by tank car. Additionally, since the rubber polymerization process concentrates the impurities, the Copolymer Plants were required to develop a recycle butadiene stream to be returned to the butadiene producer for repurification. Next, a plant for the purification of the extractive distillation agent used in the separation of the normal olefins from the paraffins and in the separation of the butadiene from the normal butylenes. Another part of this plant would also purify the absorption oil used in the recovery of the butylene-butadiene mixture from the dehydrogenation plant effluent.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process/production description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Cornitius, T. (1996). US could face butadiene shortage. Chemical Week 158(25):37.
HERO ID:	5640683
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	North American finished butadiene capacity is about 4.1 billion lbs/yr. In 1995, production reached 3.2 billion lbs/yr. North American imports of finished butadiene were almost 1 billion lbs in 1995 and crude butadiene imports were 200 million lbs. Global consumption was 13.4 billion lbs in 1995 and was projected to reach 16.5 billion lbs by 2000
Life cycle description:	Domestic Manufacturing & Imports

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and imports of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Production and life cycle description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Cornitius, T. (1997). Olefins - Asian expansions swamp butadiene growth. Chemical Week 159(17):52.
HERO ID:	5640693
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	India increased butadiene capacity to 250,000 metric tons/year in 2001. From the graph, total Asian butadiene production in 2001 is around 3.8 million metric tons/year, and consumption in 2001 is around 2.9 million metric tons/year.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from all of Asia, most of which is not in the OECD.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Cornitius, T. (1997). Olefins - TPC plans butadiene expansion; Global demand accelerates. Chemical Week 159(5):14-14.
HERO ID:	5640698
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2001, Texas Petrochemicals Corp's total production of butadiene was 1.4 billion lbs/year. Also, U.S. butadiene demand was 4.5 billion lbs in 1995.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Cornitius, T. (1995). Butadiene - Debate over top US producer. Chemical Week 156(24):36-36.
HERO ID:	5696066
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Texas Petrochemicals has 840million lb/yr nameplate capacity for butadiene extraction; Huntsman nameplate capacity raised to 770million lbs/yr in 1996
Number of sites:	Texas Petrochemicals and Huntsman mentioned

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Cote, I. L., Bayard, S. P. (1990). Cancer risk assessment of 1,3-butadiene. Environmental Health Perspectives 86(0):149-153.
HERO ID:	3262636
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The United States production of 1,3-butadiene in 1987 was approximately 3 billion pounds annually (page 3 of 5)
Process description:	produced as co-product of ethylene, by oxidative dehydrogenations of n-butenes, or by dehydrogenation of n-butanes (page 1 of 5).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data and information that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Cowfer, J. A., Gorensek, M. B. (2006). Vinyl chloride. :1-31.
HERO ID:	6301240
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The vinylmagnesium compounds can be coupled with cuprous chloride, CuCl, at -60 degrees C to give 1,3-butadiene. (page 2 of 31)By-products from EDC pyrolysis typically include 1,3-butadiene. Most of these impurities remain with the unconverted EDC, and are subsequently removed in EDC purification as light and heavy ends. The compounds that have boiling points near that of vinyl chloride, ie, methyl chloride and 1,3-butadiene, will codistill with the vinyl chloride product. Chlorine or carbon tetrachloride addition to the pyrolysis reactor feed has been used to suppress methyl chloride formation, whereas 1,3-butadiene, which interferes with PVC polymerization, can be removed by treatment with chlorine or HCl, or by selective hydrogenation. (page 13 of 31)
Chemical concentration:	Typical impurity levels of 1,3-butadiene in monomer grade vinyl chloride are a maximum level of 8–12 ppm. (page 29 of 31)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	from the Kirk-Othmer Encyclopedia of Chemical Technology
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	published by from John Wiley & Sons, an American company
	Metric 3: Applicability	Medium	The manufacture of 1,3-butadiene is only very briefly touched on, with most focus being on butadiene as an impurity, but still in a chemical manufacturer setting.
	Metric 4: Temporal Representativeness	Low	from 2000
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	CPSC, (2015). Exposure assessment: Potential for the presence of phthalates in selected plastics.
HERO ID:	5155510
Conditions of Use:	Processing in plastic material manufacturing, Recycling

EXTRACTION

Parameter	**Data**
Process description:	poly(butadiene) may be copolmerized with styrene in order to form High Impact Polystyrene (HIPS)... used to form acrylonitrile-butadiene-styrene (ABS); poly(butadiene) grafted with acrylonitrile-styrene groups is melt compounded with styrene-acrylonitrile, additives such as stabilizers, lubricants, and colorants are added during this stage... ABS manufactured by graft-type or blended-type processes; graft-type is either emulsion polymerization, mass polymerization, or mass suspension; ABS resins primarily made through emulsion polymerization... Poly(butadiene) latex prepared by free-radical emulsion polymerization; chemical or latex agglomeration of latex particles... ABS is mechanically recycled
Chemical concentration:	ABS typically prepared with compositional ratio of butadiene at 12 to 25% of monomer

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for plastic material manufacturing and recycling, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Crowl, D. A. (1995). Introduction. Environmental Science and Pollution Control Series 15:1-19.
HERO ID:	664303
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1992 production: 3.18 billion pounds
Comments:	See Table 4. page 5

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process/production data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Davis, G. D., Makin, E. C., Jr, Middlebrooks, C. H. (1970). Process evaluation of improved solvents for butadiene recovery. Advances in Chemistry 97:215-227.
HERO ID:	5715775
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	"The pure monomer is recovered from crude C4 streams by liquid-liquid extraction or extractive distillation with a selective solvent. The C4 feed is separated into two product streams in the extractive distillation column—a butane-butene stream which goes overhead from the column and a butadiene concentrate which is carried out the bottom of the column dissolved in the solvent. The butadiene concentrate contains cis- and irans-2-butene, and after being stripped from the solvent, it is subjected to normal distillation. Butadiene is distilled overhead at 99+% purity"
Throughput:	Butadiene was produced at 10,037-19,500 lb/hr depending on the solvent used.
Chemical concentration:	All experimental runs were made on a C4 feed of known composition. The feed composition ran from 37 to 40 wt % 1,3-butadiene.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene separation from hydrocarbons, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by stating the precision and accuracy of the measurements. Variability addressed by using 4 different solvents in the separation of butadiene.

Overall Quality Determination Medium

Study Citation:	Dement, J. M., Hensley, L., Gitelman, A. (1997). Carcinogenicity of gasoline: A review of epidemiological evidence. Annals of the New York Academy of Sciences, vol. 837 837:53-76.
HERO ID:	85507
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1989, approximately 140 billion gallons of gasoline were used (page 1 of 24). Olefins make up between 0-30% of gasoline by volume (2 of 24)
Process description:	Gasoline is produced by a series of refining processes beginning with the distillation of crude petroleum into fractions of different boiling ranges. Typical refinery fractions are light naphtha, heavy naphtha, kerosene, light gas oil, heavy gas oil, and reduced crude, with unleaded gasoline being largely blended from the naphtha fractions. Gasoline, a middle distillate of petroleum, contains more than 150 hydrocarbons with a boiling range of approximately 40 to 180 degrees centigrade. Catalytic cracking, coking, alkylation, and catalytic reforming are used to modify gasoline to required specifications (1 of 24)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	IARC data was used, which comes from an accredited national research laboratory.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data from USA
Metric 3:	Applicability	High	Report is within scope
Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Report clearly documents sources of data, and explains how it was obtained.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Potential bias, confounding, and variation causes are explained. Also, future work is recommended.

Overall Quality Determination High

Study Citation:	EC, (2002). Summary risk assessment report for 1,3-butadiene.
HERO ID:	7348613
Conditions of Use:	Monomer and polymer production

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The quantity of 1,3-butadiene produced and used in the EU is estimated as 1,892,000 tonnes per year.
Life cycle description:	1,3-butadiene is used as a monomer and co-monomer in the production of a range of polymeric products. It is used in the manufacture of synthetic rubbers such as styrene-butadiene rubber (SBR) and polybutadiene rubber, of thermoplastic resins such as acrylonitrile-butadienestyrene (ABS), and of styrene-butadiene latex. It is also used in the manufacture of other chemicals used as intermediates, for example hexamethylenediamine which is used in nylon production.
Chemical concentration:	The concentration of 1,3-butadiene in end-use products is low. Therefore, airborne exposure during the handling and use of such products will be minimal, with the majority of exposures below the limit of detection.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data that are from frequently used sources (EU).
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Medium	Report is 20 years old, but data is expected to be relevant.
Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The total (European) production capacity reported is between 1,202,000 and 4,960,000 tonnes/year. Western European production of 1,3-butadiene has been reported elsewhere and was thought to be 1,778,000 tonnes/year in 1991, 1,853,000 tonnes/year in 1992, and 1,752,000 tonnes/year in 1993. More recent data shows that Western European 1,3-butadiene production was 1,742,000 tonnes/year in 1993 and 1,892,000 tonnes in 1994. (page 25 of 204)
Life cycle description:	1,3-Butadiene is used in closed systems with a non-dispersive pattern of use. It is used as an intermediate for polymerisation and copolymerisation.
Process description:	The most widely used method of 1,3-butadiene production is recovery from a mixed by-product C4-hydrocarbon stream during the production of ethylene. The process can use a variety of hydrocarbon feedstocks, the heavier fractions generally giving a higher 1,3-butadiene yield/amount of ethylene produced.In the production process, the hydrocarbon feedstock is pre-heated and cracked in the presence of steam. The product then passes to a pyrolysis/quench system and from there the raw gas is compressed and CO2 and H2S are removed. The product then passes through a series of fractionators and a mixed C4-hydrocarbon stream is obtained. 1,3-Butadiene cannot normally be obtained from the mixed C4-stream by simple distillation and so an extractive distillation process is often used. In this process, a polar solvent (e.g. furfural, acetonitrile, cuprous ammonium acetate, dimethylformamide, a furfural-methoxypropionitrile system, dimethylacetamide or Nmethylpyrrolidone) is added in order to change the relative volatilities of the components of the mixture.1,3-Butadiene can also be made directly, by dehydrogenation or oxidative dehydrogenation of a C4 fraction from the crude distillation, using chromium-alumina as a catalyst.In Europe, it is thought that all production of 1,3-butadiene is by the steam cracking of hydrocarbons. (page 25 of 204)
Number of sites:	22 EU producers of 1,3-butadiene (page 25 of 204)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	From the EU
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	from 2002
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Continued on next page . . .

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Study Citation:	ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID:	5155560
Conditions of Use:	Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation: ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID: 5155560
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Production, import, or use volume:	See table 2.5 on page 28 for consumption of synthetic rubbers.
Life cycle description:	The major uses of 1,3-butadiene world-wide are in the manufacture of synthetic rubber such as styrene-butadiene rubber (SBR) and polybutadiene rubber, thermoplastic resins such as acrylonitrile-butadiene-styrene (ABS), and styrene-butadiene latex. It is also used as a chemical intermediate in the production of neoprene for automotive and industrial rubber goods, in the production of methylmethacrylate-butadiene-styrene (MBS) polymer, which is used as a PVC reinforcing agent, and for producing adiponitrile, a nylon precursor. The most widespread use of 1,3-butadiene is in the manufacture of SBR and styrene-butadiene latex, the former being used in the production of synthetic rubber products and the latter in paints, carpet backing and paper coating. The other major uses of 1,3-butadiene are in the manufacture of polybutadiene rubber for use in tyres, tyre products and car body sealants and ABS for use in the production of oil resistant gaskets, business equipment and automotive parts.
Process description:	see page 29-33 for detailed descriptions of 1,3-butadiene's part in the manufacturing of various rubbers and plastics.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	From the EU
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation: ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID: 5155560
Conditions of Use: Import

EXTRACTION

Parameter	Data
Number of sites:	two companies import 1,3-butadiene into the EU. The amounts imported are thought to be small compared with the quantities produced in the EU, thus considered negligible (page 25 of 204)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	From the EU
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 2002
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation: ECB, (2002). European Union risk assessment report: 1,3-butadiene.
HERO ID: 5155560
Conditions of Use: Distribution in Commerce

EXTRACTION

Parameter	Data
Life cycle description:	In the UK, transportation of 1,3-butadiene is mainly by road tanker or ship. In mainland Europe it is usually carried by pipeline. The EU reflects this world-wide use of 1,3-butadiene. Within the EU there are approximately 18 major companies using 1,3-butadiene as feedstock in the production of SBR, styrene-butadiene latex, ABS and other related products such as polybutadiene. These products are sold to a large number of end-user companies (page 26 of 204). See page 26 and 27 of 204 for tables showing the amount of butadiene used in a variety of product, mostly rubber.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	From the EU
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	from 2002
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	ENF, (2024). Plastic recycling plants in the United States.
HERO ID:	11360395
Conditions of Use:	Recycling plastics

EXTRACTION

Parameter	**Data**
Number of sites:	59 recycling sites per page 1

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Data sources are not listed. From the EFN Recycling Directory
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US data.
	Metric 3:	Applicability	High	Recycling is in scope.
	Metric 4:	Temporal Representativeness	High	Data are from 2024.
	Metric 5:	Sample Size	Low	Single static value.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Source does not describe how the number of sites was identified.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Environmental Defense Fund, (2021). Comment submitted by Environmental Defense Fund (EDF) regarding information on potentially exposed or susceptible subpopulations associated with 1,3-butadiene, formaldehyde, and ortho-phthalates undergoing TSCA risk evaluations.
HERO ID:	10385454
Conditions of Use:	Unknown COUs: COUs associated with sites that are required to report to TRI

EXTRACTION

Parameter	**Data**
Life cycle description:	Pg. 2/21: "1,3-Butadiene is an industrial chemical used primarily in the production of synthetic rubber, including styrene-butadiene rubber (ATSDR, 2012). 1,3-Butadiene is also used to make plastics such as acrylonitrile-butadiene-styrene resin plastics and is present in petroleum-based fuels (ATSDR, 2012). Humans are exposed to 1,3-butadiene mainly through inhalation. Environmental sources of 1,3-butadiene include industrial emissions, automobile exhaust, cooking emissions, and burning of wood, plastics, and rubber. 1,3-Butadiene is also a constituent of cigarette smoke (Nieto et al., 2021; ATSDR, 2012)."
Number of sites:	Pg. 3/21, Table 1: According to 1,3-butadiene 2015 - 2020 TRI emissions data, the number of facilities emitting 1,3-butadiene is 226. These facilities are not identified in the data source.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	TRI and ATSDR data
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The COUs are unknown, but the TRI data likely pertains to sites that are associated with COUs
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Sources clearly documented
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.
HERO ID:	7349020
Conditions of Use:	Processing Incorporation into an article

EXTRACTION

Parameter	**Data**
Life cycle description:	There are 3 types of plastics: thermoplastics, thermosets and foamed plastics. There are described in Section 2 (pg. 9/72 - 11/72)
Process description:	The major manufacturing techniques of solid and foamed plastics are extrusion, molding, and lamination. These are described in pages 11/72 - 16/72.Finishing operations as part of plastics manufacturing is briefly discussed on page 16/72.Major plastics additives are discussed on page 16/72 - 17/72.
Comments:	This data source contains a discussion of methods for estimating emissions but does not contain any emission factor data per se. Furthermore, the discussed methods do not appear to be relevant to the case of 1,3-butadiene which conceivably would be present in plastics as a monomer residual.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	EPA document
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	Data pertain to a COU
Metric 4:	Temporal Representativeness	Low	Data older than 20 years
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Sources of information are not completely stated.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Ericsson, R. L. (1972). Butadiene - Petrochemical orphan. Chemical Engineering Progress 68(10):80-83.
HERO ID:	5694113
Conditions of Use:	Domestic manufacturing, Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Provides production output in pounds for each year 1943-1971; production and capacities for US-based plants; comments on import amounts into USA for a few years
Process description:	production as ”primary” versus co-product from ethylene cracking
Comments:	Table 1-5 for specific data points over the years.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production data well characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal changes, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Fajen, J. M., Lunsford, R. A., Roberts, D. R. (1993). Industrial exposure to 1,3-butadiene in monomer, polymer and end-user industries. IARC Scientific Publication No. 127 127:3-13.
HERO ID:	5663322
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"2.5 billion lbs per year. Styrene -butadiene rubber and latex and polybutadiene rubber production are the two largest uses of butadiene in the USA, accounting for approximately 1.6 billion pounds primarily for use in the tyre industry; polychloroprene (neoprene) rubber production ranks third, with 200 million pounds."
Life cycle description:	Monomer used in polymerization process
Number of sites:	11 monomer, 17 polymer, and two end-user plants.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for butadiene monomer and polymer production, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production numbers are well characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different plants and sampling the same workers multiple times.

Overall Quality Determination High

Study Citation:	Fishbein, L. (1979). Potential halogenated industrial carcinogenic and mutagenic chemicals. I. Halogenated unsaturated hydrocarbons. Science of the Total Environment 11(2):111-161.
HERO ID:	1441315
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"In 1976, two U.S. companies produced an estimated 164 million kg of chloroprene. The total world production of chloroprene in 1977 is estimated to have been 300 million kg. 30% of these masses were from butadiene."
Life cycle description:	Monomer used in polymerization processes
Process description:	"Chloroprene is made by the chlorination of butadiene to a mixture of dichlorobutenes, from which 3,4-dichloro-l-butene is isolated and then is subjected to dehydrochlorination. In this procedure, butadiene is first reacted with chlorine to yield a mixture of dichlorobutene isomers from which the 3,4-diichlorobutene-1 isomer is isolated and then reacted with caustic to form chloroprene. 1,4-Dichlorobutene-2, the other isomer, can either be isomerized to 3,4-dichlorobutene-1 for additional chloroprene production or it can be utilized for in the production of adiponitrile."
Chemical concentration:	A typical specification for chloroprene made from butadiene is as follows: chloroprene, 98.5% min, 1-chlorobutadiene, 1.0% max, acetaldehydes, 0.2% max, and 3,4-dichlorobutene-1, 0.01% max, dimers, 0.01% max., peroxides, 1 ppm max.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the Netherlands, an OECD country.
	Metric 3:	Applicability	High	Data are for polymerization using butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Fishbein, L. (1992). Exposure from occupational versus other sources. Scandinavian Journal of Work, Environment and Health 18(S1):5-16.
HERO ID:	200024
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	US Produced 1.58 million tons in 1990... 1600million pounds used annually in synthetic polymeric elastomer production, primarily in tire industry
Life cycle description:	Domestic manufacturing, synthetic rubber manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Facility/process data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Flaris, V., Singh, G., Rao, A. R. (2009). Recycling electronic waste. Plastics Engineering 65(5):10-15.
HERO ID:	1479228
Conditions of Use:	Recycling (e-waste)

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1998 EPA study showed amounts of recycleable commodities from electronic equipment: Total plastic - 10,424 lbs (33.09%)... Scrap plastic - 4,105 lbs (13.03%)... Clean plastic - 2,594 lbs (8.23%)... Phone plastic - 7 lbs (0.02%)
Process description:	ABS can be processed in mechanical recycling for e-waste... polycarbonate/poly(ABS) blend used in electronic applications; potential for PC/ABS product with 50% virgin ABS content... blending of recycled HIPS and ABS; small amounts blended provide better overall mechanical properties; separation of virgin HIPS and ABS by froth flotation... describes various forms of mechanical, chemical, and thermal recycling of e-waste

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Friedrich, R., Obermeier, A. (1999). Chapter 1: Anthropogenic emissions of volatile organic compounds. :1-39.
HERO ID:	6201718
Conditions of Use:	Use

EXTRACTION

Parameter	**Data**
Chemical concentration:	"Butadiene percentage of VOC emissions from internal combustion engines: Otto engine, four stroke w/o catalyst: 0.6% Otto engine, four stroke three-way catalyst: 0.4% Otto engine, two stroke w/o catalyst: ND Diesel engine: 1.1%" (page 10 of 39)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, emission factors) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by providing ranges of uncertainty and best estimates. Variability is addressed by including emissions data from many different sectors under different conditions.

Overall Quality Determination Medium

Study Citation:	Gagnon, L., Macgregor, J. F. (1991). State estimation for continuous emulsion polymerization. Canadian Journal of Chemical Engineering 69(3):648-656.
HERO ID:	5695957
Conditions of Use:	Processing as a monomer

EXTRACTION

Parameter	**Data**
Process description:	SBR and NBR are manufactured by emulsion polymerization in a train of 6 to 10 CSTRs; conversion of monomers from final reactor is around 63%, but unreacted monomers are typically recovered and recycled

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality information from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3: Applicability	High	Data are for processing as a monomer, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Grant, R. L., Leopold, V., Mccant, D., Honeycutt, M. (2007). Spatial and temporal trend evaluation of ambient concentrations of 1,3-butadiene and chloroprene in Texas. Chemico-Biological Interactions 166(1-3):44-51.
HERO ID:	3004860
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Number of sites:	57

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA method used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 yearsbut no more than 20 years old.
	Metric 5:	Sample Size	N/A	life cycle description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Most critical metadata is included, but missing additional fields.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed and explained.

Overall Quality Determination High

Study Citation:	Greek, B. (1990). Butadiene is forecast to grow sluggishly.
HERO ID:	5696456
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Total 1989 consumption: 3.58 billion lbs, excluding exports... 23% used in polyBD rubber; 35% used in SBR; 12% used for hexamethylene diamine; 11% for SBR and other lattices; 6% used for polychloroprene; 6% for ABS; 3% for nitrile rubber; 4% other... total 1989 annual supply was 3.88 billion lbs in the US... Nearly 25% of US supply was imported in 1989
Process description:	coproduct from ethylene manufacture in steam crackers; accounted for 68% of US supply in 1989

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Production and process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes as shown in graph, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Greene, K., Pennington, R. E. (1977). Petrochemical outlook .4. butadiene. Chemical Engineering Progress 73(7):36-39.
HERO ID:	5696788
Conditions of Use:	Domestic manufacturing, Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Close to 75% of dry SBR and almost 100% of polyBD used are in automotive applications, primarily tire-related... BD demand in 1976 was 3.775 billion lbs in the US
Process description:	co-product from ethylene and propylene maufacture provided 40% of US BD production in 1976; imports also from co-product provided 14% in 1976; primary or on-purpose BD manufacture from n-butane or n-butylenes provided 46% of total in 1976

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: Grub, J., Löser, E. (2011). Butadiene. :381-396.
HERO ID: 9493526
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Phillips has operated a plant in Borger (Texas) since 1970 based on the O-X-D process, producing 125 000 t/a of butadiene.USA/Canada 1998 (in 10^3 t/a): Production = 2020, Capacities = 2105, Consumption = 2218
Life cycle description:	Production of butadiene using various methods such as dehydrogenation of butane and butenes, as well as steam cracking.
Process description:	The best known one-step dehydrogenation is the Houdry Catadiene process (Fig. 2), which has been in operation on a commercial scale since 1943. In this adiabatic process, several packed-bed reactors, arranged parallel to each other, are operated alternatingly. Aluminum oxide mixed with approximately 20% chromium oxide is the catalyst. n-Butane is subjected to dehydrogenation as such or in a mixture of nbutenes at 600 – 700 C and 10 – 25 kPa. The use of high temperatures results in byproducts like C1 – C3 hydrocarbons, hydrogen, and carbon deposits on the catalyst. After 5 – 15 min of running time, the reactor is switched to regeneration. The heat generated by burning the coke residue during the regeneration phase is stored in the catalyst and in the added inert material and is then reused in the next reaction phase. The concentration of butadiene at the outlet of the reactor is 15 – 18 %. During the recovery process, which includes absorption of the C3 and C4 hydrocarbons, compression, stripping, and separation from unconverted n-butane and n-butenes, the concentration of butadiene is increased to 30 – 50 %. Approximately 550 t of butadiene is obtained from 1000 t of n-butane.Phillips Petroleum has developed a two-step dehydrogenation process:1. n-Butane is catalytically dehydrogenated to butene at 600 C and 1 bar on Cr2O3 – Na2O – Al2O3.2. The n-butenes are separated by extractive distillation with auxiliaries such as acetone, acetonitrile, and furfural.3. The n-butenes are dehydrogenated to butadiene in an isothermic tubular reactor, heated with flue gas to 600 C, at a pressureof 1 bar, with addition of superheated steam on a Fe2O3 – K2O – Al2O3 catalyst.4. Butadiene is recovered by extractive distillation with the above-mentioned auxiliaries and purified.The advantages of this method are the longer running times without catalyst regeneration and higher butadiene yields (65% based on butane).For Steam Cracking processes, the Oxo-D process was first applied on a large scale in 1965. The advantages of this method are the low consumption of steam and heating energy, high conversion and selectivity per reactor cycle, longer life span of the catalyst, and no necessity for catalyst regeneration. Petro-Tex achieved a 65% conversion and a butadiene selectivity of 93%by using a molar steam/butene ratio of 12/1.
Chemical concentration:	For Houdry Catadiene process, the concentration of butadiene at the outlet of the reactor is typically 15 – 18 %, and up to 30 - 50%.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment uses high quality data that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data for production and consumption of butadiene in U.S. are from 1998.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.

