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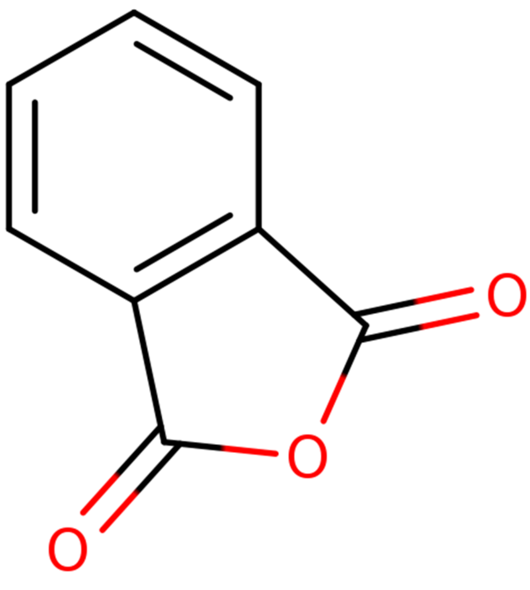
Office of Chemical Safety and
Pollution Prevention

Data Quality Evaluation and Data Extraction Information for Environmental Release and Occupational Exposure for Phthalic Anhydride

Systematic Review Support Document for the Draft Risk Evaluation

CASRN: 85-44-9



March 2026

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 Phthalic Anhydride* 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* (referred to hereafter '2021 Draft Systematic Review Protocol').

Data that met the RESO (Receptors, Exposure, Setting or Scenario, and Outcomes) 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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Study Citation:	[Redacted] (1985). [Redacted] n-Butyl alcohol, dibutyl phthalate, and phthalic anhydride concentrations, ______.
HERO ID:	10816675
Conditions of Use:	All other basic organic chemical manufacturing

EXTRACTION

Parameter	**Data**
Area sampling data:	Samples collected (on PVC filters) in area around filter presses during the production of DBP.Range: 0.01-0.02 (mg/m^3)Average: 0.02 (mg/m^3)

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 All other basic organic chemical manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (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 — Low

Study Citation:	Agaev, A. S., Nadzhafov, Y. B., Kobylkina, T. N. (1976). Cleanup of emissions from phthalic anhydride production. Chemistry and Technology of Fuels and Oils 12(11-1):873-875.
HERO ID:	5179383
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	bagging, cleaning, stripping
Exposure route:	inhalation
Area sampling data:	Table 1 provides summary (mg/m^3). Cyclones during cleaning - 8.0; Vent pipe for off gases - 1.1; Crude PA tank - 2.5; crystallizers - 1.5; Stripping still, during cleaning - 280; Bagging hopper - 2.1; Finished product warehouse - 5.5

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data referenced is from Russia, a non-OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to the manufacture of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1970s)
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes description of some unit operations, release media, some waste treatment information and source of release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Anas, E., Engstrom, B., Henriks-Eckerman, M. L. (1990). Exposure to paint degradation products when welding, flame cutting, or straightening painted steel. American Industrial Hygiene Association Journal 51(10):561-565.
HERO ID:	6011113
Conditions of Use:	Commercial or industrial - building/construction

EXTRACTION

Parameter	**Data**
Worker activity description:	Welding, flame cutting, and straightening painted steel in shipyards. The shipyards were for new building including hull construction and outfitting work. Another shipyard was a repairing yard and in a shipbreaking yard.
Exposure route:	inhalation
Physical form:	vapor, dust
Personal sampling data:	0.03 - 0.13 mg/m^3 in flame cutting. 0.2 mg/m^3 for straightening operations in the outfitting process. Table III provides data: (mg/m^3). For new building outfitting work median - 0.22, max - 0.26. Shipbreaking median - 0.082, max - 0.13.
Exposure duration:	Fumes collected only for about 30-60 minute during efficient working.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so sampling and analytical methodology is likely equivalent/accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is for Finland, an OECD country.
	Metric 3:	Applicability	High	Data is for an occupational scenario such as building and construction materials.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route, sampling duration, exposure type but lacks other important metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing across different sites, does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Barker, R. D., Tongeren, Van, M. J., Harris, J. M., Gardiner, K., Venables, K. M., Taylor, Newman, A. J. (1998). Risk factors for sensitisation and respiratory symptoms among workers exposed to acid anhydrides: a cohort study. Occupational and Environmental Medicine 55(10):684-91. [Occupational and environmental medicine].
HERO ID:	5177055
Conditions of Use:	Processing - intermediate in resin manufacturing and a cushioned flooring manufacturing.