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Study Citation: Grub, J., Löser, E. (2011). Butadiene. :381-396.
HERO ID: 9493526
Conditions of Use: Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Gugliotta, E., Spoto, M. (1985). Modification of cracking furnaces of existing plants to increase yields of valuable products and to reduce fuel consumption.
HERO ID:	5702947
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	For the new coil studied in the paper, at the inlet, where the feed must be heated up as fast as possible and cracking reactions must be supported, splitted coils of small diameters have to be used; the surface to volume ratio is high, but pressure drop and residence time are low. At the outlet, where gas specific volume is higher and the coke formation starts, the small tubes must be collected in a single coil of larger cross section: pressure drop and tubewall temperature are still in an acceptable range.
Throughput:	In a modern plant of nominal capacity of 500,000 t/year of ethylene, the rate of feedstock is about 1,500,000 t/year and the energy consumed (as equivalent oil) is in the range of 350,000-450,000 t/year.
Chemical concentration:	With a conventional furnace coil, the effluent contained 4.13-4.74 wt% butadiene. With the new split coil, the effluent contained 4.43-5.60 wt% butadiene
Comments:	See Table 1.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
Metric 3:	Applicability	Medium	Data are for ethylene cracking furnaces, which is similar to the scope of petrochemical manufacturing.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by using different configurations of coils and temperatures, but uncertainty isn't addressed.

Overall Quality Determination — Low

Study Citation:	Hallberg, L. M., Bechtold, W. E., Grady, J., Legator, M. S., Au, W. W. (1997). Abnormal DNA Repair Activities in Lymphocytes of Workers Exposed to 1,3-Butadiene. Mutation Research 383(3):213-221.
HERO ID:	2961678
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	3 billion lbs per year in the USA.
Life cycle description:	Synthetic rubber and resin manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Variation is discussed and shown in statistics.

Overall Quality Determination High

Study Citation:	Harlow, H. W., Shannon, E. S., Sercu, C. L. (1961). A petrochemical waste treatment system. Engineering Extension Series No. 109 :156-166.
HERO ID:	5701791
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	”The top 40 percent of the crude barrel is mixed with steam as a diluent, elevated to a temperature in range of 1350 - 1475 F in coils in a cracking furnace. Rearrangement of the hydrocarbon molecules takes place at this point. As the hot mixture of gases leaves the furnace the temperature is quickly reduced in a two-step operation. The first step sprays cold oil into the gas; the second step sprays water into the gas. In this second step a large portion (about 80 per cent) of the dilution steam is condensed along with heavier hydrocarbons. Cracked gas containing the residual water passes on to a complicated distillation step. The cracked gas is cooled and compressed to remove the residual water which is collected and sent along with the quench water to the waste treatment plant described later. The gas is then dried using a desiccant. A distillation step separates C3’s, C2’s, C1’s, and hydrogen from C4 and heavier materials. The C4 and· heavier materials are distilled in a distillation tower (debutanizers) to separate a C4 cut which is sent to the butadiene finishing section. During butadiene finishing, hydrocarbons are washed with caustic solution to remove sulfur. Spent caustic is sent to a disposal well. A hydrogenation step, using a selective catalyst, removes unwanted acetylenes, it unfortunately produces a pungent ””green oil”” which has caused some water pollution. Following the distillation to remove the ””green oil”” the C4 hydrocarbons are contacted with cuprous ammonium acetate. Butadiene absorbs in the CAA. and is desorbed in a heating step. A water wash removes ammonia and a distillation removes high boiling compounds. Finished butadiene is pumped by pipeline to the Midland plant.”
Throughput:	The water treatment plant on site can handle 200 gpm of oil quench condensate.
Comments:	See Fig. 4 for Butadiene finishing process.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (average throughput) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variation is addressed within the dilution levels and concentrations of organic material in water. Uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Hayes, R. B., Xi, L., Bechtold, W. E., Rothman, N., Yao, M., Henderson, R., Zhange, L., Smith, M. T., Zhang, D., Wiemels, J., Dosemeci, M., Yin, S., O'Neil, J. P. (1996). hprt mutation frequency among workers exposed to 1,3-butadiene in China. Toxicology 113(1-3):100-105.
HERO ID:	5544872
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	5 million tons of butadiene are produced annually worldwide, 1.5 million tons of which are used in the U.S.
Life cycle description:	synthetic rubber manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	N/A	production and lifecycle description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by providing data for different subgroups of the sample.

Overall Quality Determination Medium

Study Citation:	Hayes, R. B., Zhang, L., Yin, S., Swenberg, J. A., Xi, L., Wiencke, J., Bechtold, W. E., Yao, M., Rothman, N., Haas, R., O'Neill, J. P., Zhang, D., Wiemels, J., Dosemeci, M., Li, G., Smith, M. T. (2000). Genotoxic markers among butadiene polymer workers in China. Carcinogenesis 21(1):55-62.
HERO ID:	5586518
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Currently, over 5 million tons of BD are produced annually worldwide, ~1.5 million of which are used in the USA.
Life cycle description:	Polymer in: Rubber and plastic product manufacturing
Process description:	Purification of butadiene from an initial hydrocarbon stream occurred at two sites: the DMF facility, where initial distillation and extraction occurred using a proprietary dimethyl formamide process, and the recovery facility, where final distillation occurred. BD was then transported to the polymerization vats for synthesis of polybutadiene. Any BD remaining after the polymerization process was returned to the recovery unit, where it was mixed with incoming BD from the DMF recovery facility, repurified and repolymerized.
Chemical concentration:	After the first distillation, BD is over 95% pure. After the final distillation, it is over 99.9% pure.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for polymers used in plastics and rubbers, and in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 yearsbut no more than 20 years old.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different locations and worker activities in the plant.

Overall Quality Determination High

Study Citation:	Hearn, D. (1995). Health Risks Due to Motor Vehicle Emissions in Melbourne. Clean Air 29(2):37.
HERO ID:	5773789
Conditions of Use:	Fuels and related products

EXTRACTION

Parameter	**Data**
Process description:	1,3- Butadiene is highly reactive and, during summer photochemical periods, reacts rapidly with ozone and hydroxyl and nitrate radicals to form formaldehyde, acrolein and nitrated hydrocarbons. (page 5 of 8)
Chemical concentration:	Maximum annual average butadiene air concentrations in Melbourne were 0.6 ug/m3 in 1990 and 0.38 ug/m3 in 2005. (See table 3 on page 6 of 8)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for butadiene emissions to air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by listing factors that could have impacted the study. Variability addressed by sampling nine locations.

Overall Quality Determination High

Study Citation:	Hong, C. K., Isayev, A. I. (2002). Continuous ultrasonic devulcanization of NR/SBR blends. Journal of Applied Polymer Science 83(1):160-168.
HERO ID:	5641874
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Process description:	Devulcanization of rubbers (SBR) for recycling purposes; paper suggests use of ultrasonic devulcanization and then reprocessing similarly to normal rubber, involves extruder with ultrasonic die attachment with extruder operating at 120 Celsius
Chemical concentration:	Rubbers for tires typically blends of natural rubber and styrene-butadiene rubber

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for recycling of tires and vulcanized SBR, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Howell, P. P. (2010). Plant explosion emphasizes importance of implementing PSM. Process Safety Progress 29(2):144-149.
HERO ID:	4702535
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	"The reactors are operated in a semibatch mode. Solvent is first added to the reactor, then styrene and an alkyl metal initiator. BD and styrene are then added based on the recipe for the polymer being produced. The heat from the reaction is removed by means of vertical cooling tubes within the stirred reactor. This cooling system functions the same as a thermosiphon reboiler. Propane liquid flows into the bottom of the cooling tubes where the heat from the reaction causes a portion of it to vaporize. The partially vaporized propane flows to a phase separator. The liquid in the separator flows back to the bottom of the reactor cooling tubes. The vapor from the separator flows to a refrigeration system where it is cooled, liquefied, and returned to the phase separator. Even with the cooling system, the temperature in the reactor rises each time the BD and styrene are added. Therefore, the reactants are added in small amounts and the reactor is allowed to cool before additional reactants are added. This is repeated several times until the desired quantity has been reacted. At the end of the batch, a coupling agent is added that stops the polymerization reactions. The amounts of butadiene and styrene added and the sequence of adding the butadiene and styrene determine the physical properties of the polymer. The batch is then transferred to the product recovery and pelletization portion of the unit. The reactor is then ready to start another batch."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for use in polymer production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination High

Study Citation:	Hsu, Y. C., Chen, S. K., Tsai, J. H., Chiang, H. L. (2007). Determination of volatile organic profiles and photochemical potentials from chemical manufacture process vents. Journal of the Air and Waste Management Association 57(6):698-704.
HERO ID:	608305
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	735,360 ton yr-1. Acrylonitrile-butadiene-styrene (ABS)
Number of sites:	study done at 26 plant sites
Comments:	Table 6

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are for general disposal from ABS polymer processing, which is similar to the in-scope occupational scenario for butadiene disposal in ABS processing.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by measurements as explained in methodology section. Variability addressed by comparison to EPA AP-42 emissions.

Overall Quality Determination Medium

Study Citation:	Huang, P., Tan, D., Luo, Y. (2010). A case study of cleaner production in acrylonitrile butadiene styrene resin companies in China. Journal of Environmental Science and Technology 3(3):148-158.
HERO ID:	5708486
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1975 in China, the production capacity of butadiene was 2,000 tons/year. In 2000, the consumption of ABS in China was 1,766,000 tons. In 2006 it reached 3,274,000 tons. It was predicted to reach 3.82 million tons by 2010. However, the country's production of ABS was only 1,390,000 tons in 2006.
Process description:	ABS resin is produced through chemical grafting, chemical grafting blending, and physical mixing. In chemical blending, Specific types of chemical grafting include emulsion grafting-SAN latex blending, emulsion grafting-SAN suspension mixing, and the emulsion grafting-bulk-SAN blending. A flow chart of this process is provided in the report.
Throughput:	The unit consumptions for ABS resin production were 144.64 kg butadiene per ton of resin.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data is from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (flows, production rates) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Hutchinson, B. J. (1982). Styrene-butadiene latexes in adhesives. Journal of Coated Fabrics 12(1):46-58.
HERO ID:	5716037
Conditions of Use:	Processing as a monomer

EXTRACTION

Parameter	**Data**
Life cycle description:	SBR latexes form the basis for water-based adhesives for vinyl tileflooring, jute and foam backed carpets, ceramic wall and floor tile and other similar applications (Page 2 of 13)
Process description:	Compounding should be performed in a low-speed, agitated tank. Agitation should be designed to minimize formation of foam. (page 11 of 13)
Chemical concentration:	Various types of SBR latex adhesives with styrene-butadiene ratio and percent solids in latex (range 45-68% solids in latex, 35-95% BD in styrene-butadiene polymer); 100 parts SBR latex by mass in recipe with 527.2 parts total (page 2 of 13, and recipe given in Table 3 on page 3 of 13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality information that is not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for industrial use of a polymer product, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by different latex formulations and products, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Iammartino, N. R. (1975). Petrochemicals Sing to Ethylene's Tune. Chemical Engineering 82(9):52.
HERO ID:	5701788
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Dehydrogenation of butane or butylene accounted for 62% of roughly 4 billion lbs total US production in 1974; remaining production was from ethylene coproduct... About 60-64% of domestic consumption goes to automobile uses... 198 million lbs to plastics and 795 million lbs to fibers. (Page 2 of pdf)
Number of sites:	Seven US "dehydro" plant operators in 1975

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1986). 1,3-Butadiene. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, vol. 39 :155-179.
HERO ID:	1161949
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	An estimated 3.57 million tons of 1,3-butadiene were produced worldwide in 1983. Eleven major US producers with 16 plant locations produced 1.04 million tons in 1983.
Life cycle description:	An estimated 50% of the 1,3-butadiene produced in the USA is used in the production of styrene-butadiene rubber and 22% of the total supply for polybutadiene production. Other applications for 1,3-butadiene include chloroprene/ neoprene rubber (6%), nitrile rubber (3%), hexamethylenediamine (9%), acrylonitrile-butadiene-styrene resins (5%) and miscellaneous uses (5%).
Process description:	"1,3-Butadiene is manufactured either as a co-product of the steam cracking of naphtha to yield ethylene or through the catalytic dehydrogenation of n-butane or n-butene. The dehydrogenation of n-butane, known as the Houdry process, and the oxidative dehydrogenation of n-butene are currently less significant methods for the commercial production of 1,3-butadiene. The Houdry process involves passing a preheated butane feed stream over a fixed-bed reactor containing a chromia-alumina catalyst. ln oxidative dehydrogenation, a process used since 1965, a mixture of butenes, air and steam is exposed to a catalytic matrix at approximately 500-600°C. The hydrogen released in this dehydrogenation step combines with oxygen in an exothermic reaction, which increases the energy efficiency of the manufacturing process The crude C4 fraction obtained by naphtha steam cracking and the products of butane/ butene dehydrogenation contain hydrocarbons with boiling-points similar to that of 1,3-butadiene; these include isobutylene, 1- and 2-butene and n-butane. This similarity prevents the use of simple distillation techniques to separate 1,3- butadiene from the C4 hydrocarbon mixture. An extractive distillation process is used which selectively alters the volatility of the components in the distillate and ultimately permits the 1 ,3-butadiene to be removed and purified. The solvents employed for this technique include acetonitrile, furfural, dimethylformamide, dimethylacetamide and methyl pyrrolidinone. The cuprous ammonium acetate system has also proven to be useful as a selective extraction recovery process"
Number of sites:	16 plant locations in the US in 1983.
Chemical concentration:	The polymerization grade has a minimum purity of 99%.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

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Study Citation:	IARC, (1986). 1,3-Butadiene. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, vol. 39 :155-179.
HERO ID:	1161949
Conditions of Use:	Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	IARC, (1986). General remarks on the substances considered. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, vol. 39 39:33-36.
HERO ID:	5658496
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The report states that over 1 million tons of butadiene are produced annually.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	IARC, (1979). Chloroprene and polychloroprene. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans 19:131-156.
HERO ID:	5677945
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”ln 1976, seven US companies produced a combined total of 420-450 million kg acrylonitri1e-butadiene-styrene copolymers. ln the same year, 290 million kg acrylonitrile-butadiene-styrene copolymers were produced in western Europe. Worldwide production of acrylonitrile-butadiene-styrene copolymers in 1976 is estimated to have been approximately 1000 million kg. In 1976, nine companies produced 1191 million kg dry SBR, and ten companies produced 141 million kg SBR latex in the U.S. Total western Europe production in 1976 amounted to 1075 million kg.”
Life cycle description:	Synthetic Rubber Manufacturing
Process description:	SBR is produced commercially by three processes: (1) cold emulsion polymerization (85% of total US production); (2) hot emulsion polymerization (5%); and (3) solution polymerization (10%). the ingredients are reacted at 50C for about 6-7 hours unti1 60-65% conversion is achieved; the reaction is stopped by adding a short-stopping agent, and unconverted butadiene and styrene are removed; a stabilizer is added, and the emulsion is coagulated after any desired carbon black or oil has been added. If latex is the desired product, all steps after monomer removal are omitted. Hot polymerization processes are simi1ar, except that the reaction temperature is about 500C and the reaction is stopped after 12 hours with about 70-75% conversion. ln a typical solution polymerization, styrene and butadiene are copo1ymerized in a hexane or cyclohexane solution in the presence of a small amount of n-buty1lithium at 500C; 98% conversion is achieved after 4 hours, and the reaction is stopped by adding a fatty acid deactivator followed by addition of a stabilizer; solvent residues are removed when the elastomer is coagulated.
Number of sites:	7 sites in the U.S. produce ABS and 19 companies in the U.S. produce SBR.
Chemical concentration:	A typical medium impact grade of acrylonitrile butadiene-styrene copolymer is derived from 57.4% styrene, 13.3% butadiene, and 29.3% acrylonitrile

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from the U.S. and Western Europe, most of which are OECD countries.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by including production data from multiple countries. Uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Inc, É.V. (2018). Safety data sheet: Butane. SDS number 0106. Version #.03. Revision date 02 March 2018..
HERO ID:	6149865
Conditions of Use:	Fuels and related products

EXTRACTION

Parameter	**Data**
Chemical concentration:	0-0.1%

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	SDS information is primary data from the supplier. SDS does not appear to have quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	From an OECD country.
	Metric 3:	Applicability	High	SDS is applicable to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Source is from 2018, which is less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Source just provides concentration and does not document how this value was obtained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing a range of potential concentrations. Uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	Irvin, B. D. (1989). Application of styrene-butadiene latex modified Portland cement concrete overlays in parking structure repair and rehabilitation. 116:1-14.
HERO ID:	5698799
Conditions of Use:	Commercial use

EXTRACTION

Parameter	**Data**
Chemical concentration:	SB latex particle diameter approximately 2,000 Angstroms; total solids in latex by weight is 47%; use 206lbs of latex with 658lbs Portland cement, 1,054lbs of coarse aggregate, 115lbs water, and 1,725lbs fine aggregate

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality information that is not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of a polymer product, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Isayev, A. I., Chen, J., Tukachinsky, A. (1995). Novel ultrasonic technology for devulcanization of waste rubbers. Rubber Chemistry and Technology 68(2):267-280.
HERO ID:	5698797
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Process description:	The study is the first publication describing the continuous process and reactor for the ultrasonic devulcanization of rubbers. The process allows one to devulcanize or decrosslink various types of rubbers and plastics. It was achieved through the application of certain levels of ultrasonic amplitudes in the presence of pressure and heat. The process is solvent free, simple, fast and efficient. A three-dimensional network breaks down within a short period of time, on the order of seconds or less. As a most desirable consequence, ultrasonically treated rubber becomes soft, therefore enabling this material to be reprocessed, shaped and revulcanized in a manner similar to that employed with unvulcanized elastomer. The revulcanized samples retain mechanical properties sufficient for further use in various applications.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for the research and development of a rubber devulcanization process, which is similar to the in-scope occupational scenario recycling of SBR.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by listing errors in the results of the study. Variability addressed by testing the devulcanization process on two types of rubber.

Overall Quality Determination Medium

Study Citation:	Jahn, R. G. (1977). Styrene-butadiene latexes for adhesive applications. Adhesives Age 20(12):35-37.
HERO ID:	5590370
Conditions of Use:	Processing (adhesive latex manufacturing)

EXTRACTION

Parameter	**Data**
Life cycle description:	Adhesive manufacturing
Process description:	To form a film of latex, during drying, the volume fraction of the polymer particles in the latexes increases. At approximately 70% volume solids, interparticle contact occurs. Then the particle surface tension and aqueous capillary forces function to minimize surface area. Concurrently, the polymer molecules diffuse across particle interfaces to complete the film formation process.
Chemical concentration:	Low-temperature-process GR-S styrene/butadiene latex usually contains about 70-75% butadiene and 25-30% styrene. Hot-process latex has about 45-80% styrene and 20-55% butadiene. (see Table 1 for various formulation types)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for adhesive latex manufacturing, and in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	Jecha, D., Brummer, V., Martinec, J.,an, Skryja, P., Stehlik, P. (2014). Optimal Design and Modernization of Small Incineration Unit for VOC Abatement. Chemical Engineering Transactions 39(Special Issue):769-774.
HERO ID:	2845569
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Process description:	An operational thermal incinerator of gaseous waste from the manufacture of products on the base of butadiene-styrene and acrylic-styrene is situated. While producing such mixtures, gaseous vapors are discharged to the waste incineration plant. Gas containing organic substances arises (evaporates from the reactor) especially after transportation of the mixture to the reactor and subsequently at each process steps in the strippers (addition of chemicals, stripping, etc.)
Chemical concentration:	Waste gas stream of butadiene-styrene is 7.9487 mol% butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Data is from a specific site with no references to commonly used sources, but looks reliable.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from an OECD country.
	Metric 3: Applicability	High	Data is within scope.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Data sources are well-documented and referenced
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty not addressed.

Overall Quality Determination Medium

Study Citation:	Jenkins, S. (2016). Styrene-butadiene rubber via an emulsion process. Chemical Engineering 123(5):40-40.
HERO ID:	4708485
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic rubber manufacturing
Process description:	Styrene and butadiene are mixed with an emulsifier and demineralized water. The mixture is polymerized in a series of continuously stirred, jacketed tank reactors, all cooled with ammonia refrigeration. An agent is mixed with the emulsion to stop the reaction at the desired completion. The latex material is now flashed to recover unreacted butadiene. Residual BD vapors are recovered, and the degreased latex is moved to a stripping column, In BD recovery, water is removed from the stream and BD is recycled. In the column, styrene is stripped out with steam and recycled. The latex is then coagulated and becomes small crumbs suspended in water. These are sent to a drying stage with belt dryers. Then, the rubber is pressed into bales and boxed.
Comments:	see Figure 2.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Jung, W. H., Tortorella, N., Beatty, C. L., Mccarthy, S. P. (2006). Grinding and separation of the cellular phone housing. Materials Research Society Symposium Proceedings 895:151-156.
HERO ID:	5583274
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	"The first step of the demanufacturing of the solid wastes was the selection of cutting mills, such as dismantling-knife mill, shredder and fine milling, used to get particles or flakes. The most common method is sink-float devices using various separating liquids for particles with different density. The float-sink separation in a centrifugal field using hydrocyclone technology was commonly used in industry field. Electrostatic separation processes are the same continuous processes as the float-sink processes and their energy consumptions are very low such as 20~40 kV, 2~4 mA. Magnetic and non-magnetic materials can be separated by these methods, and large industrial scales of treatments possible are one of their advantages. The sponges and adhesive strips included in the cellular phone housings floated on the water surface due to lower density than water, while the metal parts sank into a basin bottom due to their higher density than water"

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	Medium	Data are for separation methods of plastics, which is similar to the in-scope occupational scenario of recycling of ABS.
Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Kelsey, K. T., Wiencke, J. K., Ward, J., Bechtold, W., Fajen, J. (1995). Sister-chromatid exchanges, glutathione S-transferase theta deletion and cytogenetic sensitivity to diepoxybutane in lymphocytes from butadiene monomer production workers. Mutation Research 335(3):267-273.
HERO ID:	5617560
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1987, 1,3-butadiene production was approximately 2.7 billion pounds in the United States with 11.9 billion pounds produced worldwide.
Life cycle description:	Domestic Manufacturing
Process description:	Most of the world's 1,3- butadiene is made as a by-product of ethylene production and is extracted.
Number of sites:	In the US there are 11 facilities involved in the extraction of 1,3-butadiene from mixed butenes.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing of butadiene monomers, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by including two duplicate sampling groups

Overall Quality Determination High

Study Citation:	Kennedy, R. E., Stover, R. R., Codling, B. S., Green, K., Pennington, R. E., Sanders, D. S., Allen, D. M. (1977). Petrochemical outlook. Chemical Engineering Progress 73(7):26.
HERO ID:	5701801
Conditions of Use:	Domestic manufacturing, Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Close to 75% of dry SBR and almost 100% of polyBD used are in automotive applications, primarily tire-related... BD demand in 1976 was 3.775 billion lbs in the US... About 525 million lbs of net imports in 1976
Process description:	co-product from ethylene and propylene maufacture provided 40% of US BD production in 1976; imports also from co-product provided 14% in 1976; primary or on-purpose BD manufacture from n-butane or n-butylenes provided 46% of total in 1976

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing and imports, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	process description
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination **Medium**

Study Citation:	Kerns, M., Henning, S., Rachita, M. (2002). Butadiene polymers. :317-356.
HERO ID:	9493542
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996, the total US production of butadiene was 1.75 million, 93% of which was co-produced. (pdf pg. 5)
Process description:	The primary source of butadiene in the world today is as a by-product of thermal pyrolysis of hydrocarbon feedstocks in ethylene production...Steam cracking of hydrocarbons yields varying amounts of butadiene, depending on the nature of the feedstock, the volume of ethylene produced, and the severity of the crackingoperations. For example, when feedstocks are switched from atmospheric gas oils and napthas to propane and butane, yields of butadiene drop by as much as 60%. (pdf pg. 5)In addition, dehydrogenation of n-butane or n-butene also affords butadiene. For example, the Houdry process for conversion of n-butane to butadiene requires temperatures of about 620°C and involves passing n-butane over a fixed bed reactor containing a chromium–alumina catalyst. Single-pass conversions reach only30–40% requiring multiple recycling passes of unreacted intermediate butylenes and n-butane. The other primary means of dehydrogenation is conducted by passing a preheated stream of n-butene, steam, and air over fixed bed reactors containing a heterogenous autoregenerative catalyst. Bismuth molybdate catalysts have been studied in this process (53), but patents suggest that zinc ferrite catalysts have been used commercially (54–57). Nickel phosphate and Li–Sn–P catalysts have been patented by Phillips (58,59). Other techniques for the preparation of butadiene have also been used commercially, including the aldol condensation of acetaldehyde and the reaction of acetylene and formaldehyde. However, these processes are no longer employedcommercially. (pdf pg. 6)See page 6 for continuation of process description that includes purification, Cuprous ammonium acetate extraction, solvent extraction.
Chemical concentration:	Typical Composition of a Crude C4 Stream contains 37.0–47.5 wt%, other components also provided at pdf pg. 5.; For polymerization, butadiene that is at least 99 mol% pure isrequired. pdf pg. 6; Commercial polymerization-grade butadiene is at least 99% pure; higher purity grades up to 99.86% are available from specialty gas suppliers (85). pdf pg. 7

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	n/a-qual. information
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The report addresses variability as it provides the various processes and uncertainty is not applicable.

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Study Citation: Kerns, M., Henning, S., Rachita, M. (2002). Butadiene polymers. :317-356.
HERO ID: 9493542
Conditions of Use: Manufacture

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation: Kerns, M., Henning, S., Rachita, M. (2002). Butadiene polymers. :317-356.
HERO ID: 9493542
Conditions of Use: Distribution in Commerce

EXTRACTION

Parameter	Data
Process description:	Butadiene is dangerous because of its explosiveness when mixed with air (38). Because of the high vapor pressure of the liquid, it must be kept under pressure. Butadiene reacts with air to form explosive peroxides and must be inhibited. Peroxides or rusty iron surfaces may initiate the formation of "popcorn" polymer which can plug pipelines. Butadiene material fires are fought like other hydrocarbon fires, with carbon dioxide or dry chemical extinguishers. Safe handling and storage require careful exclusion of oxygen, thorough grounding of all equipment, and avoidance of excessive temperatures in closed vessels. Inhibited butadiene of polymerization purity is available in cylinders (3.8–454 L),tank cars, tank trucks, and pipelines (96,97). The cylinders may be shipped by motor or rail freight (98). Containers are subject to regulations of the Department of Transportation and must be labeled "Flammable Gas" (96). Butadiene is usually stored in bulk under refrigeration rather than pressure in order to suppressformation of the dimer 1-vinylcyclohexene (99). Smaller quantities in cylinders under pressure should be kept away from sources of ignition and heat.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
Metric 5:	Sample Size	N/A	n/a-qual. information
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The report addresses variability as it provides the various processes and uncertainty is not applicable.

Overall Quality Determination High

Study Citation:	Kerns, M., Henning, S., Rachita, M. (2002). Butadiene polymers. :317-356.
HERO ID:	9493542
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 10. Global Capacity and Production for Polybutadiene byRegion—1999a provided on pg. 28 [unclear units, probably tons]
Life cycle description:	Use of polybutadiene in high impact polystryene modification and ABS resin manufacture account for 15–20% of global demand (380,381). Polybutadiene used in these applications must be essentially gel free and colorless. The remaining markets for polybutadiene are divided among industries including golf balls and footwear and assorted industrial products including, but not limited to, conveyor belts, v-belts, seals, gaskets, and wire insulation
Process description:	Polybutadiene can produced via: free-radical polymerization (least commercial use), ziegler-natta polymerization, anionic polymerization(most versatile), and cationic polymerization. [Full description of reactions on pgs. 13-25.]Polybutadiene can be prepared by a number of processes, including bulk, solution, suspension, emulsion, and gas-phase polymerizations. Of the commercially significant polymerization processes, production of polybutadiene by solution technologies are the most predominant. The relative popularity of these processes follow the limitations dictated by the chemistries most practiced when producing polybutadiene commercially, including Ziegler–Natta, anionic, free-radical, and single-site technologies. Several of the more commercially relevant processes are pgs. 25-27
Number of sites:	Major US producers of polybutadiene elastomers (2000) are The Goodyear Tire & Rubber Co (8% of world capacity) and Bridgestone/Firestone (5% of world capacity) pdf pg. 28

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	n/a-qual. information
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents its data sources, assessment methods, and assumptions. One of the results (production and capacity) were not clear on units.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The report addresses variability as it provides the various processes and uncertainty is not applicable.

Overall Quality Determination Medium

Study Citation:	Kopf, P. W. (2003). Phenolic resins.
HERO ID:	6549167
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Butadiene sulfone may be used as a latent acid catalyst in the liquid-injection molding process. These catalysts reduce the peak exotherm from over 2008C to 130–1608C. The resin catalyst mixture has a working life of up to several days at RT. The elevated temperature of molding these latent catalysts generates the corresponding acids, namely, maleic, trifluoracetic, and phenolsulfonic, which catalyze the resole reaction. Typically, a cycle time of 1–2 min is required for a mold temperature of ~150C. (see page 33 of 54)
Chemical concentration:	A typical coating composition for the coated-front (CF) component is shown in Table 11 on page 52, and includes styrene–butadiene latex at 12 parts [per roughly 100 (All parts in the table add to 99.4)]

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Kirk-Othmer
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	From USA
Metric 3:	Applicability	Medium	Butadiene products discussed, but not 1,3-butadiene itself
Metric 4:	Temporal Representativeness	Medium	from 2003
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation: Krishnan, E., Ungers, L., Morelli-Schroth, P., Fajen, J. (1987). Extent of exposure study: 1,3-butadiene monomer production industry.
HERO ID: 6558315
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	The total U.S. demand for 1,3-butadiene in 1985 was 3.25 billion pounds, of which about 2.45 billion pounds was domestically produced. Uses were 37% Styrene-butadiene rubber (SBR), 22% Polybutadiene rubber (PBR), 13% Adiponitrile, 9% Styrene-butadiene copolymer latexes, 7% Neoprene, 6%Acrylonitrile-butadiene-styrene (ABS) resins, 3% Nitrile rubber (NBR), and 3% Miscellaneous (pesticides, solvents, etc.).
Process description:	The production of 1,3-butadiene by the ethylene coproduct method is a two stage process: 1) production of a C4 coproduct during the ethylene manufacturing step, and 2) recovery of 1,3-butadiene from the coproduct. The ethylene manufacturing process consists of the cracking of hydrocarbons (e.g., naphtha, gas oil, ethane, propane) to produce ethylene as the primary product. A coproduct stream composed primarily of C4 hydrocarbons is also produced. The amount of 1,3-butadiene in the coproduct is dependent on the feedstock and the severity of the cracking process. The heavier the feedstock and the more severe the cracking, the more 1,3-butadiene is produced. Average C4 coproduct yields from naphtha and gas oil feedstocks are 16 weight percent and 22 weight percent, respectively, of the ethylene product. The 1,3-butadiene content of the C4 coproduct may range from 20 to 70 percent.
Number of sites:	1,3-Butadiene is currently produced in the U.S. by 10 companies at 12 locations.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling various job areas at 4 different plants.

Overall Quality Determination High

Study Citation:	Kuhlmann, L. A. (1985). Latex modified concrete for the repair and rehabilitation of bridges. International Journal of Cement Composites and Lightweight 7(4):241-247.
HERO ID:	5827471
Conditions of Use:	Commercial Use: Plastic and rubber products not covered elsewhere

EXTRACTION

Parameter	**Data**
Process description:	See pages 4 to 6 of 7 for a detailed description of the installation of latex modified cement. The steps include surface preparation, mixing, placement, finishing, and curing.
Chemical concentration:	Latex modified cement is made up on 0.15 parts styrene butadiene latex solids per 1.0 part cement (page 1-2 of 7)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are from concrete manufacture, which could be applied to the in-scope occupational scenario of incorporation into an article.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ratios) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by explaining the effects of weather on the process. Uncertainty isn't addresses.

Overall Quality Determination Medium

Study Citation:	Kulich, D. M., Gaggar, S. K., Lowry, V., Stepien, R. (2003). Acrylonitrile–butadiene–styrene (ABS) polymers. :414-438.
HERO ID:	9493543
Conditions of Use:	Manufacture of ABS

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Estimated ABS capacity worldwide in 2000 is given in Table 2 (172). Accurate ABS capacity figures are difficult to obtain because significant production capability is considered ‘‘swing’’ and can be used to manufacture polystyrene or SAN as well as ABS. From a regional standpoint, Asia-Pacific has the largest ABS nameplate production capability at 3977 t. The United States has approximately 17% of the world’s capacity at 1068 t.
Life cycle description:	Manufacture of acrylonitrile - butadiene - styrene (ABS)
Process description:	All manufacturing processes for ABS involve the polymerization of styrene and acrylonitrile monomers in the presence of an elastomer (typically polybutadiene or a butadiene copolymer) to produce SAN that has been chemically bonder or ‘‘grafted’’ to the rubber component termed the ‘‘substrate.’’ See Section 4 for process details.
Number of sites:	Eight producers of ABS in U.S. totaling a capacity of 8.19E8 kg.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The report uses high quality data that are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Most references in data source are greater than 20 years old.
	Metric 5: Sample Size	N/A	Sample size is not applicable to data extracted.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Variability and uncertainty are not applicable to data extracted.

Overall Quality Determination High

Study Citation:	Kulich, D. M., Gaggar, S. K., Lowry, V., Stepien, R. (2003). Acrylonitrile–butadiene–styrene (ABS) polymers. :414-438.
HERO ID:	9493543
Conditions of Use:	Processing of ABS

EXTRACTION

Parameter	**Data**
Life cycle description:	Processing of acrylonitrile - butadiene - styrene (ABS)
Process description:	ABS can be processed by all the techniques used for other thermoplastics: compression and injection molding, extrusion, calendering, and blow-molding. Postprocessing operations includecold forming; thermoforming; metal plating; painting; hot stamping; ultrasonic, spin, and vibrational welding; and adhesive bonding. See Section 5 for process details.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data that are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Most references in data source are greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size is not applicable to data extracted.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty are not applicable to data extracted.

Overall Quality Determination High

Study Citation:	Landrigan, P. J. (1993). Critical assessment of epidemiological studies on the carcinogenicity of 1,3-butadiene and styrene. IARC Scientific Publications No. 127 (127):375-388.
HERO ID:	199999
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1990, annual butadiene production in the US was 2700 million pounds.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (production amount) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Landrigan, P. J. (1990). Critical assessment of epidemiologic studies on the human carcinogenicity of 1,3- butadiene. Environmental Health Perspectives 86(0):143-148.
HERO ID:	2972492
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	annual US production is 2.7 billion pounds; BD is among top 20 organic chemicals in annual volume (pg. 1/5)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Lashmanova, N. V., Kolesnikov, V. A., Efremov, R. V., Danov, S. M. (1990). Effect of feedstock quality on concentration of 1,3-butadiene in vinyl-chloride obtained in the pyrolysis of 1,2-dichloroethane. Journal of Applied Chemistry of the USSR 63(8):1761-1763.
HERO ID:	5451716
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	The basic industrial method of production VC is thermal dehydrogenation (pyrolysis) of 1,2-dichloroethane (DCE). In the pyrolysis of DCE the concentration of impurities in the VC, including 1,3-butadiene, is affected by a number of factors. It can be proposed that the composition of the DCE being fed to the pyrolysis reactor has the greatest effect. (Page 4 of 5)
Chemical concentration:	The concentration of 1,3-butadiene in the end product for superior grade vinyl chloride must not exceed 0.001 wt. % (10 ppm) (page 3 of 5)It was shown that such impurities as DCB, CL, and alpha-Cp significantly increase the amount of 1,3-butadiene that forms during pyrolysis of DCE. (page 5 of 5). See Tables 1 and 2 on pages 3 and 4 for raw data on butadiene concentration.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are form Russia, a non-OECD country.
	Metric 3: Applicability	Medium	Data are for the production of vinyl chloride, but butadiene side-production is included.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided)
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed with a statistical analysis. Variability is addressed by testing different compositions of process mixtures on the percent of butadiene.

Overall Quality Determination Medium

Study Citation:	Lazzaro, E., Sbarski, I., Bishop, J. (2007). Recycling of engineering thermoplastics used in consumer electrical and electronic equipment. :717-724.
HERO ID:	5735801
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2004 190,979 tonnes of plastic was recycled throughout Australia, compared with the consumption of 1,510,850 tonnes. (Including ABS)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3: Applicability	High	Data are for recycling, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	Lee, N., Lee, B. K., Jeong, S., Yi, G. Y., Shin, J. (2012). Work environments and exposure to hazardous substances in Korean tire manufacturing. Safety and Health at Work 3(2):130-139.
HERO ID:	1641552
Conditions of Use:	Processing (rubber tire manufacture)

EXTRACTION

Parameter	**Data**
Process description:	See Table 1, pg 2/10"-Compounding: Vulcanizing agents and accelerators in the form of powders are weighed and fed into a Banbury mixer. Carbon black is fed by hopper. All ingredients are input on the second floor and mixed in the Banbury. The temperature in the mixer is 150-190C. The "Q rubbers" sheets are coated by the releasing agent. The cement is made in a separate building. The main organic solvent of cement is methylcyclohexane. -Extrusion: Q rubbers are carried in hot screws and cut in the shapes of tread and side wheels. The temperature of the outlet is 125C. Cement is used to bind and correct the rubbers. Pigments are used to print letters on treads. -Calendaring: The softened rubber is applied to the textile or steel cord to make ply stock of the tire. The temperature is 75-95C -Bead Building: The rubber is applied in a bead wire to make beads. -Tire Building: The green tire is assembled with tread, beads, ply stock, sidewalls, and other component on a drum. The tire building operation area is next to the curing area. -Curing: The green tire is placed in the mold and vulcanized under heat (150-180C) and pressure. The operation time of a mold is about 8-12 minutes. Approximately 200 molds are placed in the unit plant. The atmosphere in a curing operation is hot and humid. There is no air exhaust system. "

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data was collected in 2007
	Metric 5:	Sample Size	N/A	Data is qualitative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results (Only one company with 2 plants)

Overall Quality Determination High

Study Citation:	Lee, S., Kim, J., Hwang, Y., Kim, J., Kim, Y., Chen, S.,ha (2019). Butadiene substance flow analysis and management in South Korea. Journal of Cleaner Production 220:331-339.
HERO ID:	5670940
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Results show that butadiene has been used in 1,450,076 tons of domestic chemical materials in South Korea. Of this amount, 28.2% was consumed and used in the styrene-butadiene rubber (SBR) industry, 29% in the polybutadiene rubber (BR) industry, 21.2% in the acrylonitrile butadiene styrene (ABS) industry, and 21.5% in the other rubber products industry.
Life cycle description:	manufacturing, imports, processing of butadiene, synthetic rubber manufacturing, consumer uses like tires, shoes, automotive, emissions to air and emissions to water
Process description:	SBR is produced through stages of raw material storage process, chemical solution preparation process, polymerization process, unreacted material recovery process, storage and mixing process.
Throughput:	Domestic production volume and water input/output amounts were 1,231,000 tons, 449,000 tons and 204,000 tons respectively.
Number of sites:	45 companies in South Korea

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from South Korea, a non-OECD country.
Metric 3:	Applicability	High	Data are for butadiene processing and use an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty addressed in the regression analysis. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Legator, M. S., Au, W. W., Ammenheuser, M., Ward, J. B. (1993). Elevated somatic cell mutant frequencies and altered DNA repair responses in nonsmoking workers exposed to 1,3-butadiene. IARC Scientific Publication No. 127 127:253-263.
HERO ID:	2966425
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1990 study showed 26.5 million tonnes produced annually worldwide; 6.6 million tonnes produced annually in the US

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Production data. Sample size is sufficiently representative based on the cited references and multiple data sources.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by source material. Variability is not addressed.

Overall Quality Determination High

Study Citation:	Lemen, R. A., Meinhardt, T. J., Crandall, M. S., Fajen, J. M., Brown, D. P. (1990). Environmental epidemiologic investigations in the styrene-butadiene rubber production industry. Environmental Health Perspectives 86(0):103-106.
HERO ID:	200000
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	3.24 billion lbs/yr consumption of butadiene in 1984; at least 3 billion used for synthetic rubber
Process description:	Changed over time: initially rubber produced by hot temperature batch process, converted to continuous feed operating system, then finally a cold temperature continuous polymerization process; extender oils added to process in early 1950s to soften rubber product
Number of sites:	15 SBR plants and 16 butadiene production facilities during WWII

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacturing and synthetic rubber production, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Lemen, R. A., Young, R. (1976). Investigations of health hazards in styrene butadiene rubber facilities.
HERO ID:	51473
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Process description:	SBR production: use of reactor chain (reactors in series), use of pigment blend tanks, use of antioxidant mix tanks, use stripping columns, coagulation tanks
Number of sites:	US government created 15 SBR rubber plants and 16 butadiene production facilities in 1940

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for processing in synthetic rubber, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Medium

Study Citation: Levy, L. S., Lee, W. R. (1994). Aliphatic chemicals. :139-190.
HERO ID: 664424
Conditions of Use: Manufacturing, Processing as a reactant

EXTRACTION

Parameter	Data
Production, import, or use volume:	1.5 million tonnes produced in Western Europe in 1983; ranked 36th among all chemicals produced in the USA in 1983
Chemical concentration:	20% butadiene in ABS rubber

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are predominantly for Western European countries, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for domestic manufacturing and use as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Lewis, R. (1999). Overview of the rubber industry and tire manufacturing. Occupational Medicine: State of the Art Reviews 14(4):707-718.
HERO ID:	2988430
Conditions of Use:	Processing (rubber/tire production)

EXTRACTION

Parameter	**Data**
Process description:	The manufacturing of synthetic rubber is similar to other forms of polymer manufacturing. Large volumes of monomers or other precursor materials are shipped to synthetic rubber plants by rail, tank car, or pipeline. These materials are charged into large reactor vessels along with catalysts and other reaction modifiers. Polymerization of rubber ingredients takes place in enclosed vessels. SBR is produced through an emulsion polymerization reaction of aqueous styrene and gaseous· butadiene. Unreacted monomers are trapped and recycled. The polymer latex is coagulated with sulfuric acid and dried prior to shipping. Other chemicals may be added, such as carbon black, antioxidants, and curing agents, depending on the intended end use of the product. (pg. 4/13)Process description for tire manufacture begins on pg. 6/13
Number of sites:	2753 in the U.S. (Table 2, pg. 5/13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability between rubber making processes are explained, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Luther, S., Bogun, M., Schuster, R. H., Gorl, U. (2006). Experimental study of the rubber mixing process using a corotating twin screw extruder. KGK Kautschuk, Gummi, Kunststoffe 59(9):473-478.
HERO ID:	5730653
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	Twin screw extrusion of synthetic rubber is explained in the report. During the first process step of dispersive mixing of the base compound the heat of the material rises due to the high dissipative energy developed. To ensure a maximum temperature of approx. 120°c at the location where the crosslinking chemicals are added, a cooling section must be installed. After the cooling section, which consists of conveying elements the crosslinking chemicals are mixed in with the help of distributive screw elements.
Throughput:	A continuous internal mixer has a throughput of 25 kg rubber/hr, and a twin screw extruder has a throughput of 37.5 kg rubber/hr.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (operation parameters, throughputs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing throughputs of different rubber mixing machines. Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Lynch, M. (2001). Manufacture and use of chloroprene monomer. Chemico-Biological Interactions 135-136(SI):155-167.
HERO ID:	625182
Conditions of Use:	Processing as intermediate

EXTRACTION

Parameter	**Data**
Process description:	Manufacture chloroprene from butadiene; butadiene reacted with chlorine to produce isomers of dichlorobutene, performed catalytically in liquid phase and thermally in vapor phase
Number of sites:	Two United States facilities producing chloroprene from butadiene

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality information from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for processing as an intermediate/reactant, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Medium

Study Citation:	Malin, N. (1994). Carpeting, Indoor Air Quality, and the Environment. Environmental Building News 3(6):1.
HERO ID:	5708617
Conditions of Use:	Industrial Use, Adhesives and Sealants