EXTRACTION

Parameter	**Data**
Worker activity description:	Loading of PA into reactors, manually or within a closed system but would require maintenance.
Exposure route:	inhalation, ingestion
Physical form:	vapor, dust
Personal sampling data:	Measurements given in Table 3 (ug/m^3). Factory 1 arithmetic mean (AM) - 8.9, geometric mean (GM) - 2.2, geometric standard deviation (GSD) - 3.7, Range of AM - (2500-0.4); Factory 3: AM - 61.9, GM - 5.5, GSD - 5.5, Range for AM (554.4 - 1.0); Factory 4: AM - 11.9, GM - 4.5, GSD - 4.4, range of AM - (60-1.5)
Exposure duration:	They were asked, after a process of random selection within job titles, to wear an air sampling pump for the duration of a full workshift and during specific tasks. About one in 10 full shifts worked in each job title were sampled during a 2–4 week period at each factory.
Number of workers:	4 factories sampled, only tested for PA at 3 of the factories. 506 exposed, samples obtained from 401
Personal protective equipment:	At factories 1, 3, and 4,TMA was loaded manually but workers had almost always worn full respiratory protection including disposable suits and air fed hoods while handling this chemical. Respiratory protection was sometimes worn while handling MA but almost never when loading PA.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely does not contain errors in methodology and analytical technique.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from UK, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for processing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes most critical metadata such as exposure routes, sample type, worker activity, exposure duration, number of workers, physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability across multiple processing sites but does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Bookman, S. (2017). Final inhalation exposure monitoring report, phthalic anhydride, March 2017 [redacted].
HERO ID:	12979669
Conditions of Use:	Manufacturing; Processing as a Reactant; or Incorporation into formulation

EXTRACTION

Parameter	**Data**
Worker activity description:	Worker activity is only described as 'Operator' who was charging 5 super-sacs of phthalic anhydride. This sample corresponds to Sample #1Other samples were from RX-1 and RX-3. RX-1 and RX-3 are used to make maleic anhydride and other chemicals. The specifics of RX-1 and RX-3 are not stated.
Exposure route:	Inhalation
Personal sampling data:	Sample #1: 0.22 ppm (charging 5 sacs of PA)Sample#2: <0.02 ppm (Sampled RX-1)Sample #3 and #4: <0.02 ppm for both (Sampled RX-1 and RX-3).
Exposure duration:	Sample durations (4 samples): 75 minutes; 70 minutes; 79 minutes; and 78 minutesSource implies workers may work 12-hour shifts
Personal protective equipment:	Nitrile and leather gloves; FR coveralls; FRC uniform; safety shoes; full face respirator with P-100 combination cartridges; Safety glasses; face shield

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sample and analytical method is well described and stated to be a modified OSHA 90 method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	Data is likely applicable to multiple in-scope uses.
	Metric 4:	Temporal Representativeness	High	Data is from the last 10 years.
	Metric 5:	Sample Size	High	Individual samples are characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type, sample duration, PPE, and some specifics on worker activity are provided but not heavily detailed.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability.

Overall Quality Determination — High

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:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Personal sampling data:	Multiple studies referenced in article. First study was manufacturing alkyd and unsaturated polyester resins. Two groups of exposed workers were identified. One group worked directly loading the reactors from bags of phthalic anhydride (”heavy exposure” - 35 workers) and the other group was involved with ”other work” which led to ”low” exposures (25 workers). Time-weighted average air concentrations for workers from the loading of PA was 6.1 (range: 1.8-14.9) and 6.8 mg PA/m3 (range: 1.5-17.4) in plants A and B, respectively. Similar exposure levels in both plants led to pooling of data. The exposure duration of the “heavy” group was estimated at approximately 30 minutes two times a day, corresponding to the time of loading, and resulted in a full-day time weighted exposure estimate of 0.4 mg PA/m3. For those engaged in “other work” exposure levels were estimated at $<$ 0.1 mg PA/m3 (the limit of detection). In a study conducted at another plant manufacturing alkyd and/or unsaturated polyester resins, serum immunoglobulins and lung function were examined in 23 workers exposed to phthalic anhydride and 18 control subjects (Nielsen et al., 1991). Estimated exposure levels were 6.6 mg PA/m3 (range: 1.5-17) (Nielsen et al., 1988). Symptoms in workers occupationally exposed to PA during the course of producing alkyd and/or polyunsaturated polyester resins were described (Wernfors et al., 1986). Exposure estimates of breathing zone PA levels ranged from 3 to 13 mg/m3 for workers engaged directly with the handling of PA. In other areas the estimated level was <0.3 mg/m3. The study examined 48 workers who were employed at the time of the study and 70 former employees who responded to a survey of symptoms related to exposure.
Number of workers:	Different studies had different numbers of workers. First study had 35 ”heavy” exposure workers and 25 ”low” exposure workers. Second study had 23 workers and 18 control subjects. Last study examined 48 workers.
Comments:	Inhalation reference exposure level (20 ug/m^3)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed and conducted by California EPA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is within scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is just over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes sample type, some of the data has sample durations, exposure durations and frequencies.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Addresses variability by referencing multiple studies for the same industry. Address uncertainty in determined inhalation reference exposure level

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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:	Processing

EVALUATION

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

Study Citation:	Cardno ChemRisk, (2020). Phthalic anhydride risk management limit project [redacted].
HERO ID:	12980189
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers are stated to be Loaders, Operators, and Lab TechniciansSpecific occupation titles are stated in the Appendix in Tables 6, 7, and 8.
Exposure route:	Inhalation
Personal sampling data:	Table 6 provides Task specific sampling results (8 samples). Table 7 provides full-shift sampling results (15 samples).
Area sampling data:	Table 8 provides area sample results (12 samples). Some area samples are likely to be considered ONU data points (i.e. 3 samples are stated to be office)
Exposure duration:	All samples state the sampling time, implies an exposure duration of 8 to 12 hours/day. 8 and 12-hr TWAs are given.
Personal protective equipment:	Specific PPE worn are stated in the in the samples tables. Primarily Full-face 3M6700 with P100 filters. Some samples did not have any PPE. One sample did have SCBA. APF values are stated for each sample.
Engineering control:	Doorways separate control room and laboratory. Storage of FR gear in ventilated spaces reduces contamination/spread of PA. Fume hoods and LEV are in laboratory spaces.
Comments:	Source is redacted/edited it appears to hide identifiable information. Relevant information is available though and not redacted/edited.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Low	Sampling method is not stated.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	Data is applicable to in-scope use.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	Metric 5:	Sample Size	High	Samples fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source includes sampling duration, sample type, worker activities, and PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Source addresses variability by taking both full-shift and task-specific samples and includes information for the same workers about whether or not PPE was worn. Does not address uncertainty.

Overall Quality Determination — High

Study Citation:	Daniels, W. J., Donohue, M. T., Singal, M. (1985). Health Hazard Evaluation Report No. HETA-84-239-1586, Ashland Super Valu, Ashland, Wisconsin. NIOSH(HETA-84-239-1586):84-239.
HERO ID:	812650
Conditions of Use:	Commercial use - meat wrapper

EXTRACTION

Parameter	**Data**
Worker activity description:	Meat cutter, meat wrapper
Exposure route:	inhalation, ingestion
Physical form:	vapor or dust
Personal sampling data:	Not detected in process or personal samples above the limit of detection (1.54 ug/sample)
Area sampling data:	18.4 ug/g in a bulk sample of the labeling stock but not detected in the process or personal samples above the limit of detection (1.54 ug/sample)
Exposure duration:	Individual sampling is provided in table 1. Sampling times for meat wrapper was 200 minutes. For process sampling above labeler, sample time was 205, 115, and 86 minutes.
Number of workers:	5
Personal protective equipment:	A worker used a disposable dust respirator after reporting respiratory issues.
Engineering control:	Study recommended the implementation of a local exhaust ventilation system.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Study conducted by NIOSH
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Low	Data is for a commercial use out of scope, but could possibly be applied to a different scenario for commercial use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	High	Individual samples are provided. All below LOD.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Metadata such as sampling time, worker activity, number of workers, exposure route, etc. (includes nearly all metadata)
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	Griesenbrock, A. (2017). Final inhalation exposure monitoring report, phthalic anhydride, April 2017 [redacted].
HERO ID:	12979667
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Worker sampled was a loader/unloader, and a full-shift sample was taken while the worker was unloading a phthalic anhydride truck (about 42,000 lbs).
Exposure route:	Inhalation
Personal sampling data:	<0.003 ppm
Exposure duration:	483 minutes
Personal protective equipment:	Ear plugs, hard hat, FRC uniform, safety toe boots, full face respirator with combination cartridge.
Comments:	Source is partially redacted but underlying data seems to imply this is for the use of phthalic anhydride as some type of raw material (worker is unloading phthalic anhydride).