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Americans purchased 5.5 sq yds of carpet per person (or nearly 1.5 billion sq yds total) in 1993
Throughput:	In a typical commercial installation, carpet adhesive is spread over the entire surface, covering between 7 and 16 square yards per gallon, depending on the carpet type. There are many different types of adhesives, but the majority are based on SB latex, the same resin used in carpet backing (page 5 of 21). SB latex applied as secondary backing for carpeting as much as 2 lbs/sq yd of carpet used (page 8 of 21). Standard residential carpet products use relatively large amounts of SB latex adhesive, about 28 ounces per square yard of carpet, to bind fibers to the carpet backing (page 7-8 and 16 of 21)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for industrial use, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Martinez, E., Beltramini, L., Leone, H., Ruiz, C. A., Huete, E. (1992). Knowledge elicitation and structuring for a real-time expert system for monitoring a butadiene extraction system. Computers & Chemical Engineering 16(Suppl. 1):S345-S352.
HERO ID:	5794661
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The purification sector of the Butadiene Plant that PASA operates in Puerto San Martin, Santa Fe Province, Argentina, consists of a distillation train composed of six distillation columns in serial operation and two washer columns. The core of this sector is an extractive distillation column, and its corresponding solvent stripper column, where butadiene is extractively distilled from other components, such as butanes and butenes, to produce a butadiene stream with a low amount of impurities. The main operating objectives are to reduce the loss of butadiene and to achieve very low contents of butene-1. The separation efficiency of this pair of columns has a major effect on the economics of the process. Due to material recycling, energy recovery and inherent difficulties with extractive distillation schemes, maintaining stable and economic modes of operation is difficult without a permanent monitoring of the process variables. Certain loops deserve special attention. There exist two important temperature loops in the solvent stripped stream. The first one controls the degree of vaporization of the feed by using the vaporizer by-pass. The other one controls the temperature of the solvent that is recycled to the extractive column. As it is described later, these two variables have a great influence on the continuous flow of solvent in the solvent circuit t. Finally, the temperature control of the solvent stripper column has a great impact on the solvent concentration and efficiency of stripping operation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Argentina, a non-OECD country.
	Metric 3: Applicability	Medium	Data are for improvement of butadiene purification processes, which is similar to the in-scope occupational scenario of butadiene production.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by discussing the effect different process variables have on the system, but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	Matanoski, G. M., Santos-Burgoa, C., Schwartz, L. (1990). Mortality of a cohort of workers in the styrene-butadiene polymer manufacturing industry (1943-1982). Environmental Health Perspectives 86(0):1990.
HERO ID:	51499
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Synthetic Rubber Manufacturing
Process description:	Emulsion polymerization to produce SBR; combine BD and Sturene monomers in aqueous soap solution and add initiator along with mercaptan; add inhibitor when desired level of polymerization is reached; BD is recovered through distillation and styrene is stripped by steam for reuse; antioxidants added to extend life of the latex; coagulate the latex using salt and sulfuric acid, which is then washed and dried with crumb as finished product; may add other additives such as carbon black or extender oils
Number of sites:	US government created 15 SBR plants in 1942; only 10 of the initial 15 plants in operation in 1977, and two more plants closed by 1984

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Mckeen, L. W. (2014). 4 - Styrenic plastics. :73-84.
HERO ID:	5697296
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	Styrene-acrylonitrile polymer is formed in a polymerization system in the presence of polybutadiene rubber latex. The final product is a complex mixture consisting of styrene-acrylonitrile copolymer, a graft polymer of styrene-acrylonitrile and polybutadiene and some free polybutadiene rubber.
Chemical concentration:	The proportions of the monomers typically range from 15% to 35% acrylonitrile, 5% to 30% butadiene, and 40% to 60% styrene.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the U.S.
	Metric 3:	Applicability	High	Data are for the polymerization of ABS, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination High

Study Citation:	Meinhardt, T. J., Young, R. J., Hartle, R. W. (1978). Epidemiologic investigations of styrene-butadiene rubber production and reinforced plastics production. Scandinavian Journal of Work, Environment and Health 4 Suppl 2:240-246.
HERO ID:	2975722
Conditions of Use:	Domestic manufacturing, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Process description:	typical SBR recipe includes 75parts butadiene per 100parts monomer; other ingredients are sturene n-dodecyl mercaptan, paramenthane hydroperoxide, sodium formaldehyde sulfoxylate, soap flakes, water (emulsion polymerization)... ingredients pumped from separate storage tanks into and through a series of agitated reactors until required degree of conversion is reached; reaction terminated by stopping free radicals with chemical such as sodium polysulfide; butadiene then recovered through distillation and styrene by steam stripping; antioxidant then added and latex is coagulated by brine and then dilute sulfuric acid
Number of sites:	15 SBR plants and 16 butadiene production facilities financed and built by US Government during WWII

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality data and information that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for domestic manufacturing and synthetic rubber manufacturing, in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Melnick, R. L., Shackelford, C. C., Huff, J. (1993). Carcinogenicity of 1,3-butadiene. Environmental Health Perspectives 100(0):227-236.
HERO ID:	646923
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	12 billion pounds worldwide; 3 billion pounds in the United States
Number of sites:	industrial hygiene survey at 4 monomer manufacturing and 5 polymer manufacturing plants

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	facility/process data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Menad, M., Bjorkman, B., Allain, E. G. (1998). Combustion of plastics contained in electric and electronic scrap. Resources, Conservation and Recycling 24(1):65-85.
HERO ID:	2078055
Conditions of Use:	Recycling (of plastics)

EXTRACTION

Parameter	**Data**
Process description:	poly(ABS) plastics components may be recovered in recycling processes using solvent extraction methods
Chemical concentration:	poly(ABS) found in personal computers as a plastic; plastics as a whole make up 30% of electrical and electronic application devices; only 25% of plastic wastes from electronics are recyclable

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from European countries, primarily OECD countries.
	Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Milbrandt, A., Coney, K., Badgett, A., Beckham, G. T. (2022). Quantification and evaluation of plastic waste in the United States. Resources, Conservation and Recycling 183:106363.
HERO ID:	11360398
Conditions of Use:	Disposal of plastics

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	44 Mt of plastic waste managed in 2019 domestically (abstract). See Table 2 (pg 4 of 8) for granular breakdown of amount of each type of plastic disposed. The word document supplement contains tables of polymer types in plastic waste used in the study on page 2 of 12
Life cycle description:	It was estimate plastic waste constituted approximately 13.7% of total MSW (municipal solid waste I assume? It's not clarified) managed nationwide in 2019 (pg 3 of 8)
Number of sites:	According to it, there were 2904 active landfills in the United States in 2019. The 1776 landfills considered here represent the main facilities receiving MSW. The remaining 1128 locations receive primarily construction and demolition waste, and while some accept MSW as well, that amount is small, about 1% of total landfilled MSW in the country. There are 99 combustionfacilities in the 2019 Waste Business Journal's database of which 85 reported values for received MSW. (Section 2.2, pg 2 of 8)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Data sources are generally high quality industry sources and EPA sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from US.
	Metric 3: Applicability	High	Disposal is in scope.
	Metric 4: Temporal Representativeness	High	Data used in the study are from 2019.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination High

Study Citation:	Minari, R. J., Stegmayer, G. S., Gugliotta, L. M., Chiotti, O. A., Vega, J. R. (2007). Industrial SBR process: Computer simulation study for online estimation of steady-state variables using neural networks. Macromolecular Reaction Engineering 1(3):405-412.
HERO ID:	5736922
Conditions of Use:	Processing as a monomer

EXTRACTION

Parameter	**Data**
Process description:	SBR production uses ””cold”” emulsion polymerization processes in series CSTRs, up to 15 reactors in series; typical conversion is limited to around 70%, and chain transfer agents usually added (page 2 of 8). Example SBR production from 7 series CSTRs; reactors were each 17,473 L and operated at 10 deg Celsius; all reagents fed into first reactor, unreacted monomers recuperated, bulk rubber separated from latex by coagulation and filtering. Base recipe for SBR grade 1502 at 302.8 L/min flow rate in parts per hundred monomer (pphm): 28.8 styrene, 71.2 BD, 200 water, 5.36 emulsifier, 0.040 initiator, 0.031 ferrous salt, 0.060 reducing agent, 0.182 CTA (page 3-4 of 8)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Argentina, a non-OECD country.
	Metric 3: Applicability	High	Data are for processing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Morgan, M. L. (1998). The C-4 industry beyond 2000. Chemistry & Industry 1998(3):90-94.
HERO ID:	5736027
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The global demand for butadiene was about 7.lMt in 1996. The U.S. was 25% of this demand. The consumtion was 29% SBR, 28% polybutadiene rubber, 13% SB latex, 10% ABS, 6% SB copolymers, 6% hexamethylenediamine, 4% nitrile rubber, 2% polychloroprene rubber, 1% MBS resins, and 1% miscellaneous.
Process description:	In the case of a steam cracker processing naphtha, the C4 stream can be handled in a variety of ways. The major use for the C4 steam is the extraction of butadiene, however, mixed C4s can be fully and partially hydrotreated and also recycled to the cracker without any hydrotreatment. The C4 stream can also be exported to other companies for butadiene extraction. All these methods of C4 disposal are practised, and choices are made depending on factors such as downstream integration and the economic situation.
Chemical concentration:	Typical naptha steam cracker mixed C4 streams contain 46-49% butadiene. If the feedstock is gas oil, ths C4 stream contains 43% butadiene. IF the feedstock is Propane, the C4 stream contains 69% butadiene. If the feedstock is Ethane, the C4 stream contains 75% butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from the U.K., an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, totals) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	Morris, L., G.D. (2005). Strong demand drives butadiene. Chemical Week 167(14):23.
HERO ID:	5700084
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Butadiene is manufactured, then passed downstream to latex and acrylonitrile-butadiene-styrene rubber producers. (page 1 of 1)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Europe, most of which are OECD countries.
	Metric 3:	Applicability	Low	Data are for the economic status of the butadiene industry, which isn't in scope nor can be compared to an occupational scenario, however the lifecycle of butadiene is touched upon in the article
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Morrow, N. L. (1990). The industrial production and use of 1,3-butadiene. Environmental Health Perspectives 86:7-8.
HERO ID:	5616600
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1987, 1,3-butadiene production was approximately 11.9 billion pounds worldwide and 2.7 billion pounds in the U.S. The uses of the butadiene are for styrene-butadiene rubber (32.7%), polybutadiene rubber (22.3%), adiponitrile (12.5%), styrene-butadiene latex (9.9%), chloroprene (6.6%), ABS resins (4.4%), nitrile rubber (2.7%), and other, including export (3.9%).
Life cycle description:	Domestic Manufacturing
Process description:	The extraction plants use an extraction solvent such as dimethylfornamide or acetonitrile to produce a highpurity (99.0% +) 1,3-butadiene monomer.
Number of sites:	In the U.S. there are 30 ethylene plants located in six states. The crude butadiene streams from these facilities are processed in 11 extraction units located in Texas and Louisiana. In the U.S., the majority of 1,3-butadiene is consumed by 18 companies that use 1,3-butadiene at 35 sites in 14 states.
Chemical concentration:	A high purity (99.0%+) butadiene monomer is extracted.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Mullins, J. A. (1990). Industrial emissions of 1,3-butadiene. Environmental Health Perspectives 86(0):9-10.
HERO ID:	5554351
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"Production of 1,3-butadiene in the United States is approximately 2.7 billion pounds per year almost totally as a by-product of ethylene production. Imports of 1,3-butadiene are about 0.5 billion pounds per year. The largest consumption of 1,3-butadiene (1.4 billion pounds in 1986) is for the production of styrene butadiene copolymers, which accounts for over 40% of the total. The next largest category of 1,3-butadiene consumption is in the production of polybutadiene. This process consumed about 730 million pounds in 1986, or 23% of the total United States consumption."
Life cycle description:	Domestic Manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for Emissions to Air, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	N/A	Process/life cycle description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing how much the results may differ than the values provided in the report. Variability is not addressed.

Overall Quality Determination — High

Study Citation:	Murphy, C. F., Allen, D. T. (2005). Hydrocarbon emissions from industrial release events in the Houston-Galveston area and their impact on ozone formation. Atmospheric Environment 39(21):3785-3798.
HERO ID:	121742
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Number of sites:	States that a total of 82 entities reported HRVOC emissions in the four Texas counties

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for chemical manufacturing and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	facility data
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing specific process unit and facility information.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples from multiple sites and different times, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	(1996). Phthalic anhydride - Sisas keeps Pioltello shut as Asia expands capacity. European Chemical News 66(1741):10-10.
HERO ID:	5178650
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Total production of all sites listed in the article is 717,000 tons/year of butadiene.
Throughput:	Occidental's butadiene manufacturing plant in Corpus Christi has a capacity of 95,000 tons/year. Lyondell's butadiene manufacturing plant in Chanelview has a capacity of 272,000 tons/year. Texas Petrochemicals' butadiene unit in Houston produces 350,000 tons/year.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total production) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	(2008). New 100 kt/a butadiene unit came online at Yangzi Petrochemical Company. China Petroleum Processing and Petrochemical Technology (2):61-61.
HERO ID:	5662689
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Throughput:	Originally, one butadiene unit at Yangzi Petrochemical Company made 53 kt/yr. The company increased total production capacity of this unit to 100 kt/yr in 2008. The company's total butadiene capacity is 200 kt/yr.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — Low

Study Citation:	(1999). Shell, BASF, Fina to build biggest butadiene plant. Oil and Gas Journal 97(29):34-35.
HERO ID:	5708119
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	By 2002, the world's largest butadiene plant was expected to start up with a production capacity of 900 million lbs/yr in Port Arthur, TX.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Production information.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	(2000). Three firms approve butadiene unit. Chemical & Engineering News 78(46):15-15.
HERO ID:	5708410
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Throughput:	The proposed extraction facility in Port Arthur, TX will produce 900 million lbs of butadiene per year.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination Medium

Study Citation:	(2006). Huntsman to sell US butadiene business. Chemical Engineering Progress 102(4):16-17.
HERO ID:	5709084
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Huntsman transfers its BD business to TX Petrochemicals, includes 900 million lb/yr BD plant in Port Neches, TX

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Production number.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	(1996). Butadiene - Fair contract price set. European Chemical News 67(1746):11-11.
HERO ID:	5716942
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Butadiene production in the U.S. was 635,000 tons in November 1996 and 626,000 tons in December 1996.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the U.S.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (total production) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	(1998). Butadiene - Europe's buyers slate Q2 contract. European Chemical News 69(1810):11-11.
HERO ID:	5717628
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1998, BASF had a 90,000 ton/year butadiene unit in Germany, Huls (now Evonik) had a 145,000 ton/year unit in Germany, and Enichem had a 130,000 tons/year unit in Italy.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Germany and Italy, both OECD countries.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production capacity) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Low

Study Citation:	(2011). Asahi to commercialize butadiene and propylene processes. Focus on Catalysts 2011(12):6.
HERO ID:	5721996
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Asahi Kasei Chemicals planned to start a 50,000-100,000 ton/year butadiene production site in Japan in 2015.
Process description:	The site planned to use BB-Flex process enables manufacture of butadiene using the C4 fraction butane

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Japan, on OECD country.
	Metric 3:	Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1993). NTP technical report on the toxicology and carcinogenesis studies of 1,3-butadiene (CAS no. 106-99-0) in B6C3F1 mice (inhalation studies).
HERO ID:	5160111
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1990 annual production volume is 12 billion pounds worldwide and 3 billion pounds in the USA (pg. 16/389)
Life cycle description:	Butadiene elastomers are used in the manufacture of rubber tires, footwear, sponges, hoses and piping, luggage, packaging, and a variety of other molded products. (pg. 16/389)
Process description:	coproduct in steam cracking of petroleum fractions for ethylene (pg. 16/389)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (1999). NTP report on carcinogens background document for 1,3-butadiene.
HERO ID:	5160135
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	75% used for synthetic rubber manufacture (1990)... In 1986... 32.7% used for SBR, 22.3% for polyBD rubber, 12.5% for adiponitrile, 9.9% for SB latex, 6.6% for chloroprene, 4.4% for ABS resins, 2.7% for nitrile rubber, and 3.9% other uses ; major end use products are tires and nylon products... 3.8billion pounds/yr in the United States in 1996; projected global production in 2001 is 18.5billion pounds with 5.5billion pounds in North America (pg. 8/143)
Process description:	production of 1,3-BD by distillation or extraction from crude butadiene byproduct in ethylene production
Number of sites:	10 sites (8 in Texas and 2 in Louisiana) (pg. 8/143)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacturing and processing, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fifteenth edition: 1,3-butadiene.
HERO ID:	5160138
Conditions of Use:	Domestic manufacturing, import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Between 1980-2002, US production ranged from low of 1.9billion lbs in 1982 to 4.4billion lbs in 2000... Import amounts from late 1970s onwards, with 1.4billion lbs in 2000; 200million lbs in 2002; 1.7billion lbs in 2008
Process description:	production of 1,3-BD by distillation or extraction from crude butadiene byproduct in ethylene production
Number of sites:	Worker exposures at 2,201 facilities
Comments:	See Page 2.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for domestic manufacturing and imports, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by temporal change, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	3.09 billion lb in 1993 (see page 44 of 52 for additional production volumes for different years)
Life cycle description:	An estimated 50% of the 1,3-butadiene produced in the USA is used in the production of styrene-butadiene rubber and 22% of the total supply for polybutadiene production. Other applications for 1,3-butadiene include chloroprene/neoprene rubber (6%), nitrile rubber ((3%), hexamethylenediamine (9%), acrylonitrile-butadiene-styrene resins (5%) and micellaneous uses (5%). (page 43 of 52)
Process description:	It is made from the processing of petroleum... (page 2 of 52) 1,3-Butadiene is manufactured primarily as a coproduct of steam cracking to produce ethylene in the United States, Western Europe, and Japan. (page 42-43 of 52, see pages for additional detail)
Number of sites:	29 reporting facilities through TSCA (page 19 of 52). 26 manufacturing facilities (page 41-42 of 52)
Chemical concentration:	Butadienes, stabilized or Butadienes and hydrocarbon mixture,stabilized containing more than 40% butadienes (page 37 of 52, in the context of shipment methods/regulation). Technical (98.0%); chemically pure (99.0%), instrument (99.4%), research (99.8%) (page 43 of 52)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1.2 billion lbs in 1998 and 1999 (page 45 of 52, see page for additional years)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Butadiene is a waste chemical stream constituent which may be subjected to ultimate disposal by controlled incineration. (page 38 of 52) For product, burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. For contaminated packaging, dispose of as unused product. (page 39 of 52)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 7845 1,3 Butadiene.
HERO ID:	10171483
Conditions of Use:	Processing, Plasticizer

EXTRACTION

Parameter	**Data**
Life cycle description:	An estimated 50% of the 1,3-butadiene produced in the USA is used in the production of styrene-butadiene rubber and 22% of the total supply for polybutadiene production. Other applications for 1,3-butadiene include chloroprene/neoprene rubber (6%), nitrile rubber ((3%), hexamethylenediamine (9%), acrylonitrile-butadiene-styrene resins (5%) and micellaneous uses (5%). (page 43 of 52)
Process description:	Important commercial chemical that is used to make synthetic rubber used in tires and various plastics and resins. Small amounts are found in gasoline (page 2 of 52) . It is an industrial chemical used in the production of polymers, polybutadiene, styrene-butadiene rubbers and lattices and nitrile-butadiene rubbers. (page 3 of 52).The majority of the butadiene produced worldwide is used as a monomer or co-monomer in the manufacture of synthetic rubber, above all for styrene - butadiene rubber and latex (SBR), polybutadiene rubber (BR), acrylonitrile - butadiene rubber and latex (NBR), and for chloroprene rubber (CR). Important plastics containing butadiene as a monomer component are impact-resistant polystyrene, a two-phase system consisting of polystyrene and polybutadiene; ABS polymers, consisting of acrylonitrile, butadiene, and styrene; and a copolymer of methyl methacrylate, butadiene, and styrene (MBS), which is used as a modifier for poly(vinyl chloride). In addition, butadiene is an intermediate in the synthesis of several important chemicals. (page 41 of 52, see page for additional uses).
Number of sites:	29 reporting facilities through TSCA (page 19 of 52). 26 manufacturing facilities (page 41-42 of 52)
Chemical concentration:	Butadienes, stabilized or Butadienes and hydrocarbon mixture,stabilized containing more than 40% butadienes (page 37 of 52, in the context of shipment methods/regulation). Technical (98.0%); chemically pure (99.0%), instrument (99.4%), research (99.8%) (page 43 of 52)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Last edited 2015 but most data is from the 90s
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	Newman, F. C. (1970). Process for butadiene manufacture by catalytic oxydehydrogenation of butenes. Industrial & Engineering Chemistry 62(5):42-47.
HERO ID:	5730059
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Domestic Manufacturing
Process description:	"Processes based on high temperature dehydrogenation of butane or butenes have assumed a much greater importance in the USA. This is done by extraction processes, with the effluent from cracked propane mixtures as the major feedstock. Oxydehydrogenation of n-butenes is a popular technique, and this reaction is readily accomplished in the vapor phase over a catalyst bed. The reaction involved is C4H8 + 1/2 O2 → C4H6 + H20."
Throughput:	Two tons per day of C4 hydrocarbon mixture containing 50-60% butadiene.
Chemical concentration:	Butadiene yields were typically 50-60% by weight.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3: Applicability	High	Data are for the synthesis of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by using different feedstock compositions and reactor types for the synthesis but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation:	NICNAS, (2013). 1,3-Butadiene: Human health tier II assessment.
HERO ID:	5155542
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Australia in 2000: total reported volume of BD was 325,700 tonnes

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1984). Current intelligence bulletin 41, 1,3-butadiene.
HERO ID:	62350
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	4,150,000,000 lbs (page 7 of 22)
Process description:	78% (3240 million pounds) of all 1,3-butadiene is produced as coproduct in the manufacture of ethylene, 22% (910 million pounds) produced by dehydrogenation of n-butene and n-butane (page 7 of 22)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	from United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	From 1984
	Metric 5:	Sample Size	N/A	N/A- no sampling data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1984). Current intelligence bulletin 41, 1,3-butadiene.
HERO ID:	62350
Conditions of Use:	Processing as a reactant, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	2,880,000,000 lbs of 1,3-butadiene is used in manufacturing of styrene-butadiene rubber (SRB) and polybutadiene rubber (BR), 320,000,000 used in manufacturing polychloroprene (neoprene) rubber (page 7-8 of 22)
Life cycle description:	manufacturing of SRB, BR, neoprene rubber, styrene-butadiene copolymer latexes used as carpet backing and paper coating materials, acrylonitrile-butadiene-styrene (ABS) resins used to make high impact resistant pipes and parts for automobiles and appliances, and in production of nitrile rubber, adiponitrile/hexamethylenediamine for nylon, polybutadiene polymers, thermoplastic elastomers, and methyl methacrylate-butadiene-styrene and nitrile resins. As an intermediate 1,3-butadiene is used in the production of various chemicals such as 1,4-hexadiene, 1,5-cyclooctadiene, and fungicides such as tetrahydrophthalic anhydride (page 8 of 22)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	from United States
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	From 1984
	Metric 5: Sample Size	N/A	N/A- no sampling data.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1981). In-depth industrial hygiene composite report on exposure to styrene and butadiene at two styrene-butadiene rubber processing plants.
HERO ID:	6580285
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1977, production for two plants in the study was reported to be around 326,000 metric tons annually.
Process description:	"The styrene and butadiene are first polymerized in the "Polymerization Unit" which consists of a number of reactor trains. Next, unreacted monomers are recovered in the "Recovery Unit". Finally, in the "Process Unit", the polymer is separated from the latex and dried. The details involved in each unit operation may vary from Plant A to Plant B in that throughput, extent of polymerization, other process variables, and chemical components other than styrene and butadiene are not necessarily the same."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
Metric 5:	Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Most critical metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1992). Occupational safety and health guideline for butadiene (1,3-butadiene).
HERO ID:	8408503
Conditions of Use:	Distribution in Commerce/Storage

EXTRACTION

Parameter	**Data**
Process description:	Butadiene should be stored in a cool, dry well-ventilated area in tightly sealed and pressurized containers that labeled in accordance with OSHA's hazard communication standard. Outside, isolated, or detached storage is preferred; inside storage should be in a non-combustible location. Containers of butadiene should be stored upright and should not be stacked. Containers of butadiene should be stored upright and should not be stacked. Containers of butadiene should be protected from physical damage and should be stored separately from oxygen, chlorine, phenol, chlorine dioxide, crotonaldehyde, copper, copper alloys, oxidizers, heat, spark, and open flame. The manufacturer's recommendation regarding shelf life, rotation of inventory, and monitoring levels of inhibitor should be followed rigorously. Only nonsparking tools may be used to handle butadiene. To prevent static sparks, containers should be grounded and bonded for transfers. Because containers that formally contained butadiene may hold product residues, they should be handled appropiately.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from NIOSH.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	U.S. data.
	Metric 3: Applicability	High	Applicable to multiple occupational scenarios.
	Metric 4: Temporal Representativeness	Low	More than 20 years old.
	Metric 5: Sample Size	N/A	N/A- qualitative information.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	NIOSH, (1978). Occupational health guideline for butadiene.
HERO ID:	8435202
Conditions of Use:	General

EXTRACTION

Parameter	**Data**
Life cycle description:	Liberation during molding and vulcanizing operations in processing of rubber products from styrenebutadiene (SBA) elastomer; polybutadiene elastomer into rubber products; manufacture of high-impact polystyrene containing SBA/polybutadiene elastomer and manufacture of SBA foams; processing into products of ABS resins and styrene-butadiene copolymer resins; processing of neoprene elastomers into rubber products; processing of nilrile elastomer into nitrile latexes and rubbers; processing of nitrile elastomer and PVC-nitrile polyblends; into rubber products and calendered plastic products.Use in manufacture of SBA elastomer, polybutadiene elastomer, neoprene elastomer, nitrile elastomer, and SB copolymer and ABS resins.Use in manufacture of adiponitrile, cycloolefins, 1,4-hexadiene tetramethylene sulfone, and tetrahydrophthalic anhydride.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size not applicable to qualitative life cycle information.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty not applicable to qualitative life cycle information.