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methods is an OSHA method. Stated to be a modified OSHA 90 method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Source is from the US.
	Metric 3:	Applicability	High	Source is likely applicable to multiple in-scope uses (unloading) but not specific.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	Metric 5:	Sample Size	High	Only one sample but fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes all metadata such as exposure type, sample duration, and worker activity.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability.

Overall Quality Determination — High

Study Citation:	Heitbrink, W. (1993). In-depth survey report: Control technology for autobody repair and painting shops at Team Chevrolet, Colorado Springs, Colorado.
HERO ID:	6558535
Conditions of Use:	Commercial use - spray painting.

EXTRACTION

Parameter	**Data**
Worker activity description:	sanding, grinding, welding, spray painting.
Number of workers:	13
Personal protective equipment:	half face piece air purifying respirators are used to reduce worker exposure to paint overspray in spray painting booths. NIOSH study recommends use of supplied-air respirators operated in a positive pressure mode. Eye and skin protection to be worn - rubber gloves should be worn, presently in the study they wear uniforms.
Engineering control:	Spray painting booths have air entering the booth through fiilters in the door or through a supply air plenum. Air flows parallel to the ground, around the car and toward exit filters located in the back of the car. Car remains in booth until dry. Two booths opearte at a flow rate of 9500 cfm, one booth had flow rate of 3000 cfm and increased to 7000 cfm when adjusted. At the time 12,000 cfm is specified by OSHA standard for spray painting.
Comments:	There is sampling data but not for PA or any phthalates.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling conducted by NIOSH
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Medium	Occupational scenario falls under a condition of use but PA or phthalates are not mentioned.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	No samples provided for PA.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes process description, PPE and some engineering controls
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation: Heitbrink, W., Cooper, T., Edmonds, M., Bryant, C., Ruch, W. (1993). In-depth survey report: control technology for autobody repair and painting shops at Valley Paint and Body Shop, Amelia, Ohio.
HERO ID: 6558536
Conditions of Use: commercial use - spray painting

EXTRACTION

Parameter	Data
Number of workers:	7
Personal protective equipment:	Half-facepiece, air-purifying respirators are used to control worker exposure to airborne particles during some sanding and welding operations. During abrasive blasting operations with crystalline-silica containing sand, a positive pressure air-supplied, half-facepiece respirator is used. At the time, OSHA respiratory practice standards is not being completely followed.
Engineering control:	Air flow measurements on Spray Painting Booths - airflow into entry duct: 8200 cfm; airflow from top of booth: 13000 cfm; airflow from bottom of booth: 11400 cfm; airflow at exhaust stack: 11600 cfm; leakage into exhaust air plenum: 1300 cfm; recirculation around damper: 750 cfm. Employees required to wear respirators when operating with spray paint operations as well as sanding, grinding, and welding.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Study conducted by NIOSH.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Medium	Data is likely for an in-scope of use which is paints and coatings, however the study does not mention PA or phthalates in this source.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Low	Samples do not consist of PA data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains process description, number of workers, PPE and some engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Kolena, B., Petrovicova, I., Pilka, T., Pucherova, Z., Munk, M., Matula, B., Vankova, V., Petlus, P., Jenisova, Z., Rozova, Z., Wimmerova, S., Trnovec, T. (2014). Phthalate exposure and health-related outcomes in specific types of work environment. International Journal of Environmental Research and Public Health 11(6):5628-5639.
HERO ID:	2345960
Conditions of Use:	Disposal (Waste Management)

EXTRACTION

Parameter	**Data**
Worker activity description:	Waste management workers: waste truck drivers and co-drivers, sorting and processing waste substances for recycling
Exposure route:	inhalation, dermal
Exposure duration:	At least 8 hours per shift
Exposure frequency:	Men were employed on average 7.9 years and women 5.6 years.
Number of workers:	20 men and 10 women

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
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Slovakia, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario within the scope of the risk evaluation but not for any specific chemical.
	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	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing concentrations, engineering controls, PPE, particle size, and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparing results to other published studies.

Overall Quality Determination — Medium

Study Citation:	Koppers, (1979). Status report of industrial hygiene monitoring at the Bridgeville, Pennsylvania, Plant Chemical Division, Organic Materials Group.
HERO ID:	1480906
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Batch Still Operator, PAA Bagger
Exposure route:	inhalation, ingestion
Personal sampling data:	0.4 ppm and 0.2 ppm for Batch Still Operator and PAA bagger respectively.
Exposure duration:	Exposure duration was 99 and 396 minutes for the two samples.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling was conducted by a government branch (Office of Toxic Substances)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to COUs
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old.
	Metric 5:	Sample Size	Low	Individual samples provided however there are only 2 for PA.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides worker activity, exposure duration and exposure route.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Addresses variability by testing on different days. Addresses uncertainty in its analytical technique in appendix A.

Overall Quality Determination — Medium

Study Citation:	Lansink, M., C.J., Breelen, C., M.S., Marquart, J., Hemmen, van, J. J. (1996). Skin exposure to calcium carbonate in the paint industry. Preliminary modelling of skin exposure levels to powders based on field data..
HERO ID:	6387380
Conditions of Use:	Applies to multiple COUs: Dermal contact with solids/powders

EXTRACTION

Parameter	**Data**
Worker activity description:	1. Collection of the raw material - Manual collecting raw material (in bags), including bags of calcium carbonate, on a pallet or (flat) car in the storehouse of raw material and transportation of the raw material to the place of production.2. Manual weighing - Manual weighing of amounts of calcium carbonate (powder) out of bags, tons or cans on a balance and collecting the weighed amount in a bag or a can on e.g. a pallet.3. Manual dumping - Lifting the bag or the weighed amount of raw material (calcium carbonate) from the pallet or (flat) car to the dump-shelf, cutting the bag and manual dumping the bag or cans in a tub or vessel.4. Collection and removal of empty bags - Collection and transportation of the empty bags to (e.g.) a container or bale-press and compacting the bags by pushing them in the container or placing them in the bale-press.5. Manual dumping and collection and removal of empty bags - Combination of bag dumping and collection and removal of empty bags.6. Drumming of powdered paint - Drumming of powdered paint in 25 or 50 pound bags, whereby the bags are closed by sewing them together.
Dermal exposure data:	COLLECTING RAW MATERIALn = 12, GM = 476 mg, GSD = 1.83, Min = 139 mg, Max = 1090 mg, 10th %tile = 243 mg, 90th %tile = 1064 mgMANUAL WEIGHINGn = 6, GM = 685 mg, GSD = 2.5, Min = 247 mg, Max = 2511 mgMANUAL DUMPINGn = 19, GM = 888 mg, GSD = 2.5, Min = 123 mg, Max = 4214 mg, 10th %tile = 216 mg, 90th %tile = 3046 mgCOLLECTING EMPTY BAGSn = 14, GM = 215 mg, GSD = 2.7, Min = 53 mg, Max = 1042 mg, 10th %tile = 55 mg, 90th %tile = 1039 mg

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodologies are well described and found to be equivalent to approved OSHA or NIOSH methods.
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	The study is about 20 years old (1996); however, worker activities associated with the data are expected to be representative of current operations, equipment, and activities.
	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, exposure durations, and worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure, as well as uncertainty in the exposure estimates based on sampling method.

Overall Quality Determination High

Study Citation: Levy, S. A., Storey, J., Phashko, B. E. (1978). Meat worker's asthma. Journal of Occupational and Environmental Medicine 20(2):116-117.
HERO ID: 94889
Conditions of Use: Commercial use - PVC meat wrapping (film and sheets)

EXTRACTION

Parameter	**Data**
Worker activity description:	PVC film meat wrapper
Exposure route:	inhalation
Physical form:	vapor due to thermal degradation of film
Exposure duration:	15 minutes
Number of workers:	1
Comments:	A Phthalic Anhydride solution was created in the exposure experiment and used to measure the workers bodily response when exposed. Solution was 6.8 x 10^-4 M