Overall Quality Determination High

Study Citation:	NIOSH, (1973). Health hazard evaluation: Gates Rubber Company.
HERO ID:	8689109
Conditions of Use:	Synthetic rubber manufacturing (braided hose)

EXTRACTION

Parameter	**Data**
Process description:	The process consists of applying a braided polyester thread reinforcement to various types of unvulcanized rubber hose. Braiding machines weave the thread around the hose and most of the work force are engaged in operating these machines. The threads are passed through dip tanks containing the previously-mentioned chemicals prior to winding on spools and utilization by the braider. The composition of these dips is varied depending upon the characteristics desired in the finished hose.
Number of sites:	An initial hazard evaluation survey of the braided hose department, Gates Rubber Company, Denver. Colorado, was made on November 22, 1972.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Process description for braided-hose manufacturing does not indicate any quality issues. Reported from NIOSH HHE.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Report is over 20 years old.
	Metric 5: Sample Size	N/A	Sample size is not applicable to process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Variability and uncertainty are not applicable to process description.

Overall Quality Determination High

Study Citation:	Noor-Drugan, N. (1998). Markets - Butadiene set to move. Chemical Week 160(22):17-17.
HERO ID:	5748054
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	European inventories of butadiene slipped from 270 million lbs in March of 1998, to 231 million lbs in April, to 201 million lbs in May.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from European butadiene markets.
	Metric 3:	Applicability	High	Data are for butadiene production and imports, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Low

Study Citation:	Nunez, C., McMinn, B., Vitas, J. (1996). Barriers to the use of radiation-curable adhesives in the coated and laminated substrate manufacturing industry. Journal of Hazardous Materials 45(1):59-78.
HERO ID:	5466433
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Natural rubber and styrene-butadiene rubber (SBR) are the preferred polymers for solvent based saturants that are applied to paper. Although pollution problems and high costs of solvents make water-based saturants more attractive, solvents are considered necessary for the manufacture of electrical paper tapes because of the high performance characteristics currently offered only by solvent-based saturants . Several synthetic latexes used in the water-based saturants are SBR, acrylics, and carboxylated SBR. The most widely used latex saturants are acrylics. (page 4 of 20)
Process description:	Incoming coating formulation raw materials are blended in mix tanks or drums with high- or variable-speed dispersers. The dedicated-line facilities typically formulate a coating from resins (e.g., natural or synthetic rubbers), solvents, and additives. Batch processors often mix purchased blends with performanceenhancing additives or use and apply coatings premixed by a supplier. ... After the coatings have been mixed, they are pumped via a manifold system to the appropriate coating application system. While a dedicated-line facility may have a cylinder library consisting of 10 gravure cylinders (one for each coating thickness), the batch processor might have a library consisting of several hundred gravure cylinders, each one dedicated to a certain coating thickness for a specific customer. Similarly, a dedicated-line facility limits itself to a single type of substrate (e.g.,film) with varying thicknesses, weights, and/or widths. A batch processor uses a variety of substrates, often including films, papers, foils, and foams. The substrate webs are loaded onto an unwinder. The substrate is guided by idling rolls to a coating application station where the appropriate coating is applied. Once the coating has been applied, it enters an oven (typically zoned) for drying. The dried substrate is then ready for the second coating, laminating, or winding. Following its final rewind, the coated, and possibly laminated, web is slit according to customer specifications (if necessary), packaged, and shipped. (page 5-6 of 20, Butadiene not specifically mentioned.)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources including the EPA.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data from US
Metric 3:	Applicability	High	Data are for solvents in synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by describing different methods of curing and coating rubbers, but uncertainty is not addressed.

Overall Quality Determination High

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Study Citation:	Nunez, C., McMinn, B., Vitas, J. (1996). Barriers to the use of radiation-curable adhesives in the coated and laminated substrate manufacturing industry. Journal of Hazardous Materials 45(1):59-78.
HERO ID:	5466433
Conditions of Use:	Processing

EVALUATION

Domain	Metric	Rating	Comments

Study Citation:	Pelzl, B., Wolf, R., Kaul, B. L. (2018). Plastics, additives. :1-57.
HERO ID:	9493527
Conditions of Use:	Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Miscellaneous Coupling Agents. These include aluminates [103], zirconium aluminates [104], stearic acid and stearates, chlorinated paraffins, polyolefin waxes, and carboxylated polybutadienes, or polypropylenes modified with acrylic or maleic acid.Stearic acid and stearates are mainly used in CaCO3, especially CCP grades. Chemically modified polypropylene and polybutadiene areused on glass fibers, mica, CaCO3, and other fillers, chiefly in polypropylene.Graft Copolymers of Acrylonitrile and Styrene on Polybutadiene (ABS). ABS is a classical impact modifier for PVC (profiles, sheets, pipes, housings, bottles). The transparency of articles produced depends on the composition. ABS is less suitable for outdoor applications.Styrene–Butadiene Rubber. Finely divided styrene–butadiene rubber in polystyrene gives high impact products with a better transparency than high-impact polystyrene (HIPS) produced by graft polymerization of styrene on polybutadiene.
Process description:	Phenolic antioxidants (up to 2000 ppm) are added to high-impact polystyrene modified with polybutadiene. They are usually introduced before polymerization. Phosphites and phosphonites are sometimes employed as color stabilizers.In acrylonitrile–butadiene–styrene copolymers (ABS), the antioxidants are usually introduced into the polybutadiene latex phase by emulsification before it is blended with polystyrene–polyacrylonitrile. Along with 1000–2000 ppm of phenolic antioxidants, larger amounts of phosphite 8 or DLTDP are used.Methyl Methacrylate–Butadiene–Styrene Copolymers (MBS). The MBS agents are prepared by graft polymerization of styrene and methyl methacrylate on polybutadiene. They are used chiefly in PVC, where they offer advantages in clear products (bottles) and, to a lesser extent, in polycarbonates (automotive parts). Because of their sensitivity to light, they are less suitable for outdoor service.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	The writers are from an OECD country other than the U.S.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Source is from 2018.
	Metric 5: Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination — High

Study Citation:	Penman, M., Banton, M., Erler, S., Moore, N., Semmler, K. (2015). Olefins and chemical regulation in Europe: REACH. Chemico-Biological Interactions 241:59-65.
HERO ID:	4140906
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 3 on page 6 of 7 lists tonnes per year of various exposure scenarios developed for 1,3-butadiene. Use at industrial site - use as fuel: 500,000Use at industrial site - lab reagent: 1,000 tonnes/yearUse by professional - polymer processing: 25,000

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from European Union countries, which includes OECD countries.
Metric 3:	Applicability	High	Data are for manufacturing, processing, and commercial uses, which are in-scope occupational scenarios.
Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Penman, M., Banton, M., Erler, S., Moore, N., Semmler, K. (2015). Olefins and chemical regulation in Europe: REACH. Chemico-Biological Interactions 241:59-65.
HERO ID:	4140906
Conditions of Use:	Distribution

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 3 on page 6 of 7 lists tonnes per year of various exposure scenarios developed for 1,3-butadiene. Use at industrial site - distribution: 5,000,000

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from European Union countries, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for manufacturing, processing, and commercial uses, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation: Penman, M., Banton, M., Erler, S., Moore, N., Semmler, K. (2015). Olefins and chemical regulation in Europe: REACH. Chemico-Biological Interactions 241:59-65.
HERO ID: 4140906
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Table 3 on page 6 of 7 lists tonnes per year of various exposure scenarios developed for 1,3-butadiene. Use at industrial site - intermediate use: 250,000Use at industrial site - use in rubber production and processing: 3,000,000Use at industrial site - polymer production: 1,000,000 Use at industrial site - polymer processing: 250,000.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from European Union countries, which includes OECD countries.
	Metric 3: Applicability	High	Data are for manufacturing, processing, and commercial uses, which are in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Penman, M., Banton, M., Erler, S., Moore, N., Semmler, K. (2015). Olefins and chemical regulation in Europe: REACH. Chemico-Biological Interactions 241:59-65.
HERO ID:	4140906
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table 3 on page 6 of 7 lists tonnes per year of various exposure scenarios developed for 1,3-butadiene. Manufacturing: 5,000,000Formulation: 750,000

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from European Union countries, which includes OECD countries.
	Metric 3:	Applicability	High	Data are for manufacturing, processing, and commercial uses, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Penn, A., Snyder, C. A. (2007). 1,3-Butadiene exposure and cardiovascular disease. Mutation Research 621(1-2):42-49.
HERO ID:	2949035
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	4.4E09 lbs produced in 2000, 200E06 additional lbs imported
Life cycle description:	Synthetic rubber manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report summarizes many laboratory studies and journal articles by reputable sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data is from USA.
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old, but less than 20 years old.
Metric 5:	Sample Size	N/A	Process description/production data
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Every study mentioned is cited and explained with regards to methods.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Possible limitations of each study are discussed.

Overall Quality Determination — High

Study Citation:	Penn, A., Snyder, C. A. (2010). 6.27 - 1,3-butadiene and cardiovascular disease. :513-521.
HERO ID:	5697247
Conditions of Use:	Domestic manufacturing, Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	More than 2 billion kg produced in 2000; US output is approx. 25% of world's total annual production... 90 million kg additional imported into US per year to satisfy needs based on 2001 EPA study

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacturing and imports, in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	Peters, R. W., Daniels, E. J., Wolsky, A. M. (1992). RESEARCH AGENDA FOR WASTE MINIMIZATION. Water Science and Technology INTERNATIONAL ASSOCIATION ON WATER POLLUTION RESEARCH AND CONTROL(INTERNATIONAL ASSOCIATION ON WATER POLLUTION RESEARCH AND CONTROL):17-20.
HERO ID:	1621894
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	From Table 2, pg 4/8: In 1998, 1.6 million tons butadiene produced in the USA

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Pfäffli, P., Säämänen, A. (1993). The occupational scene of styrene. IARC Scientific Publications No. 127 (127):15-26.
HERO ID:	1151166
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1992 in the USA, 170,000 tons of ABS were used in appliances and electronics, 3,000 tons were used in furniture, 21,000 tons were used for toys and recreation, 69,000 tons were used for building and construction, 17,000 tons were used for packaging and disposal, 122,000 were used in automobiles, and 78,000 tons were used in other applications.
Process description:	SBR is produced in an emulsion polymerization process. Styrene-butadiene latex formulations are manufactured by reacting styrene and butadiene in the presence of water and catalysts.
Chemical concentration:	A typical styrene-butadiene rubber emulsion system for tire and wire and cable coatings contain 75 parts of butadiene, 25 parts of styrene, 180 parts of water and 5.7 parts of additives. The copolymer of styrene-butadiene latex contains 3 parts of styrene and two parts of butadiene.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3: Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production values, compositions) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability is addressed by providing statistics for different applications of butadiene. Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Posada, J. A., Patel, A. D., Roes, A., Blok, K., Faaij, A. P., Patel, M. K. (2012). Potential of bioethanol as a chemical building block for biorefineries: Preliminary sustainability assessment of 12 bioethanol-based products. Bioresource Technology 135:490-499.
HERO ID:	1454566
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Market in million m.t. is 12.2 (Page 2 of 10, Table 1)
Process description:	1,3-Butadiene is produced via catalytic conversion of bioethanol by steam cracking of naphtha with mass yield of 0.51 and molar yield of 0.44. (Page 2 of 10, Table 1)From a sustainability point of view, 1,3-butadiene and diethylether were the most favorable compounds to be produced through a bioethanol-based process as compared to the petrochemical route (See pages 5 and 6 for discussion).

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Medium	Data are from Netherlands, an OECD country.
Metric 3:	Applicability	Medium	Data are for experimental domestic manufacturing methods, which is similar to the in-scope occupational scenario for domestic manufacturing.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ramirez, R. A., Rojas-Nastrucci, E. A., Weller, T. M. (2018). Laser-assisted additive manufacturing of mm-wave lumped passive elements. I E E E Transactions on Microwave Theory and Techniques 66(12):5462-5471.
HERO ID:	5717968
Conditions of Use:	Processing as a monomer

EXTRACTION

Parameter	**Data**
Process description:	acrylonitrile-butadiene-styrene used for dielectric layers in fabrication of microwave components (capacitors for example); use of additive manufacturing with 3D printing of ABS base layers along with laser that etches small cavities in ABS for filling with conductive paste

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality information from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of a polymer product, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ray, R., Thorpe, R. B. (2007). A comparison of gasification with pyrolysis for the recycling of plastic containing wastes.
HERO ID:	5720319
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Process description:	”With pyrolysis processes, a substantial amount of the intrinsic chemical energy of plastic waste can be recovered through products, for instance monomers and transport fuel. Pyrolysis produces a mixture of combustible gases (primarily methane, other hydrocarbons, hydrogen and carbon monoxide), hydrocarbon liquids (contain several constituents over a wide range of molecular weight) and carbon rich solid residues. The relative quantities of gas, liquid and solid depend on the mode of pyrolysis and operating conditions like temperature, rate of heating, pressure and residence time. More liquid is produced at lower temperatures whereas higher temperatures and longer residence times produce more gas. Lower process temperature and longer vapor residence time favor the production of charcoal . In high temperature pyrolysis, where the temperature varies within the range of 650-850C, secondary gas phase cracking occurs and the primary devolatilization products are cracked to result a wide spectrum of smaller hydrocarbons (ranging from C1–C9) like alkenes, alkanes, aromatics and gaseous by-products. ”
Chemical concentration:	A typical composition of the gas resulting form pyrolisis of plastics is 4-10% methane, 22-31 wt% ethylene, 1.5- 2.7 wt% ethane, 10-14 wt% propylene, 0.5-1 wt% propane, 4.5–5 wt% n/iso-butene, 0.3-0.6 wt% cis/trans-2-butene, 6-7 wt% butadiene (mostly 1,3-butadiene)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3:	Applicability	High	Data are for the disposal and recycling of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty and variability of the waste composition isn’t addressed.

Overall Quality Determination Medium

Study Citation:	Roff, W. J., Scott, J. R. (1971). Section 34 - Styrene/butadiene rubbers. Elsevier Elsevier(Elsevier):383-395.
HERO ID:	5697322
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	""""1,3-Butadiene and styrene are copolymerized using a catalyst, usually in emulsion, but sometimes in solution. In emulsion polymerization, the liquid monomers are emulsified in water containing a soap and/or other emulsifying agent, and are polymerized either (i) at 50°C using potassium persulphate or an organic peroxide as initiator, to give 'hot rubber, or (ii) at 5°C using a redox initiating system, e.g. ferrous sulphate plus a peroxyl compound (p-menthane hydroperoxide) with or without sodium formaldehyde sulphoxylate, to give 'cold rubber. Normally the reaction mixture contains also a modifier or regulator (to control molecular weight), buffer salts (e.g. phosphates), and sequestering agents (to control the ferrous ion concentration when a redox system is used). Polymerization is terminated at 70 % conversion by adding a 'short-stopper' (e.g. quinol, or sodium dimethyldithiocarbamate plus an alkylene polyamine). Unreacted monomers are removed by 'flashing' followed by steam heating at reduced pressure. After addition of an antioxidant ('stabilizer'), the polymer suspension is coagulated (sometimes with prior creaming by addition of brine) and the crumb-like coagulum is separated and dried. In solution polymerization The monomers, diluted with a hydrocarbon solvent, are copolymerized by a stereospecific catalyst, e.g. a lithium alkyl, generally as in the solution polymerization of butadiene. Solution polymers contain less non-polymer constituents than emulsion polymers.""""
Chemical concentration:	The molar proportion of styrene in SBR can range from 1.8-40%, but is normally 13.5-15%, making the proportion of butadiene typically 85-86.5%.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	It is unclear where the data is from.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability is addressed by including different production methods of SBR and different types of SBR. Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Russell, I. M., Evans, D. J. (1990). Wool butadiene copolymers. I. Preparation and morphology. Journal of Applied Polymer Science 40(11-12):1951-1970.
HERO ID:	5735866
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	"Polymerizations initiated with gamma-radiation were conducted in cylindrical stainless-steel pressure vessels of 250 cm3 or 700 cm3 total capacity. Samples of wool, preconditioned to the required moisture content, were placed in the precooled pressure vessels containing solvent (if required), and liquid butadiene was added. Typically, 50 g of wool was treated with 100 cm3 of liquid butadiene. The vessel was sealed, and a little butadiene gas was expelled from a vent to remove air remaining in the container. No attempt was made to degas the wool prior to its addition to the vessel. The sealed vessels were irradiated with a 6oCo gamma-radiation facility at Ansell, Medical Aids, Melbourne. The dose rate was approximately 5 kGy/ h, and the total dose was 25 kGy. The irradiated vessels were opened after 72 h, and the wool samples were sequentially washed in toluene, acetone, ethanol, and finally water. The polymer deposition was calculated as the percentage increase in the weight of the sample after exhaustive solvent extraction in toluene." (page 2 of 20)
Chemical concentration:	Preliminary experiments conducted with wool at ambient regain (approximately 12% moisture) showed that weight uptakes of polybutadiene of 40%- 50% could be achieved when wool and butadiene were mutually irradiated with 25 kGy of gamma radiation at a dose rate of approximately 5 kGy/h. (page 4 of 20)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for organic fabric manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by stating the limits of detection in the experiment. Variability addressed by using different solvents.

Overall Quality Determination High

Study Citation:	Rutkowski, J. V., Levin, B. C. (1986). Acrylonitrile butadiene styrene copolymers (ABS) - pyrolysis and combustion products and their toxicity - a review of the literature. Fire and Materials 10(3-4):93-105.
HERO ID:	1479361
Conditions of Use:	Processing (ABS plastic)

EXTRACTION

Parameter	**Data**
Process description:	ABS polymers can be produced by two general methods, each of which generates a different type of plastic. Type A ABS polymers are produced by a mechanical blending of a styrene-acrylonitrile copolymer resin with a butadiene-based elastomer (butadiene acrylonitrile rubber). The production of Type B ABS involves a grafting of styrene and acrylonitrile onto polybutadiene. The Type B polymer also contains a styrene-acrylonitrile copolymer and ungrafted polybutadiene. The types of plastics are varied further by differences in the relative proportions of the monomer components.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for use in polymer production, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Ryan, M. E., Stephenson, M. J., Grosser, K., Karadin, L. J., Kaknes, P. (1996). Statistical analysis of product variability associated with continuous and cut sheet thermoforming operations. Polymer Engineering and Science 36(19):2432-2442.
HERO ID:	5794481
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Polymer in rubber manufacturing, plastic and resin manufacturing
Process description:	The material used to produce the drinking cups is a blend of a styrene-butadiene block copolymer. The operating temperatures studied were in the range of 130 to 150°C (270 to 310°F). The commercial production process uses a roll-fed sheet having a thickness of 0.2 mm (80 mils), whereas the pilot test former employs a roll-fed sheet having a thickness of 0.1 mm (42 mils).

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene polymer use in plastic production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Scarselli, A., Corfiati, M., Marzi, Di, D., Iavicoli, S. (2017). Appraisal of levels and patterns of occupational exposure to 1,3-butadiene. Scandinavian Journal of Work, Environment and Health 43(5):494-503.
HERO ID:	4140715
Conditions of Use:	Domestic Manufacturing, Processing, Commercial use

EXTRACTION

Parameter	**Data**
Life cycle description:	At industrial level, 1,3-butadiene is used as a chemical intermediate to produce many chemicals, mostly in the manufacturing of rubber, plastics, and their copolymers, as well as in the production of resins.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for various in-scope occupational scenarios including processing and commercial use.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination — Medium

Study Citation:	Sigma-Aldrich, (2020). Safety data sheet: 1,3 Butadiene. :11.
HERO ID:	6307829
Conditions of Use:	Laboratory Chemical

EXTRACTION

Parameter	**Data**
Chemical concentration:	<=100%

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	SDS information is primary data from the supplier. SDS does not appear to have quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Product is from a US supplier.
	Metric 3:	Applicability	High	SDS is applicable to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Source is from 2024, which is less than 10 years old.
	Metric 5:	Sample Size	Low	Single value - no distribution/statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Source just provides concentration and does not document how this value was obtained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Sim, P. H. (2001). Olefins - Texas petrochemicals boosts butadiene capacity by one-third. Chemical Week 163(28):14-14.
HERO ID:	5707574
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Texas Petrochemicals in Houston has a total butadiene production of 1.2 billion lbs/yr (page 1 of 1)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by explaining the decline of the butadiene market. Variability is not addressed.