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so methodology is likely highly accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is commercial use of PVC film in meat packing industry.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	Data is qualitative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Liss, G. M., Albro, P. W., Hartle, R. W., Stringer, W. T. (1985). Urine phthalate determinations as an index of occupational exposure to phthalic anhydride and di(2-ethylhexyl)phthalate. Scandinavian Journal of Work, Environment and Health 11(5):381-387.
HERO ID:	63766
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Chemical operators (DEHP, PA and BEP operators), mechanics spending most of their time in the PAl DEHP area, and tank farm operators, storekeepers; wastewater operators; boiler operators; quality control operators; instrument technicians ; first-line supervisors; and employees involved in administration, safety, engineering, and accounting work.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Table 1 provides personal breathing zone sampling data (ug/m^3). DEHP production had range (6-102) mean: 38. PA and DEHP maintenance: range (11-26), mean: 24; Batch ester plant production: range (5-21) mean: 11; Batch ester plant maintenance: range (21-44) mean: 33; tank farm range (17-203), mean: 79.
Number of workers:	In 1980, 142,000 workers in US were potentially exposed to PA. In this study they sampled 48 workers in high exposure and 47 workers in low exposure.
Personal protective equipment:	Respiratory protection is required.
Engineering control:	Local exhaust ventilation is utilized at the loading ports.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed and uses NIOSH analytical method(S-179)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for processing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes sample type, exposure type, and analytical method as well as some PPE and engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing across different exposure levels and compares with urinary metabolite data. Does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Liss, G. M., Albro, P. W., Hartle, R. W., Stringer, W. T. (1985). Urine phthalate determinations as an index of occupational exposure to phthalic anhydride and di(2-ethylhexyl)phthalate. Scandinavian Journal of Work, Environment and Health 11(5):381-387.
HERO ID:	63766
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Chemical operators (DEHP, PA and BEP operators), mechanics spending most of their time in the PAl DEHP area, and tank farm operators, storekeepers; wastewater operators; boiler operators; quality control operators; instrument technicians ; first-line supervisors; and employees involved in administration, safety, engineering, and accounting work.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Table 1 provides personal breathing zone sampling data (ug/m^3). PA Production - range (4-187), mean: 53.
Number of workers:	In 1980, 142,000 workers in US were potentially exposed to PA. In this study they sampled 48 workers in high exposure and 47 workers in low exposure.
Personal protective equipment:	Respiratory protection is required.
Engineering control:	Local exhaust ventilation is utilized at the loading ports.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed and uses NIOSH analytical method(S-179)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing.
	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.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes sample type, exposure type, and analytical method as well as some PPE and engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing across different exposure levels and compares with urinary metabolite data. Does not address uncertainty.

Overall Quality Determination — Medium

Study Citation: Liss, G. M., Hartel, R. W. (1983). Health Hazard Evaluation Report No. HETA-82-032-1384, Badische Corporation, Kearny, New Jersey. NIOSH(HETA-82-032-1384):82-032.
HERO ID: 1334319
Conditions of Use: manufacturing, processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Maintenance, operator, technician.
Exposure route:	inhalation
Physical form:	vapor, dust.
Personal sampling data:	Exposure concentrations are provided in Table 1 through 4. PA concentration (mg/m^3) ranged from <0.003 up to 0.203 depending on worker activity and location.
Number of workers:	163 employees, 76 hourly, 87 non-hourly. 4 operators work in the PA plant each shift. 2 in another reactor area and the other 2 in the PA reactor area.
Personal protective equipment:	Half-face dual cartridge respirators (GMC-H) are available for the PA operators, although their use is not required. It is required for truck or rail car loading of PA, and for removing PA from the sublimator boxes.
Comments:	*Exposures relate to both manufacturing and processing of PA.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Study conducted by NIOSH
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	High	Individual samples provided with their respective metadata.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes sample type, exposure type, sample duration, exposure duration, worker activities, personal protective equipment, etc.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling on different days throughout the year. Does not address uncertainty.

Overall Quality Determination **High**

Study Citation:	Maidment, S. C. (1998). Occupational hygiene considerations in the development of a structured approach to select chemical control strategies. Annals of Occupational Hygiene 42(6):391-400.
HERO ID:	1023667
Conditions of Use:	manufacturing, processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Filling and handling of bags. Charging reactor
Exposure route:	inhalation, ingestion
Physical form:	vapor/dust
Personal sampling data:	4 hour personal exposure measurements taken during filling and handling of 25 kg bags range from <0.17 to 1.7 mg/m^3. Arithmetic mean 0.43 mg/m^3 90 minute personal exposure measurements charge reactor with 25 kg bags range from 0.1-1.2 mg/m^3.
Area sampling data:	5 hr measurement taken during filling of 0.5 and 1 tonne bulk bags range from 0.86 to 4.1 mg/m^3. Arithmetic mean 2.37 mg/m^3.
Engineering control:	Model discusses need for implementation of certain engineering controls. Engineering controls include ventilation (natural or forced ventilation), containment controls and then assessment of needed controls on a case by case basis.
Comments:	*COU is either manufacturing or processing, not clearly specified in the article*Source is a model prediction and for the samples above the model predicted 0.1-1 mg/m^3 airborne exposure for personal sampling and 1-10 mg/m^3 for the area sampling. Despite source being for modeling, the data used in reference are actual samples and usable data is for monitoring data, the model just predicts what an exposure level is going to be and compares it to another source of sampled data.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed and sampling data is from a previous source already evaluated.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from UK, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides sampling time, worker activity and likely media (dust), but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation: Malten, K. E., Zielhaus, R. L. (1964). Food and cosmetics toxicology. :59-70.
HERO ID: 5353572
Conditions of Use: Processing - resin manufacturing