Overall Quality Determination Medium

Study Citation:	Sim, P. H. (2005). Butadiene continues to rise. Chemical Week 167(2):36.
HERO ID:	5709145
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Sabina Petrochemicals plant in Port Arthur, TX has capacity of 410,000 metric ton/yr started up in 2004... US BD demand in 2004 was 2.25 million metric ton; globally it was 9 million metric tons. (page 1 of 1)
Life cycle description:	Global growth of butadiene is driven by polybutadiene rubber, which consumes butadiene (page 1 of 1)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Steinle, P. (2016). Characterization of emissions from a desktop 3D printer and indoor air measurements in office settings. Journal of Occupational and Environmental Hygiene 13(2):121-132.
HERO ID:	3124670
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Life cycle description:	In this study Acrylonitrile butadiene styrene (ABS) is used as a filament 1.75 or 3 mm in diameter for use in FDM-printers. ABS is also a widely used standard polymer for many toys and consumer products (page 2 of 13). for ABS, carbon monoxide and hydrogen cyanide are regarded as critical combustion products and the respective copolymers as main component of injection-molding emissions (page 3 of 13).
Process description:	Most FDM-printers operate with either PLA or ABS filaments of 1.75 or 3 mm diameter, which are extruded at temperatures of usually about 210°C (PLA) and 240°C (ABS) through a moving nozzle onto maneuverable base plates, which are usually heated (temperature range 50–100°C). On this platform, the object is build layer by layer. (Page 2 of 13)
Chemical concentration:	Yellow ABS and PLA filament of 1.75 mm diameter was obtained from the same manufacturer. Composition according to the material safety data sheet (MSDS): 95–100% ABS / 80–90% PLA, rest not declared. (Page 3 of 13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Switzerland, an OECD country.
	Metric 3:	Applicability	High	Data are for 3D printer emissions in an office space, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning undetectable species and explaining differences between printer types. Variability addressed by multiple visits to the same site 7 months apart.

Overall Quality Determination High

Study Citation: Sun, H. N., Wristers, J. P. (2002). Butadiene.
HERO ID: 5349218
Conditions of Use: Manufacture

EXTRACTION

Parameter	Data
Production, import, or use volume:	4.4 billion pounds (2:0X109 kg) (2000 U.S. production) pg. 1; Capacities in terms of x10^6 kg (10^6lb)BP Amoco, Chocolate Bayou, Texas 90.7 (200)Equistar, Channelview, Texas 281.2 (620)Equistar, Chocolate Bayou, Texas 68.0 (150)Equistar, Corpus Christi, Texas 90.7 (200)Exxon, Baton Rouge, La. 149.7 (330)Exxon, Baytown, Texas 122.5 (270)Huntsman, Port Neches, Texas 370.6 (850)Shell, Deer Park, Texas 136.0 (300)Shell, Norco, La. 260.8 (575)Texas Petrochemicals, Houston, Texas 415.0 (915)Total 1985 (4,410)
Life cycle description:	Butadiene is used primarily in polymers, including SBR, BR, ABS, SBL, and NR. In 2000 these uses accounted for about 89% of butadiene consumed in the United States (1). Styrene–butadiene rubber, the single largest user of butadiene, consumes 29% of the total. It is followed by polybutadiene rubber at 27%. Consumptionfor the other polymers, ABS, SBL, polychloroprene, and nitrile rubber are listed in Table 9. Another significant butadiene use is for manufacturing adiponitrile, NC(CH2)4CN [111-69-3], a precursor for nylon-6,6 production. Other miscellaneous chemical uses, such as for ENB (ethylidene norbornene) production, account for 7% combined (Fig. 4) (271). pg. 20
Process description:	1,3-Butadiene is manufactured primarily as a coproduct of steam cracking to produce ethylene in the United States, Western Europe, and Japan. However, in certain parts of the world it is still produced from ethanol. The earlier manufacturing processes of dehydrogenation of n-butane and oxydehydrogenation of n-butenes have significantly declined in importance and output. Efforts have been made to make butadiene from other feedstocks such as other hydrocarbons, coal (2,3), shale oil (4); and renewable sources like animal and vegetable oil (5), cellulose,hemicellulose, and lignin (6,7), but in the United States none of these have moved beyond the research and development stage.During the reaction a hydrocarbon feedstock is heated to~800oC and 34 kPa (5 psi) for less than a second during which carbon–carbon and carbon–hydrogen bonds are broken. As a result, a mixture of olefins, aromatics, tar, and gases are formed. These products are cooled and separated into specific boiling range cuts of C1, C2, C3, C4, etc. The C4 fraction contains butadiene, isobutylene, 1-butene, 2-butene, and some other minor hydrocarbons.The overall yields of butadiene depend on both process parameters (231) and the composition of feedstocks (Table 4) (232). Generally, heavier steam cracking feedstocks produce greater amounts of butadiene as a by-product. Thus, with heavier feedstocks like light naphtha or virgin gas oil, up to about 5.4 wt% of the total product is butadiene. The processes of separating butadiene from the other C4compounds are described later. pg. 14Dehydrogenation of n-butane pg. 14Oxidation of n-butenes pg.15Separation and purification of butadiene from other components is dominated commercially by the extractive distillation process. Full description on pg. 15
Number of sites:	10 sites
Chemical concentration:	>=99.5% 1,3-butadiene

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data

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Study Citation: Sun, H. N., Wristers, J. P. (2002). Butadiene.
HERO ID: 5349218
Conditions of Use: Manufacture

Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report addresses variability but not uncertainty in the results.

Overall Quality Determination — High

Study Citation: Sun, H. N., Wristers, J. P. (2002). Butadiene.
HERO ID: 5349218
Conditions of Use: Processing as a reactant

EXTRACTION

Parameter	Data
Process description:	Pages 4-151,3-butadiene is processed as a reactant for the production of hexamethylenediamine [124-09-4], a key comonomer in nylon-6,6 production; Chloroprene (qv), 2-chloro-1,3-butadiene, [126-99-8] is produced commercially from butadiene in a three-step process; 1,4-butanediol; 1-butene or 2-butene substituted products; sulfolane; SBR, polybutadiene (BR), styrene– butadiene latex (SBL), acrylonitrile–butadiene–styrene polymer (ABS), nitrile rubber (NR) and more...

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	n/a- no sampling data
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The report addresses variability but not uncertainty in the results.

Overall Quality Determination High

Study Citation:	Suresh, S. S., Bonda, S., Mohanty, S., Nayak, S. K. (2018). A review on computer waste with its special insight to toxic elements, segregation and recycling techniques. Process Safety and Environmental Protection 116:477-493.
HERO ID:	4665434
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 2014, 41.8 million metric tons of waste electrical and electronic equipment were produced. 20% of this waste is plastics, and 30% of the plastic waste is ABS.
Process description:	"Plastics and metals have to be sorted prior to recycling of any WEEE products. The first step in the recycling process is pre-treatment of the material for removing visible contaminants which are adhered to the products, such as oil particles, dust, labels etc. The computer parts include various products like plastic housing, monitors including both CRT and LCD, floppy, DVD and CD drive, wires for data and electrical transmission cables, electronic products such as power supply batteries, PCBs which is implanted with various metals in a supporting insulator plastic etc... The liberation and diminution of the recyclable materials in a computer waste are usually achieved by shredding or crushing process with the help of harmer milling or shredders... After shredding of the computer waste materials a variety of sorting techniques such as magnetic separation, electrostatic separation, eddy current separation, triboelectrostatic separation and density separation and forth flotation can be used for the isolation of metals and plastics from the mixture. Major portions of the computer waste comprise of metals and plastics, which can be recovered during disassembly stage and can be used for further applications through upgrading their properties. This is performed by metallurgical processes like hydrometallurgy or pyrometallurgy. The recycling methods such as mechanical recycling, chemical recycling and thermal recycling techniques are commonly used for the recycling of plastics recovered from the computer waste. However, most of the plastic resins have incorporated with various additives such as fillers, FRs and heavy metals, and most of them are hazardous to the environment. Therefore a sufficient attention should be given prior to the selection of the recycling methods. Thermoplastics materials like ABS are commonly recycled via mechanical recycling like injection molding, extrusion, rotational molding and compression molding to new shaped products."
Chemical concentration:	As of 2012, ABS makes up 34 wt% of computers, 45% of CPU's, and 70% of CRT monitors.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	High	Data are for the disposal and recycling of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, production data) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variation in chemical compositions of plastic components is addressed. Uncertainty isn't addressed.

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Study Citation:	Suresh, S. S., Bonda, S., Mohanty, S., Nayak, S. K. (2018). A review on computer waste with its special insight to toxic elements, segregation and recycling techniques. Process Safety and Environmental Protection 116:477-493.
HERO ID:	4665434
Conditions of Use:	Disposal

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		**High**	

Study Citation:	Tan, H., Wang, Q., Wang, A., Ye, Y., Feng, N., Feng, X., Lu, L., Au, W., Zheng, Y., Xia, Z. (2010). Influence of GSTs, CYP2E1 and mEH polymorphisms on 1, 3-butadiene-induced micronucleus frequency in Chinese workers. Toxicology and Applied Pharmacology 247(3):198-203.
HERO ID:	2583451
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	It is estimated that the total amount of BD capacity is approximately 12 million tons worldwide in 2006, in which in China is nearly 1.61 million tons.
Life cycle description:	Production for synthetic rubber and resin manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Data from peer reviewed journal.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	The data are from a non-OECD country
Metric 3:	Applicability	High	Report is within scope.
Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 yearsbut no more than 20 years old.
Metric 5:	Sample Size	N/A	Production and life cycle description.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Most metadata included.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Texaco Chem Co, (1992). Initial submission: Letter from Texaco Chem Co to USEPA regarding a study in mutation and human exposure to butadiene with cover letter dated 110292 and attachments.
HERO ID:	5665270
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Total production in 1987 of 2.7 billion lbs (pg 13)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The data source is unspecified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 30 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination Medium

Study Citation:	Texaco Chem Co, (1993). Support: mutation and human exposure to butadiene with cover letter dated 121692.
HERO ID:	5665287
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Total production in 1987 of 2.7 billion lbs.
Life cycle description:	Domestic Manufacturing

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different sites within the plant.

Overall Quality Determination High

Study Citation:	Tossavainen, A. (1978). Styrene use and occupational exposure in the plastics industry. Scandinavian Journal of Work, Environment and Health 4(2 SUPPL.):7-13.
HERO ID:	1151237
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	1.8 million tons of ABS produced per year. 4 million tons of styrene-butadiene copolymers produced per year.
Life cycle description:	Polymerization of plastic resins

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Data comes from Institute of Occupational Health in Finland, and Kirk-Othmer.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data is from an OECD country.
	Metric 3: Applicability	High	Data is within scope.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Data sources are clearly cited and included.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Toxicology Excellence for Risk Assessment (TERA) (2016). Exposure assessment: Potential for the presence of phthalates in specified materials at concentrations above 0.1 percent.
HERO ID:	5155525
Conditions of Use:	Processing for plastic materials manufacturing, Recycling

EXTRACTION

Parameter	**Data**
Process description:	Ethylene-butadiene rubber: synthesized using catalysts such as titanium-based, vanadium-based, metallocene, lanthanide-based organometallics, neodymocenes... Impact-modified PS: used as copolymer; polyBD synthesized, then PS grafted on using Ziegler Natta catalyst; use injection molding, extrusion, blow molding, or thermoforming.. SBS and SB Rubber: SBS prepared commercially using anionic polymerization methods and either sequential, coupling, or multifunctional methods to achieve triblock copolymer; SB rubber prepared by emulsion polymerization, or batch or continuous solution anionic polymerization; processed using injection molding as most common for thermoplastic elastomers... Recycling: may use mechanical, thermal, chemical recycling for typical polymers; rubbers recycled via ambient, cryogenic, or wet grinding into smaller pieces, but also devulcanization and further reprocessing to form a thermoplastic elastomer
Chemical concentration:	SB rubber is randomly copolymerized with approximately 75% BD by weight; final styrene content in anionic polymerzation of SBR is typically 10-40% styrene waste electrical and electronic equipment contians approx. 10-30% plastic with mainly styrene based ABS and HIPS as constituents

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic materials manufacturing and recycling, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	ToxStrategies, (2021). Analysis of 1,3-butadiene industrial hygiene data.
HERO ID:	9356965
Conditions of Use:	Manufacturing and Processing as a Reactant conditions of use

EXTRACTION

Parameter	**Data**
Process description:	Butadiene is produced commercially by three processes:• Steam Cracking of Paraffinic Hydrocarbons: In this process, butadiene is a coproduct in the manufacture of ethylene (the ethylene co-product process)• Catalytic Dehydrogenation of n-Butane and n-Butene (the Houdry process)• Oxidative Dehydrogenation of n-Butene (the Oxo-D or O-X-D process) These manufacturing processes are performed in closed systems. Each of these processes produces a stream commonly referred to as crude butadiene that is rich in 1,3-butadiene. Separation and purification of the butadiene stream is typically carried out by extractive distillation, since the boiling points of the various C4 components are so close to each other. The final concentration in the purified butadiene product is typically <99 wt % pure and is stored liquefied in a pressurized sphere. Liquefied butadiene is shipped by pipelines, ships, barges, rail tank cars, tank trucks and bulk liquid containers to industrial customers who use it as a reactant or ingredient.The immediate industrial users of 1,3 butadiene either polymerize the butadiene monomer or use it as a chemical intermediate. It is important to note that these intermediates are subsequently sold to manufacturers who make final end products for consumers, listed
Number of sites:	47

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Comprehensive study by trade association
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The NAICS codes for which the data are represented are:324110 – Petroleum refineries325110 – Petrochemical manufacturing325199 – Other organic chemical manufacturing325210 – Resin and synthetic rubber manufacturing325211 – Plastic and resin manufacturing325991 – Custom compounding of purchased resins325998 – All other chemical product and preparation manufacturing
	Metric 4:	Temporal Representativeness	High	All of the Consortium data were collected during theyears of 2010 -2019 and therefore directly applicable to EPA's risk evaluation.
	Metric 5:	Sample Size	N/A	process description
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	process description
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	process description

Overall Quality Determination High

Study Citation:	Tuncay, V., Ooijen, van, A., P.M. (2019). 3D printing for heart valve disease: a systematic review. 3(1):9.
HERO ID:	5789597
Conditions of Use:	Plastic and rubber products

EXTRACTION

Parameter	**Data**
Process description:	PDF Pg. 4"The literature shows that acrylonitrile butadiene styrene or ABS (4/14, 29%) and TangoPlus FullCure 930 (5/14, 36%) (Stratasys Ltd., Eden Prairie, MN, USA) are the most commonly used materials (Table 1). TangoPlus FullCure 930 is a commercially available translucent rubber-like PolyJet photopolymer material. It can simulate different levels of hardness, elongation, and tear resistance. Because of the difficulty of direct printing in flexible materials, many papers describe a process in which print casts and molds are printed in other materials that are then dipped in, or coated with, silicone to obtain flexible vessels and valves with more accurate tissue properties [12, 27]. A challenge with this method is that it must either be possible to remove the silicone from the cast or mold after hardening or the cast or mold should be printed in a dissolvable material. Few examples of customised printers also exist that directly print with (sanitary) silicone [11, 31]."PDF Pg. 5"Several printing techniques exist. Among them, most frequently used and well known are fused deposition modeling (FDM), STL, PolyJet, and laser sintering."PDF Pg. 6"Based on the literature review performed, it is clear that STL is the preferred method for cardiac valve printing (40%), followed by FDM (30%). The preference for STL can be mainly explained by its ability to print more easily with flexible and transparent materials than other techniques. In some cases, a dedicated setup was built to allow less conventional printing materials or printing hardware. One example setup in the literature was built with a syringe filled with (sanitary) silicone that was used to print a semi-transparent, flexible aortic root [31]. A high accuracy could be achieved (3.0% error along the x- and y-axes; 4.1% error along the z-axis). Although this was a very cheap solution, printing and post-processing time of the print were quite long (from 3 h and 20 min to 3 days)."

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are from the Netherlands, an OECD country.
	Metric 3: Applicability	High	Data are for Plastic and Rubber products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	N/A - process description.

Overall Quality Determination High

Study Citation:	U.S. BLS, (2023). U.S. Census Bureau of Labor Statistics Data from 2021.
HERO ID:	11138808
Conditions of Use:	All

EXTRACTION

Parameter	**Data**
Number of sites:	Used to develop a method to estimate number of sites and workers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	BLS is expected to use reliable survey methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	U.S. based economic data.
	Metric 3:	Applicability	High	These economic data cover all industry and occupation types in scope for all chemicals.
	Metric 4:	Temporal Representativeness	High	The BLS OES data are from 2021.
	Metric 5:	Sample Size	High	The BLS OES program provides detailed statistics and estimated relative standard error for each state, industry, and occupation survey conducted (https://www.bls.gov/oes/current/oes_research_estimates.htm).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	BLS documents results and methods, but underlying survey results not accessible.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Limited discussion of variability and uncertainty in results.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene. Review draft.
HERO ID:	10293377
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1977 between 2.1 and 7.3 billion pounds was produced or imported (15 of 104)
Comments:	See pages 47-70 for summary of epidemiologic studies, most of which did not have extractable information but did have general information about various studies done in different specific plants such a number of workers that work at a given facility and how many years worked (mostly rubber plants)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (1985). Mutagenicity and carcinogenicity assessment of 1,3-butadiene. Review draft.
HERO ID: 10293377
Conditions of Use: Processing as a Reactant

EXTRACTION

Parameter	Data
Life cycle description:	Used by the styrene-butadiene rubber and polybutadiene rubber industries (page 9 of 104) Used as intermediate in production of polymers, elastomers, and other chemicals. Major use in manufacture of styrene-butadiene rubber (synthetic rubber). Also used as intermediate to produce a variety of industrial chemicals and adhesives (page 15 of 104)
Chemical concentration:	Typical recipe for SBR, butadiene accounts for 26% of total ingredients (page 49 of 104)
Comments:	See pages 47-70 for summary of epidemiologic studies, most of which did not have extractable information but did have general information about various studies done in different specific plants such a number of workers that work at a given facility and how many years worked (mostly rubber plants)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	The data are from the United States.
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (2020). 2020 CDR: Commercial and consumer use.
HERO ID:	10366189
Conditions of Use:	Manufacture and Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Provides U.S. domestic manufactured and imported PV and %PV to downstream uses.
Number of sites:	Provides number of manufacturing and import sites.
Chemical concentration:	Provides concentration.
Physical form:	Provides physical form.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA is a trusted source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	CDR is U.S. based data.
	Metric 3:	Applicability	High	CDR covers chemical manufacturers and importers, which are in scope for all chemicals.
	Metric 4:	Temporal Representativeness	High	EPA used data from the 2020 CDR.
	Metric 5:	Sample Size	Medium	Due to reporting threshold, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Submissions do not include method of how production volumes were determined. CDR industry sector codes, industrial processing and use codes, industrial function codes, and commercial product codes provide good metadata; but lack of clarifying information and narratives and occasional misreportings limit clarity of data.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	CDR data do not address variability or uncertainty in submitter provided data.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1984). Assessment of occupational exposure data on 1,3-butadiene in plants producing synthetic rubbers, plastics, and resins.
HERO ID:	10476131
Conditions of Use:	Plastic material and resin manufacturing, Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Rubber and Plastic Manufacturers who use Butadiene
Number of sites:	Number of North American SBR Plants: 11
Chemical concentration:	Pure Butadiene (100% concentration)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2019). Synthetic turf field recycled tire crumb rubber research under the Federal Research Action Plan, Final report part 1: Tire crumb rubber characterization, volume 1.
HERO ID:	11803647
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Number of sites:	EPA reached out to 6 tire recycling companies with 9 facilities where tire crumb rubber samples were collected.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for recycling, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.
HERO ID:	46492
Conditions of Use:	Processing –incorporation into formulation, mixture, or reaction product

EXTRACTION

Parameter	**Data**
Process description:	See page 475 for a process description of solvent base surface coating, to which styrene-butadiene rubber acts as a coating solid in the coating formulation.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 1995
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.
HERO ID:	46492
Conditions of Use:	Processing - processing as a reactant

EXTRACTION

Parameter	**Data**
Process description:	Because of the brittleness of crystal polystyrene, styrene is frequently polymerized in the presence of dissolved polybutadiene rubber to improve the strength of the polymer. Such modified polystyrene is called high-impact, or rubber-modified, polystyrene. (page 725 of 2050) In the polystyrene batch bulk polymerization process, there is a step where, for the production of impact-grade polystyrene, chopped polybutadiene rubber is added to the feed dissolver, where it is dissolved in the hot styrene. See page 726-729 for more information on this process. See section 6.10 on page 775 to 777 for an in depth process description for producing Styrene-Butadiene Copolymers

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	from 1995
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	U.S. EPA, (1983). Draft existing chemical market review 1,3-butadiene.
HERO ID:	5664524
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1981, the net U.S. production capacity was 4,645 million lbs. 462 million lbs came from imports. (pg. 5/18).
Life cycle description:	Domestic Manufacturing & Imports
Process description:	The majority of butadiene produced in the U.S. is produced as a coproduct with ethylene from the steam cracking of hydrocarbon feedstocks (65%). It is also commercially produced by oxidating dehydrogenation of n-butenes and catalytic dehydrogenation of n-butene (35%). (pg. 6/18 and percentages from pg. 7/18))
Number of sites:	13 known producers (See Table 1)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for manufacturing and imports of butadiene, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID:	6389860
Conditions of Use:	Processing as a reactant: Plastic material and resin manufacturing & Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Section 3 contains information about share of 1,3-butadiene PV that is used for producing the products listed below.
Life cycle description:	1,3-butadiene used in production of styrene-butadiene (SB)copolymer, polybutadiene, adiponitrile, neoprene, acrylonitrile-butadiene-styrene (ABS) copolymer, and nitrile elastomer.
Process description:	See Section 5 of the document for process descriptions of the above processes.
Number of sites:	See section 5.0 for number of sites of some of the above processes.Also, Appendix C contains company and location information for sites at which the above listed products are produced.
Chemical concentration:	See section 5 of the document for concentration of 1,3-butadiene in some of the processes.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Data source is EPA report
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old, and the data may be outdated with the exception possibly of the process description.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Several of the data sources are apparently internal EPA memoranda that are not publicly available.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability is addressed by including different processes but uncertainty is not addressed.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID: 6389860
Conditions of Use: Manufacture

EXTRACTION

Parameter	Data
Production, import, or use volume:	Pg. 30/247: Almost all 1,3-butadiene production, [1.47 millions tons (1.33 million megagrams) in 1993] results from recovery of butadiene as a byproduct of ethylene generation.
Process description:	Pg. 30/247: 1,3-Butadiene production in the United States is accomplished through either of two processes: recovery of butadiene from a mixed-C4 hydrocarbon stream generated during ethylene production, or through oxidative dehydrogenation of n-butenes.Fig 4-1,2, and 3 are relevant process diagram.
Number of sites:	Pg. 30/247: Of the 10 U.S. producers, 8 are located in Texas and 2 in Louisiana. The majority of these producers generate the feedstock at the same location as butadiene production. See Table 4-1 for list of facilities.Table C-1 in Appendix C contains the company name and location of 1,3-butadiene production facilities.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Data source is EPA report
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	US data
Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old, and the data may be outdated with the exception possibly of the process description.
Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Some sources are apparently internal EPA sources and are not publicly available.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1996). Locating and estimating air emissions from sources of 1,3-butadiene.
HERO ID:	6389860
Conditions of Use:	Multiple COUs