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	dust, vapor
Area sampling data:	Russian factory (1959) reported 118 workers exposed to 10-18 mg PA/m^3.
Number of workers:	118 in 1959 russian study.
Engineering control:	Local and general exhaust ventilation implemented for phases of production of alkyd resins.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so the sampled data used is likely accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Sampling data was conducted by non-OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for processing resins
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1959)
	Metric 5:	Sample Size	Medium	Data characterized by range.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains process information, exposure route, area data, but lacks other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Address variability throughout the study by referencing multiple studies regarding PA exposure but only one study provides sampling data, the rest is qualitative descriptions of the affects of exposure such as illnesses. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Milford, E. (2018). Final inhalation exposure monitoring report, phthalic anhydride, April 2018 [redacted].
HERO ID:	12979668
Conditions of Use:	Manufacturing; Processing as a reactant; or incorporation into formulation

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers are only described as 'Operators'. Specific activities are not stated.
Exposure route:	Inhalation
Personal sampling data:	Sample 1 & 2 were both 0.007 mg/m3; Sample 3 was <0.008 mg/m3
Exposure duration:	Sample 1: 595 minutes; Sample 2: 699 minutes; Sample 3: 683 minutes
Comments:	Source is partially redacted/edited so that it is unclear what COU is applicable.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical method is well described and stated to be a modified OSHA 90 method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	Source could be applicable to multiple COUs in scope that utilize PA as a raw material or is generated in a plant setting.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	Metric 5:	Sample Size	High	All 3 samples are fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Metadata such as sample duration and exposure route are stated. Specific worker activities are not.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination — High

Study Citation: NCBI, (2020). PubChem Compound Summary for CID 6811 Phthalic anhydride.
HERO ID: 10171484
Conditions of Use: Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation, Dermal
Physical form:	vapor, dust (colorless liquid or needles, white needles,and white flakes.)
Personal sampling data:	Workers employed in plants producing alkyd or polyunsaturated resins in factories: 3 to 13 mg/cu m as a TWA for breathing-zone samples during direct handling of phthalic anhydride. (P. 6/50)manufacturing plant: Measured exposure levels were up to 5 mg/cu m (long term, 3.5 hr) and 30 mg/cu m (short term, 1.5 min). (P. 7/50)
Area sampling data:	In two plants producing alkyd and unsaturated polyester resins:the time-weighted average air level during loading of phthalic anhydride (PA) was 6.6 (1.5 to 17.4) mg/cu m. In a full workday the level was 0.4 mg/cu m. (P. 6/50)
Number of workers:	NIOSH (NOES Survey 1981-1983) has statistically estimated that 81,311 workers (14,675 of these are female) are potentiallyexposed to phthalic anhydride in the US(1). (P. 22/50)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and analytical methodology are not provided in summary, but references J Nielsen et al 1988.
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	Low	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	Low	From summary it is unclear what type of monitoring data was collected (area or personal). Also, summary is lacking additional metadata of data measurements.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling multiple facilities. However, measurement uncertainty is not addressed.

Overall Quality Determination **Medium**

Study Citation:	Nielsen, J., Fahraeus, C., Bensryd, I., Akesson, B., Welinder, H., Linden, K., Skerfving, S. (1989). Small airways function in workers processing polyvinylchloride. International Archives of Occupational and Environmental Health 61(7):427-430.
HERO ID:	5175880
Conditions of Use:	Processing - PVC