EXTRACTION

Parameter	**Data**
Life cycle description:	Section 7 contains various processes that that emit 1,3-butadiene either because 1,3-butadiene is used as a raw material or because it is present as an impurity.
Process description:	Section 7 contains some process descriptions of various processes that emit 1,3-butadiene either because 1,3-butadiene is used as a raw material or because it is present as an impurity.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Data source is EPA report
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The processes for which information is given may be occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old, and the data may be outdated with the exception possibly of the process description.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Several of the data sources are apparently internal EPA memoranda that are not publicly available.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7310513
Conditions of Use:	Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Emulsion Crumb Process Polymerization of styrene and butadiene proceeds continuously through a train of reactors, with a residence time in each reactor of approximately 1 hour. The reaction product formed in the emulsion phase of the reaction mixture is a milky white emulsion called latex. The overall polymerization reaction ordinarily is not carried out beyond a 60 percent conversion of monomers to polymer, because the reaction rate falls off considerably beyond this point and product quality begins to deteriorate.Because recovery of the unreacted monomers and their subsequent purification are essential to economical operation, unreacted butadiene and styrene from the emulsion crumb polymerization process normally are recovered. The latex emulsion is introduced to flash tanks where, using vacuum flashing, the unreacted butadiene is removed. The butadiene is then compressed, condensed, and pumped back to the tank farm storage area for subsequent reuse. The condenser tail gases and noncondensables pass through a butadiene adsorber/desorber unit, where more butadiene is recovered. Some noncondensables and VOC vapors pass to the atmosphere or, at some plants, to a flare system. The latex stream from the butadiene recovery area is then sent to the styrene recovery process, usually taking place in perforated plate steam stripping columns. From the styrene stripper, the latex is stored in blend tanks.From this point in the manufacturing process, latex is processed continuously. The latex ispumped from the blend tanks to coagulation vessels, where dilute sulfuric acid (H2S04 of pH 4 to 4.5) and sodium chloride solution are added. The acid and brine mixture causes the emulsion to break, releasing the styrene-butadiene copolymer as crumb product. The coagulation vessels are open to the atmosphere.Leaving the coagulation process, the crumb and brine acid slurry is separated by screens into solid and liquid. The crumb product is processed in rotary presses that squeeze out most of the entrained water. The liquid (brine/acid) from the screening area and the rotary presses is cycled to the coagulation area for reuse.The partially dried crumb is then processed in a continuous belt dryer that blows hot air atapproximately 93°C (2000 P) across the crumb to complete the drying of the product. Some plants have installed single-pass dryers, where space permits, but most plants still use the triple-pass dryers, which were installed as original equipment in the 19408. The dried product is baled and weighed before shipment.Emulsion Latex ProcessEmulsion polymerization can also be used to produce latex products. These latex productshave a wider range of properties and uses than do the crumb products, but the plants are usually much smaller. Latex production, shown in Figure 6.10-2, follows the same basic processing steps as emulsion crumb polymerization, with the exception of final product processing. As in emulsion crumb polymerization, the monomers are piped to the processing plant from the storage area. The polymerization reaction is taken to near completion (98 to 99 percent conversion), and the recovery of unreacted monomers is therefore uneconomical. Process economy is directed towards maximum conversion of the monomers in one process trip. Because most emulsion latex polymerization is done in a batch process, the number ofreactors used for latex production is usually smaller than for crumb production. The latex is sent to a blowdown tank where, under vacuum, any unreacted butadiene and some unreacted styrene are removed from the latex. If the unreacted styrene content of the latex has not been reduced sufficiently to meet product specifications in the blowdown step, the latex is introduced to a series of steam stripping steps to reduce the content further. Any steam and styrene vapor from these stripping steps is taken overhead and is sent to a water-cooled condenser. Any uncondensables leaving the condenser are vented to the atmosphere.After discharge from the blowdown tank or the styrene stripper, the latex is stored in process tanks. Stripped latex is Passed through a series of screen fIlters to remove unwanted solids and is stored in blending tanks, where antioxidants are added and mixed. Finally, latex is pumped from the blending tanks to be packaged into drums or to be bulk loaded into railcars or tank trucks.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.

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Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7310513
Conditions of Use:	Synthetic rubber manufacturing

			EVALUATION	
Domain		Metric	Rating	Comments
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data - Process Description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7315820
Conditions of Use:	Paints and coatings

EXTRACTION

Parameter	**Data**
Process description:	Though 1,3-Butadiene is not specifically mentioned, the group of articles provide information on various types of coating on metal and non-mental surfaces. Solvent base surface coating is conceptually a simple process. A continuous roll of backing material (called the web) is unrolled, coated, dried, and rolled again. A typical solvent base coatingline is shown in Figure 4.2.2.9-1. Large lines in this industry have typical web widths of 152 centimeters (60 in.), while small lines are generally 48 centimeters (24 in.). Line speeds vary substantially, from 3 to 305 meters per minute (10 to 1000 ft/min). To initiate the coating process the continuous web material is unwound from its roll. It travels to a coating head, where the solvent base coating formulation is applied. These formulations have specified levels of solvent and coating solids by weight. Solvents used include toluene, xylene, heptane, hexane, and methyl ethyl ketone. The coating solids portion of the formulations consists of elastomers (natural rubber, styrene-butadiene rubber, polyacrylates), tackifying resins (polyterpenes, rosins, petroleum hydrocarbon resins, asphalts), plasticizers (phthalate esters, polybutenes, mineral oil), and fillers (zinc oxide, silica, clay). The order of application is generally release coat, primer coat (if any), and adhesive coat. A web must always have a release coat before the adhesive can be applied. Primer coats are not required on all products, generally being applied to improve the performance of the adhesive.
Chemical concentration:	The products manufactured by the PSTL surface coating industry may have several different types of coatings applied to them. The 2 primary types of coatings are adhesives and releases. Adhesive coating is a necessary step in the manufacture of almost all PSTL products. It is generally the heaviest coating (typically 0.051 kg/m2, or 0.011 lb/ft2 and therefore has the highest level of solvent emissions (generally 85 to 95 percent of total line emissions). Release coatings are applied to the backside of tape or to the mounting paper of labels. The function of release coating is to allow smooth and easy unrolling of a tape or removal of a label from mounting paper. Release coatings are applied in a very thin coat (typically 0.00081 kg/m2, or 0.00017 lb/ft2). This thin coating produces less emissions than does a comparable size adhesive coating line.Solvent base adhesive formulations contain approximately 67 weight percent solvent and 33 weight percent coating solids, whereas solvent base releases average about 95 weight percent solvent and 5 weight percent coating solids.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data sources are greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size not applicable to process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				

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Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7315820
Conditions of Use:	Paints and coatings

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	N/A	Variability and uncertainty are not applicable to qualitative process description information.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (1995). Ap-42: Chapter 4.12 - Manufacture of rubber products.
HERO ID:	7315841
Conditions of Use:	Rubber Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Many of the rubber manufacturing facilities in the United States produce pneumatic tires for automobile, trucks, airplanes, and farm machinery. However, many rubber manufacturing facilities produce other engineered rubber products. The processes involved in these industries are very similar. Differences basically consist of the raw rubber material (natural or synthetic) used, the chemical additives, and the type of curing employed. The following is a description of a generic rubber manufacturing facility applicable to both tire and other manufactured rubber products, except where noted. The manufacturing of rubber products involves six processing steps (mixing, milling, extrusion, calendaring, curing, and grinding), with ancillary steps in between. Initially, the raw rubber (natural or synthetic) is mixed with several additives which are chosen based upon the desired properties of the final product. The mixed rubber is often milled and transferred to an extruder where it can be combined with other rubbers. Many rubber products contain synthetic fabric or fibers for strengthening purposes. These fibers are typically coated with mixed rubber using a calender. The extruded rubber and rubber coated materials are then assembled into a final shape and cured. Among the steps in the tire assembly process are bead building; cementing and marking; cutting and cooling; tire building; and green tire spraying. It is during the curing process that the rubber vulcanizes (crosslinks), producing the characteristic properties of finished rubber. Once the final product is cured, it is often ground to remove rough surfaces and/or to achieve symmetry.Mixing consists of taking the raw rubber and mixing it with several chemical additives. These additives consist of accelerators (to initiate the vulcanization process), zinc oxides (to assist in accelerating vulcanization), retarders (to prevent premature vulcanization), antioxidants (to prevents aging), softeners (to facilitate processing of the rubber), carbon black or other fillers (to serve as reinforcing / strengthening agents), and inorganic or organic sulfur compounds (to serve as vulcanizing agents). Mixing typically is performed in an internal batch mixer. The internal mixer contains two rotors which shear the rubber mix against the wall of the vessel. Internal mixing is performed at elevated temperatures up to approximately 330 F. Once mixed, the rubber is discharged from the mixer and processed into slab rubber or pellets. Rubber mixing typically occurs in two or more stages wherein the rubber is returned to the mixer and remixed with additional chemicals. The initial stage results in non-productive compounds, and the final stage results in productive compounds. It should also be noted that various rubber compounds produced at a particular facility can be exported to other facilities for use there. Non-productive compounds consist of the raw rubber, process oils, reinforcing materials such as carbon black and / or silica and the antioxidant / antiozonant protection system. These materials are mixed at temperatures around 330F. The final, “productive,” stage involves mixing the rubber from the last non-productive stage with the activators, accelerators and sulfur curing agents. This stage is mixed at a lower temperature (around 230 F) because the rubber compound will now scorch and cure at elevated temperatures.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	N/A-process description
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.

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Study Citation: U.S. EPA, (1995). Ap-42: Chapter 4.12 - Manufacture of rubber products.
HERO ID: 7315841
Conditions of Use: Rubber Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (2021). National analysis TRI dataset (TRI): Data used for TSCA risk evaluations, reporting year 2019.
HERO ID:	8347325
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Number of sites:	Number of submitters to TRI in 2019, 2018, 2017, 2016, 2015, respectively: 203, 201, 203, 210, 211.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	TRI uses high quality data and techniques that are submitted directly from industrial and commercial facilities.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including number of sites from different years but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.
HERO ID:	8726953
Conditions of Use:	Drum cleaning

EXTRACTION

Parameter	Data
Life cycle description:	Chemicals are transported in a variety of containers, including railroad cars, tank truck cars, ocean barges, intermodal containers, intermediate bulk containers (IBCs), drums, pails, jerricans, glass and plastic bottles, bags, and gas cylinders. PMN submissions report the most commonly used container for liquid transport is drums. Drums are used to transport thousands of different cargos, including oil, solvents, paint, resins, chemicals, lacquers and varnishes, adhesives, cleaners, and food.Drums are cleaned primarily to recondition the container for reuse, preventing contamination of materials from one cargo shipment to the next. Drums are also cleaned to facilitate the reconditioning process: removing dents, inspecting fittings and valves, and painting the exterior. Additionally, empty drums may be sent to an Industrial Container and Drum Cleaning (ICDC) facility (drum reconditioner). Depending on the thickness and handling, steel drums may be recycled and reused five to six times before they need to be sent for reconditioning. Plastic drums may last up to 10 years but will realistically make around five to ten trips before they are sent to a reconditioner.
Process description:	Manufacturers, processers and users may clean out drums with solvent (if solvent-based materials were in the drums) or with water (if water-based materials were in the drums). The rinsate may be either sent to onsite wastewater treatment, used in the process, or incinerated (offsite or onsite). This section discusses typical drum washing occurring at drum reconditioning facilities. Note that industrial facilities may employ these methods when cleaning drums.Water-based cleaning:Drums are washed by spraying the drum interior and exterior with hot caustic solution. Drums are typically turned upside down and loaded onto a conveyor, which transports the drums through an automatic drum cleaning machine in an assembly-line style. Alternatively, drums may be washed manually using hand-held spray nozzles. After caustic washing, drums undergo single or multiple rinses, depending on facility preference. Next, drums are inspected for rust (steel drums) and cleanliness. Rusty drums are washed with a hydrochloric acid solution in the same manner as caustic washing described above, followed by one or more rinses. Emissions from the acid washer go through a packed column scrubber, which uses fresh water or dilute caustic solution. If a steel drum cannot be cleaned, it is either sent for conversion to an open-head drum for burning or crushed for recycling. Plastic drums that cannot be cleaned are not burned, but are instead shredded and typically sold to a plastics recycler (EPA Office of Water, 2002).After rinsing, plastic drums are dried using vacuum siphons or hot air, and pressure tested using air. Plastic drums are then inspected and the final bungs and fittings are attached. Drums may also be labeled at this step. Steel drums are dried using vacuum siphons, hot air or flame treating; dedented; rechimed; and placed into a submerger to check for leaks. Steel drums are then shot blasted to prepare the surface for painting. Shot-blast emissions are controlled by dust bags with shot-blast dust either recycled with scrap steel or disposed. After painting, the drums are oven cured. As a final step, the drums have bungs and fittings attached and are inspected (EPA Office of Water, 2002).Solvent-based cleaning:EPA identified one foreign company (Hoyer in Antwerp, Belgium) that uses solvents to clean water-insoluble cargos such as varnishes, paints, and lacquers. The facility began cleaning operations in September 1999. Solvent cleaning is performed in a multi-stage process and is designed for maximum recovery of solvent. The facility also operates a hermetically sealed solvent washing cabinet to clean heavily soiled IBCs. Solvent emissions are incinerated on site, along with heels and residues from solvent recovery. EPA has no data on the solvent used or potential air pollution problems. EPA is not aware of any ICDC facilities in the United States that perform solvent washing (Industrial Containers, 2004).Drum Reclamation Furnace Process:Drum reclamation furnaces clean and recondition open-head steel drums for resale, reuse, or disposal. Upon receipt of a drum shipment, the reclamation furnace facility inspects the drums and returns those that are damaged or not considered empty to the shipper. The drum reclamation furnace facility visited by EPA in 2000 does not pour or otherwise remove heels prior to burning. In fact, small amounts of heel with high BTU value may be beneficial to offset furnace energy requirements (EPA Office of Water, 2002). Open-head drums are burned in tunnel-type continuous furnaces. One drum reclamation furnace facility visited by EPA in 2000 included a primary furnace that operates at 1,100F, an afterburner that operates at 1,850F to 1,900F to control emissions, automatic controls, and continuous emissions monitoring for carbon monoxide and temperature. Drums traveled through the furnace upside down on a moving chain with the drum lids placed on top of the drums. Drums exiting the furnace were cooled by a steam curtain, which also removed ash from drums. The furnace chain was quenched with water at the end of the furnace (EPA Office of Water, 2002). After the furnace, the drums are rinsed with an aqueous solution containing a rust inhibitor (typically sodium nitrite). The drums are then shot blasted (inside and out) to remove any remaining paint. Shot-blast emissions are controlled by dust bags with shot-blast dust either recycled with scrap steel or disposed. Next, drums are mechanically dedented by curling, expanding, and body rolling, and the bottom chime is sealed on a chime roller (rechimed). Drums are then leak tested in a submerger and inspected. Finally, drums are dried, painted, and oven cured; often, the inside of the drum receives an interior coating. The drum lids and rings are then replaced to complete the process (EPA Office of Water, 2002).
Throughput:	No data on throughput.

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Study Citation: U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.
HERO ID: 8726953
Conditions of Use: Drum cleaning

Domain	Metric	EVALUATION Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	The assessment or report uses high quality data that are from frequently used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, 1,3-butadiene is not mentioned specifically.
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	Sample size not applicable to process descriptions.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Uncertainty and variability not applicable to process descriptions.

Overall Quality Determination High

Study Citation: U.S. EPA, (2016). Federal research action plan on recycled tire crumb used on playing field and playgrounds. Status report.
HERO ID: 9102524
Conditions of Use: Recycling

EXTRACTION

Parameter	Data
Production, import, or use volume:	4.77 million tons of waste tires were generated in 2013, and 40.5 percent, or 1.93 million tons, were recovered through recycling and production of retreaded tires (pg. 11) In 2013, approximately 172,000 tons of scrap tires were converted to tire shreds for use in road and landfill construction, septic tank leach fields, and other construction applications (RMA, 2016a).Approximately 975,000 tons of scrap tires (i.e., approximately 59.5 million tires) were used in the ground rubber applications market, which includes the manufacture of new rubber products,rubber-modified asphalt, and playground and sports surfacing (RMA, 2014 and 2016a). (pg. 11)
Life cycle description:	Recycled rubber from tires is used in several types of recreational venues, including use as infill material in synthetic turf fields, on playgrounds either as loose rubber mulch or rubber mats, for running surfaces, and in equestrian arenas. Recycled tire material may also be used in other applications, such as tire-derived rubber flooring materials (pg. 11) In the United States, tires typically are collected at tire dealerships and automobile service stations and shipped to tire recyclers. Tires of different types (e.g., passenger cars, trucks) and from different manufacturers are mixed together at tire collection stations and tire recyclingplants (pg. 13)
Process description:	Two tire recycling processes, (1) ambient and (2) cryogenic, are used to create tire crumb rubber in the 10- to 20-mesh (0.84- to 2.0-mm) size, which is generally the size used in synthetic turf infill. The ambient process uses granulation or cracker mills to produce tire crumb rubber at room temperature. Cracker mills use revolving rollers with serrations in them to size-reduce the tires. Once the granules are produced, they are fed through screens and sorted to the appropriate size. The cryogenic process uses liquid nitrogen to freeze partially shredded tires, which then are fed into a hammer mill to create tire crumb rubber. Fabric (i.e., polyester, nylon, or other fibers) and steel belt components of the scrap tire are separated in both processes. Fabric is removed from the rubber using air classifiers or vacuums, while the steel is removed using magnetic separators. Gravity separators also can be used to remove contaminant particles, such as rocks, and can aid in the sorting process. Likewise, water can be used for pre-washing to remove gravel and dirt and cooling during the ambient process; otherwise no chemicals are added to the original rubber composition during either process. Following processing, tire crumb rubber typically is placed into one-ton sacks and distributed to fields for spreading. (14/169)
Number of sites:	Currently, there are between 12,000 and 13,000 synthetic turf recreational fields in the United States, with 1,200 – 1,500 new installations each year. (4/169) There are nine tire crumb rubber producers in the U.S. that produce 95% of the recycled rubber used in synthetic turf. (13/169) There are approximately eight major synthetic field installers in the United States. (15/169)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but information is not chemical-specific.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				

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Study Citation:	U.S. EPA, (2016). Federal research action plan on recycled tire crumb used on playing field and playgrounds. Status report.
HERO ID:	9102524
Conditions of Use:	Recycling

		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by explaining two turf production processes. Uncertainty isn't addressed in terms of facility information..

Overall Quality Determination — High

Study Citation: U.S. EPA, (2023). AP-42: Chapter 5 - Petroleum industry.
HERO ID: 9102566
Conditions of Use: Petroleum Refining

EXTRACTION

Parameter	Data
Life cycle description:	The petroleum refining industry converts crude oil into more than 2500 refined products, including liquefied petroleum gas, gasoline, kerosene, aviation fuel, diesel fuel, fuel oils, lubricating oils, and feedstocks for the petrochemical industry. Petroleum refinery activities start with receipt of crude for storage at the refinery, include all petroleum handling and refining operations and terminate with storage preparatory to shipping the refined products from the refinery.
Process description:	The petroleum refining industry employs a wide variety of processes. A refinery's processing flow scheme is largely determined by the composition of the crude oil feedstock and the chosen slate of petroleum products. The example refinery flow scheme presented in Figure 5.1-1 shows the general processing arrangement used by refineries in the United States for major refinery processes. The arrangement of these processes will vary among refineries, and few, if any, employ all of these processes. Petroleum refining processes having direct emission sources are presented on the figure in bold-line boxes. Listed below are 5 categories of general refinery processes and associated operations:1. Separation Processes -The first phase in petroleum refining operations is the separation of crude oil into its major constituents using 3 petroleum separation processes: atmospheric distillation, vacuum distillation, and light ends recovery (gas processing). Crude oil consists of a mixture of hydrocarbon compounds including paraffinic, naphthenic, and aromatic hydrocarbons with small amounts of impurities including sulfur, nitrogen, oxygen, and metals. Refinery separation processes separate these crude oil constituents into common boiling-point fractions.2. Conversion Processes - To meet the demands for high-octane gasoline, jet fuel, and diesel fuel, components such as residual oils, fuel oils, and light ends are converted to gasolines and other light fractions. Cracking, coking, and visbreaking processes are used to break large petroleum molecules into smaller ones. Polymerization and alkylation processes are used to combine small petroleum molecules into larger ones. Isomerization and reforming processes are applied to rearrange the structure of petroleum molecules to produce higher-value molecules of a similar molecular size.3. Treating Processes - Petroleum treating processes stabilize and upgrade petroleum products by separating them from less desirable products and by removing objectionable elements. Undesirable elements such as sulfur, nitrogen, and oxygen are removed by hydrodesulfurization, hydrotreating, chemical sweetening, and acid gas removal. Treating processes, employed primarily for the separation of petroleum products, include such processes as deasphalting. Desalting is used to remove salt, minerals, grit, and water from crude oil feedstocks before refining. Asphalt blowing is used for polymerizing and stabilizing asphalt to improve its weathering characteristics.4. Feedstock And Product Handling - The refinery feedstock and product handling operations consist of unloading, storage, blending, and loading activities.5. Auxiliary Facilities - A wide assortment of processes and equipment not directly involved in the refining of crude oil isused in functions vital to the operation of the refinery. Examples are boilers, waste water treatment facilities, hydrogen plants, cooling towers, and sulfur recovery units. Products from auxiliary facilities (clean water, steam, and process heat) are required by most process units throughout the refinery.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, butadiene is not mentioned specifically.
	Metric 4:	Temporal Representativeness	Low	Data referenced for process descriptions are based on studies greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size not applicable to life cycle and process descriptions.

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Study Citation: U.S. EPA, (2023). AP-42: Chapter 5 - Petroleum industry.
HERO ID: 9102566
Conditions of Use: Petroleum Refining

			EVALUATION	
Domain		Metric	Rating	Comments
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty are not applicable to qualitative descriptions of processes and life cycle.

Overall Quality Determination High

Study Citation:	U.S. EPA, (2023). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	Transportation And Marketing Of Petroleum Liquids

EXTRACTION

Parameter	**Data**
Life cycle description:	The transportation and marketing of petroleum liquids involve many distinct operations, each of which represents a potential source of evaporation loss. Crude oil is transported from production operations to a refinery by tankers, barges, rail tank cars, tank trucks, and pipelines. Refined petroleum products are conveyed to fuel marketing terminals and petrochemical industries by these same modes. From the fuel marketing terminals, the fuels are delivered by tank trucks to service stations, commercial accounts, and local bulk storage plants. The final destination for gasoline is usually a motor vehicle gasoline tank. Similar distribution paths exist for fuel oils and other petroleum products.
Process description:	A general depiction of transportation activities related to petroleum liquids is shown in Figure 5.2-1.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment uses high quality data that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation. However, butadiene is not mentioned specifically.
	Metric 4:	Temporal Representativeness	Low	Data referenced for process descriptions are based on studies greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size not applicable to life cycle and process descriptions.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty are not applicable to qualitative descriptions of processes and life cycle.

Overall Quality Determination High

Study Citation:	UAB, (1995). Support: a follow-up study of synthetic rubber workers (cohort mortality study of male employees of 8 styrene-butadiene rubber plants), with cover letter dated 10/24/95.
HERO ID:	5554378
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing
Process description:	SBR production involves several major steps, including polymerization, recovery, coagulation and finishing. SBR may be produced by an emulsion or a solution process, the former being more common. All SBR plants also have tank farm, warehouse, laboratory, utilities and maintenance operations. Emulsion polymerization involves the mixing in water of the monomers, BD and STY, with soaps, activators (sulfoxylates) and initiators (peroxydisulfates, peroxides}. The polymerization, which takes place in 3,000-6,000 gallon reactor vessels, proceeds until about 70-75% of the monomers have been converted into polymers, at which point shortstop chemicals (~.g., dithiocarbamates, diethyl hydroxylamine} are used to terminate the process. The product of polymerization is a liquid material, called latex, that contains both polymers and unreacted monomers. Recovery involves removing unreacted BD and STY monomers from the latex. Flash distillation and steam stripping are used, respectively, to remove BD and STY. The recovered monomers are recycled into the production process. After the removal of unreacted monomers, the latex is blended with antioxidants, oils (optional) and carbon black (optional) and then is coagulated by the addition of dilute sulfuric acid or aluminum sulfate. This produces a rubber crumb. In finishing, the coagulated crumb is washed with water, mechanically dewatered, dried and formed into 70-90 pound bales.
Throughput:	3000-6000 gallons/batch
Number of sites:	10 North American SBR producers.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling sites more than once, and sampling different sites.

Overall Quality Determination High

Study Citation:	UAB, (1995). Initial submission: Letter from intl inst syn rubber prod to USEPA RE prelim results in cohort mortality study of employees of 8 styrene butadiene rubber plants, dated 05/19/95.
HERO ID:	5665016
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	4 of the plants produce >200 million pounds per year, others not specified.
Life cycle description:	synthetic rubber manufacturing
Process description:	Emulsion polymerization involves the mixing in water of the monomers, BD and STY, with soaps, activators (sulfoxylates) and initiators (peroxydisulfates, peroxides}. The polymerization, which takes place in 3,000-6,000 gallon reactor vessels, proceeds until about 70-75% of the monomers have been converted into polymers, at which point shortstop chemicals (e.g., dithiocarbamates, diethyl hydroxylamine} are used to terminate the process. The product of polymerization is a liquid material, called latex, that contains both polymers and unreacted monomers. Recovery involves removing unreacted BD and STY monomers from the latex. Flash distillation and steam stripping are used, respectively, to remove BD and STY. The recovered monomers are recycled into the production process. After the removal of unreacted monomers, the latex is blended with antioxidants, oils (optional) and carbon black (optional) and then is coagulated by the addition of dilute sulfuric acid or aluminum sulfate. This produces a rubber crumb. In finishing, the coagulated crumb is washed with water, mechanically dewatered, dried and formed into 70-90 pound bales.
Throughput:	3,000-6,000 gallon reactor vessels per batch
Number of sites:	10 North American SBR producers.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size	N/A	N/A- extracted data not applicable
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by discussing limitations of the study, and where further research needs to be done. Variability addressed by sampling multiple plants and age groups.

Overall Quality Determination High

Study Citation:	USTMA, (2020). Comment regarding 1,3-butadiene, submitted by U.S. Tire Manufacturers Association (USTMA), dated 05/26/2020.
HERO ID:	8802198
Conditions of Use:	Processing as a Reactant: Synthetic rubber manufacturing;

EXTRACTION

Parameter	**Data**
Life cycle description:	Pg. 4/24: "Tires contain a number of rubber compounds...Each rubber compound in a tire contains synthetic polymers. The two main types of synthetic polymers used in tire manufacturing are butadiene rubber (BR) and styrene butadiene rubber (SBR)."
Chemical concentration:	Pg. 4/24: "According to data submitted by IISRP, butadiene rubber (BR) and styrene butadiene rubber (SBR) polymers typically contains less than 50 ppb of residual 1,3-butadiene monomer."

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The data is expected to be high quality because it is reported by the trade association.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	Tire manufacture is a COU
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	The data is reported by the trade association.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Vega, J. R., Gugliotta, L. M., Meira, G. R. (2002). Emulsion copolymerization of acrylonitrile and butadiene. Semibatch strategies for controlling molecular structure on the basis of calorimetric measurements. POLYMER REACTION ENGINEERING 10(1-2):59-82.
HERO ID:	5709984
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing
Process description:	Nitrile rubber or NBR is industrially produced by polymerizing acrylonitrile and butadiene in the ‘‘cold’’ emulsion process. The reactor can be either batch, semibatch, or a train of continuous stirred-tanks. (page 3 of 25)A propane-propylene refrigerant circulates through an internal set of vertical tubes laid out to operate as reactor baffles. The reaction heat is mainly removed by the evaporated refrigerant. The reaction temperature is held at approximately 10 degrees C by means of an external control loop. A second control loop maintains a constant level of refrigerant in the accumulator. Except for the initiator, all other reagents were first emulsified and cooled to the reaction temperature. The polymerization starts when the initiator is loaded. (page 5 of 25)
Throughput:	The reaction was carried out in a 21 000 dm3 industrial stirred-tank reactor. (page 4 of 25)
Chemical concentration:	The recipe was as follows: Acrylonitrile: 2048 Kg; Butadiene: 4475 Kg; emulsifier: 230 Kg; initiator (di-isobutyl hydroperoxide): 0.32 Kg; CTA (tert-dodecyl mercaptan): 26.7 Kg; and water: 11100 Kg (page 4-5 of 25)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality techniques from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from Argentina, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the polymerization of nitrile rubber.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by using external feedback loops in the experiment. Variability addressed by comparing polymerization results to a simulation.

Overall Quality Determination High

Study Citation:	Vielvoye, R. (1990). Rising demand forecast for refined butadiene. Oil and Gas Journal 88(49):33.
HERO ID:	5711472
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"World demand for refined butadiene will increase to 7.1 million metric tons in 1994... CMAI says ABS production will be about 3.5 million tons in 1994, up from 2.5 million tons in 1988... By 1994, world ABS capacity will surpass 4.4 million tons, exceeding 1988 capacity by about 1.25 million tons... World production of styrene butadiene rubber will increase by an average 1 %/ year to 4.4 million tons in 1994 from 4.1 million tons in 1989, CMAI predicts"

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are worldwide.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production volumes, percent increases) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Uncertainty and variability not addressed.

Overall Quality Determination — Medium

Study Citation:	Vinodh, S., Jayakrishna, K., Joy, D. (2012). Environmental impact assessment of an automotive component using eco-indicator and CML methodologies. Clean Technologies and Environmental Policy 14(2):333-344.
HERO ID:	4717694
Conditions of Use:	Commercial Use

EXTRACTION

Parameter	**Data**
Life cycle description:	In raw material production phase, the ABS copolymer resin is manufactured through polymerization. Later this co-polymer is made into ABS sheet using injection molding process. For injection molding process, power is provided separately as a process in the model plan. The ABS sheet is transported using truck to instrument panel manufacturing unit. This is done using a truck which needs diesel as the input. In the actual production phase, the ABS sheet is subjected to a number of processes, namely, dehumidification and vacuum forming, which requires power and compressed air. Then in the use phase, the data pertaining to the instrument panel in use such as emissions to air and water are given as the flows. The scrapped instrument panel is the output of this process. Finally, in the ABS recovery process, the recovery method and its conversion to ABS co-polymer are given as flows returning to injection molding process.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3: Applicability	Medium	Data are for the life cycle of automotive ABS components, which is similar to the in-scope occupational scenario of plastic and resin manufacturing.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Ward, E. M., Fajen, J. M., Ruder, A. M., Rinsky, R. A., Halperin, W. E., Fessler-Flesch, C. A. (1995). Mortality study of workers in 1,3-butadiene production units identified from a chemical workers cohort. Environmental Health Perspectives 103(6):598-603.
HERO ID:	646931
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	approximately 3,000 million pounds of BD produced each year in the United States
Life cycle description:	Synthetic Rubber manufacturing, intermediate
Process description:	Butadiene from ethanol... 1) Acetaldehyde conversion system: ethanol partially converted to acetaldehyde in a catalytic converter containing copper-chromium catalyst; heated by circulating Dowtherm 2) Butadiene conversion system: acetaldehyde and ethanol passed through titanium oxide catalyst; 15-20% converted to BD at 60-65% efficiency 3) Purification: involved stripping crude BD from condensed fluids of BD converters, then passing through water scrubber to absorb acetaldehyde in vapor, then fed to another column where BD vapor is absorbed by Chlorex, then Chlorex and water condensed and separated 4) Recovery: a recovery distillation system reconcentrated unreacted ethanol and acetaldehyde and removed by-products Butadiene form olefin cracking... recovered BD as normal by-product from ethylene process; four-carbon molecules fed to an absorber column with Chlorex used to desorb BD (BD around 88-90% pure at this point); Chlorex fed to stripper column and scrubbed with water, then condensed BD compressed and piped to intermediate storage tanks with sodium nitrite to remove reactive oxygen; then a final refining step in two-step distillation, with catechol added at end to inhibit polymerization; 1965 and later, used dimethyl acetamide in place of Chlorex
Chemical concentration:	Final product from each process was BD at 99.5% purity

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Background information surrounding production
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Ward, E. M., Fajen, J. M., Ruder, A. M., Rinsky, R. A., Halperin, W. E., Fesslerflesch, C. A. (1996). Mortality study of workers employed in 1,3-butadiene production units identified from a large chemical workers cohort. Toxicology 113(1-3):157-168.
HERO ID:	2454177
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	approximately 3,000 million pounds of BD produced each year in the United States (pg. 2/12, Jebens, 1994)
Process description:	Process descriptions are in the appendix, pg. 10/12:Butadiene from ethanol... 1) Acetaldehyde conversion system: ethanol partially converted to acetaldehyde in a catalytic converter containing copper-chromium catalyst; heated by circulating Dowtherm 2) Butadiene conversion system: acetaldehyde and ethanol passed through titanium oxide catalyst; 15-20% converted to BD at 60-65% efficiency 3) Purification: involved stripping crude BD from condensed fluids of BD converters, then passing through water scrubber to absorb acetaldehyde in vapor, then fed to another column where BD vapor is absorbed by Chlorex, then Chlorex and water condensed and separated 4) Recovery: a recovery distillation system reconcentrated unreacted ethanol and acetaldehyde and removed by-products..... Butadiene from olefin cracking... recovered BD as normal by-product from ethylene process; four-carbon molecules fed to an absorber column with Chlorex used to desorb BD (BD around 88-90% pure at this point); Chlorex fed to stripper column and scrubbed with water, then condensed BD compressed and piped to intermediate storage tanks with sodium nitrite to remove reactive oxygen; then a final refining step in two-step distillation, with catechol added at end to inhibit polymerization; 1965 and later, used dimethyl acetamide in place of Chlorex
Chemical concentration:	Final product from each process was BD at 99.5% purity (pg. 10/12)
Comments:	Identical to HERO ID 646931

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Warren,, Highline (2015). Safety Data Sheet (SDS): Rubber patch.
HERO ID:	12033015
Conditions of Use:	Processing: Plastics and Rubber Converting

EXTRACTION

Parameter	**Data**
Chemical concentration:	23-24%

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	SDS information is primary data from the supplier. SDS does not appear to have quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Product is from a US supplier.
	Metric 3:	Applicability	High	SDS is applicable to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Source is from 2015, which is less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Source just provides concentration and does not document how this value was obtained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing a range of potential concentrations. Uncertainty not addressed.

Overall Quality Determination High

Study Citation:	Wehrenberg, R. H. (1982). Practical plastics recycling. Materials Engineering 95(2):44-50.
HERO ID:	1159266
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Recycling of ABS (acrylonitrile-Butadiene-styrene)
Process description:	In this article, ABS is recycled from plastic telephones. Hammermilling frees cotton, metals, and labels from parts. Next, aspirators, screeners and a magnetic separator remove light contaminants from the scrap. Then, phenolics, cellulosic, and acrylics are removed with a floatation system.
Throughput:	At the Omaha Service Center, 500 lb/hr of color-separate ABS Type 2.
Comments:	manufacturing capacity of 750,000 lbs/year. Page 3 of the pdf document.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Data comes from a manufacturer of ABS recycled products. While not a frequently used source, this seems reliable due to the experience this plant has with the topic.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Medium	Data is similar to an in-scope scenario and mentions recycling of a butadiene-containing product, 1,3-butadiene isn't specifically mentioned.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	facility data/Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Data sources are not mentioned or cited.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Uncertainty is not addressed.

Overall Quality Determination Low

Study Citation:	Wett, T., Bruce, D. S., Tice, G. F., Chang, E. C., Rothman, S. N., Bonnifay, P., Cha, B. (1977). Oil & Gas Journal Petrochemical Report. Oil and Gas Journal 75(12):89.
HERO ID:	5584448
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1974, 3,682 million lbs of butadiene were produced worldwide. In 1975, 2,645 million lbs of butadiene were produced, a 28% decrease from the previous year. In 1976, 3,254 lbs of butadiene were produced, a 23% increase from the previous year. In 1974, 857 million lbs of ABS were produced worldwide. In 1975, 642 million lbs of ABS were produced, a 25% decrease from the previous year. In 1976, 987 lbs of ABS were produced, a 54% increase from the previous year.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Assessment uses high quality techniques from frequently-used sources. (International trade commission)
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are worldwide.
	Metric 3: Applicability	High	Data are for the manufacture of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (total production, percent change) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Worrell, E., Beer, De, J. G., Faaij, C., A.P., Blok, K. (1994). Potential energy savings in the production route for plastics. Energy Conversion and Management 35(12):1073-1085.
HERO ID:	5707583
Conditions of Use:	Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	550 ktons of butadiene were produced in the Netherlands in 1986. (Table-2, pg 2/13)
Process description:	"Butadiene is produced from the C4 fraction of a naphtha cracker by separating the higher hydrocarbons in the debutanizer. Butadiene is separated at the bottom of the column by means of an extractive distillation step using a solvent (like acetonitrile). " (pg 4/13)
Throughput:	49 kg of butadiene are produced per ton of naphtha run through the cracker. (Table 4, pg. 5/13)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Medium	Data are for the Netherlands, an OECD country.
	Metric 3: Applicability	High	Data are for petrochemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination Medium

Study Citation:	Wright, S. L., Kelly, F. J. (2017). Plastic and Human Health: A Micro Issue?. Environmental Science & Technology 51(12):6634-6647.
HERO ID:	3862800
Conditions of Use:	Processing as a monomer

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	320 million tonnes of plastics produced per year; 40% are as single-use packaging
Chemical concentration:	Concentration of microplastics present in various foods and consumer exposure scenarios

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from United Kingdom, an OECD country.
	Metric 3:	Applicability	Low	Data are for consumer exposures and generic plastic production, which is similar to the the in-scope occupational scenario for butadiene processing as a monomer for plastics.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium

Study Citation:	Wu, X. G., Liu, H. Q. (1996). Comparison of the technology of oxidative dehydrogenation in a fluidized-bed reactor with those of other reactors for butadiene. Industrial and Engineering Chemistry Research 35(8):2570-2575.
HERO ID:	5648783
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1994 the world production capacity was 13.166 million ton/yr, and 80% of the synthetic rubber was made from the raw material butadiene.
Life cycle description:	Domestic Manufacturing
Process description:	The oxidative dehydrogenation process involves vaporized butene and water steam being mixed in a preheater between 130 and 180 °C. Air and the butene/ steam mixture are then mixed, in a mixer, prior to entering the fluidized-bed reactor from the bottom. This mixture reacts with the catalyst and produces butadiene gas, which is channeled through the top of the reactor to a water washing tower, where the catalyst powder is separated from the gas produced using a two-tier graded circle wind separator. When the butadiene gas enters the water washing tower, it is cooled and the catalyst and oxidized impurities are dissolved in water. The resulting butadiene gas is compressed to 1.3 MPa and is suitable for usage in industrial production processes.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for the production of butadiene, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Variability addressed by changing reactor conditions, but uncertainty isn't addressed.

Overall Quality Determination Medium

Study Citation:	Xiao, F.,ei, Peng, X., Qian, S. (2010). A study on addictives for fume reduction in asphalt pavement construction. Intelligent Automation and Soft Computing 16(5):797-803.
HERO ID:	4716263
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	"The mechanism of styrene-butadiene-styrene on smoke suppression primarily has following two aspects: 1. SBS in asphalt will swell and SBS uniformly is distributed in asphalt and under high temperature and mixing so on associated actions asphalt and SBS have fine compatibility. Light oil component will pervade towards SBS phase and SBS phase will have swelling and its volume increases continuously. With SBS in asphalt few macromolecules chains dissolve in asphalt and partial macromolecules are swelled by light oil. And majority polymers is scattered in asphalt primarily in form of micro small grains. This way asphalt can only swell but can not be completed dissolved by asphalt. The two parts reach balance of swelling which causes the changes of matrix asphalt property particularly reduction of micro molecule components. Thus the volatilized components are reduced. Hence the yield of asphalt smoke can be reduced. 2. When SBS and asphalt reach a critical limit value SBS forms one type of stabilized and elastic net structure. When this value is exceeded asphalt and SBS modified system takes place phase variation. SBS is transformed from discrete phase into continuous phase and asphalt changes from continuous phase into discrete phase. This type of net crosslink between SBS can catch the granular substance in asphalt fumes and bind the light component in asphalt so as to reduce the yield of asphalt smoke. "

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are from asphalt manufacture, which could be applied to the in-scope occupational scenario of incorporation into an article.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Medium

Study Citation:	Yang, J., Chang, P., Chie, W., Liu, J., Wu, F.,u, C. (2016). Large-scale search method for locating and identifying fugitive emission sources in petrochemical processing areas. Process Safety and Environmental Protection 104(Part A):382-394.
HERO ID:	4701807
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Butadiene makes up 62.06% of raw material used in styrene-butadiene-rubber plant area, 98.79% of raw material used in butadiene-rubber plant area, and 42.44% of raw material used in thermoplastic elastomer plant area
Life cycle description:	Synthetic rubber manufacturing
Chemical concentration:	Air concentrations range from ND to 355.2+-34.6 ppbv in 17 regions of production

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3: Applicability	High	Data are for synthetic rubber manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	Uncertainty is addressed by discussing limitations of data collection. Variability addressed by taking many samples and sampling at different locations.

Overall Quality Determination Medium

Study Citation:	Yang, X., Sun, L., Xiang, J., Hu, S., Su, S. (2013). Pyrolysis and dehalogenation of plastics from waste electrical and electronic equipment (WEEE): A review. Waste Management 33:462-473.
HERO ID:	5519320
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Global production of waste electrical and electroic equipment is around 40 million tonnes per year, 30% of which is plastic. 30% of this plastic is ABS.
Life cycle description:	Emissions to Air & Landfills

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
Metric 3:	Applicability	High	Data are for Emissions to Air and Land, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. Production volumes and concentrations are well characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Variability addressed by studying different methods of pyrolisis, but uncertainty is not addressed.

Overall Quality Determination High

Study Citation:	Ye, Y., Galbally, I. E., Weeks, I. A., Duffy, B. L., Nelson, P. F. (1998). Evaporative emissions of 1,3-butadiene from petrol-fuelled motor vehicles. Atmospheric Environment 32(14-15):2685-2692.
HERO ID:	5547367
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Life cycle description:	Emissions to Air
Chemical concentration:	The mass fractions of 1,3- butadiene in Australian petrols ranged from 0.003 to 0.052% with a weighted average value of 0.015% for Sydney petrols and 0.020% for Melbourne petrols.
Comments:	See table 6.

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for emissions to air , an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing disposal/treatment method, release quantity, number of sites, release days, and pollution prevention.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by statistics and methodology. Variability addressed by sampling different vehicle makes, models, and years.

Overall Quality Determination Medium

Study Citation:	Yew, G. Y., Tham, T. C., Law, C. L., Chu, D. T., Ogino, C., Show, P. L. (2019). Emerging crosslinking techniques for glove manufacturers with improved nitrile glove properties and reduced allergic risks. Materials Today Communications 19:39-50.
HERO ID:	5696411
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	**Data**
Process description:	Process for producing rubber gloves as applies to latex and nitrile-based gloves; catalysts for hydrogenation of nitrile-butadiene rubber and process for carboxylated nitrile-butadiene rubber
Chemical concentration:	acrylonitrile butadiene rubber is 18% to 50% acrylonitrile

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination High

Study Citation:	Young, I. (1998). Crisis hits Asian prices. Chemical Week 160(4):44.
HERO ID:	5709525
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Hyundai built a new 90,000 metric ton butadiene unit in Korea in 1998. However, because of a recession at this time, operating rates at plants in Korea stood at about 85%-90% and in Japan at about 90%. Two new ABS plants were being built in China with an expected capacity of 150,000 metric tons. Even later on, a 50,000 metric ton ABS unit was planned to open in China and another 100,000 metric ton ABS unit was planned to open in Korea.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Report does not specify the methods used.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China and Korea, non-OECD countries.
	Metric 3: Applicability	High	Data are for butadiene manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	General production information.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by explaining the decline of the butadiene market. Variability is not addressed.

Overall Quality Determination — Low

Study Citation:	Zhang, L., Hayes, R. B., Guo, W., Mchale, C. M., Yin, S., Wiencke, J. K., O'Neill, Patrick, J., Rothman, N., Li, G. L., Smith, M. T. (2004). Lack of increased genetic damage in 1,3-butadiene-exposed Chinese workers studied in relation to EPHX1 and GST genotypes. Mutation Research 558(1-2):63-74.
HERO ID:	5562516
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	synthetic rubber manufacturing, plastic and resin manufacturing
Process description:	The purification of BD from an initial hydrocarbon stream occurred at two sites: the DMF facility, where initial distillation and extraction occurred using a proprietary dimethyl formamide (DMF) process; and the recovery facility, where final distillation occurred.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for synthetic rubber and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	High	Most critical metadata included.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling two groups of subjects.

Overall Quality Determination Medium

Study Citation:	Šrám, R. J., Rössner, P., Peltonen, K., Podrazilová, K., Mračková, G., Demopoulos, N. A., Stephanou, G., Vlachodimitropoulos, D., Darroudi, F., Tates, A. D. (1998). Chromosomal aberrations, sister-chromatid exchanges, cells with high frequency of SCE, micronuclei and comet assay parameters in 1,3-butadiene-exposed workers. Mutation Research: Genetic Toxicology and Environmental Mutagenesis 419(1-3):145-154.
HERO ID:	2454197
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	annual production in the world is estimated to exceed 5 million tons (page 2 of 10)
Life cycle description:	It is mainly used as a monomer in the manufacture of various synthetic rubber and plastic polymers and copolymers, the largest single use being styrene–butadiene rubber for tires and tire products (page 2 of 10)

EVALUATION

Domain	Metric		Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	From Czech Republic, an OECD country.
	Metric 3:	Applicability	High	For domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	greater than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination Medium