EXTRACTION

Parameter	**Data**
Worker activity description:	Machine attendants, calendar operators
Area sampling data:	PAE: The mean exposure level for machine attendants in the thin-film department was 0.2 mg/m^3 and for calendaring operators 2.0 mg/m^3, when calendaring PVC with plasticizers; for machine attendants/calendar operators in the thick-film department the level was 0.4 mg/m^3.
Number of workers:	20 workers
Comments:	Source does not contain information about PA specific exposure, but phthalic acid esters.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely is error free.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Sweden, an OECD country.
	Metric 3:	Applicability	Medium	Data is for occupational exposure, but is not specific for PA but a class of chemicals that PA falls into.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes worker activity, sampling data, and number of workers.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Nielsen, J., Welinder, H., Schutz, A., Skerfving, S. (1988). Specific serum antibodies against phthalic anhydride in occupationally exposed subjects. Journal of Allergy and Clinical Immunology 82(1):126-133.
HERO ID:	5176341
Conditions of Use:	Processing - resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	During 5 to 30 minutes, one to two times during a working shift, paper bags containing 25 kg of flaked PA were cut open and manually emptied into chemical reactors.
Exposure route:	inhalation, ingestion
Physical form:	dust, vapor
Personal sampling data:	Table 1: Workroom air-dust levels of PA in breathing zone of workers in two plants. Plant A for loading reactors, TWA (mg/m^3) 6.1 with range (1.8-14.9). For other work at Plant A: <0.1 TWA. Plant B for loading reactors - TWA: 6.8 with range (1.5-17.4). Across both plants: TWA for both plants was 6.6 with range (1.5-17.4).
Exposure duration:	Sampling periods 6 to 36 minutes.
Number of workers:	60 workers sampled. 31 in plant A, and 29 in plant B.
Personal protective equipment:	Personal respiration protection equipment was used irregularly.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so sampling and analytical methodology likely does not contain errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Sweden, an OECD country.
	Metric 3:	Applicability	High	Source is directly applicable to condition of use listed.
	Metric 4:	Temporal Representativeness	Low	Source is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample size characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes most metadata, sample types, exposure route, exposure duration, exposure frequency, worker activity, personal protective equipment, number of workers
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing different processing plants, does not address uncertainty.

Overall Quality Determination	**Medium**

Study Citation:	OSHA, (2019). Chemical exposure health data (CEHD) sampling results: CASRNs 75-34-3, 85-68-7, 84-74-2, 78-87-5, 117-81-7, 106-93-4, 50-00-0, 95-50-1, 85-44-9, 106-46-7, 79-00-5, and 115-86-6.
HERO ID:	6499659
Conditions of Use:	OSHA data contains multiple industries

EXTRACTION

Parameter	**Data**
Personal sampling data:	Personal samples range from ND to 29 mg/m
Area sampling data:	Area samples are all ND

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	OSHA and state inspectors are expected to use OSHA or NIOSH sampling methods. Samples sent to the OSHA SLTC are expected to be analyzed using OSHA or NIOSH analytical 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	Medium	The OSHA data include occupational scenarios within the scopes of the chemicals as identified by NAICS code and facility name. However, some occupational scenarios are not clear and cannot be clearly mapped to conditions of use within scope.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	High	Individual measurements are provided so the sample sets can be fully statistically characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	OSHA data include sample type and exposure type. Sample times also provided. Exposure frequency is inconsistently provided. Worker job descriptions provided, but often lacks sufficient clarity.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	OSHA data do not discuss variability or uncertainty.

Overall Quality Determination — High

Study Citation:	Pfaeffli, P. (1994). Sampling of airborne combustion fume for chemical analysis: Application to determination of phthalic anhydride in condensed powder paint fume. Staub, Reinhaltung der Luft 54(11):403-407.
HERO ID:	5176000
Conditions of Use:	Use (use of powdered coatings but also maybe processing of plastics if it is done at elevated temperatures)

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	particles, fumes, and vapors
Area sampling data:	Substantial amounts of paint dust were also found in the workplace air, averaging 47.5 mg/m3 at the coating point and 9.8 mg/m3 in the other places in the hall air.
Particle size characterization:	The particles in the powder paint fume were small, the diameter averaging less than 0.2 µm. The particles in the workplace samples were partly somewhat larger (up to 1 µm) than those collected in experimental conditions, probably because they had had plenty of time to grow in the factory hall air.
Exposure duration:	6 hours/day
Comments:	From the article; "In hot processes, as in the processing of plasticised polyvinyl chloride, welding and heat cutting of alkyd or polyester painted metals or painting with polyester powder paints, phthalic anhydride is liberated from the compounds."

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 commercial use of paints and coatings, 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	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 locations using different equipment.

Overall Quality Determination — High

Study Citation:	Pfaffli, P. (1986). Phthalic anhydride as an impurity in industrial atmospheres: Assay in air samples by gas chromatography with electron-capture detection. Analyst 111(7):813-817.
HERO ID:	1334569
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Phthalic anhydride concentrations were measured in the atmosphere of a plant that produces this anhydride and unsaturated polyester resins. Phthalic anhydride was prepared from aromatic hydrocarbons by oxidation at high temperature and purified by distillation. The process was automatic and closed. At the end of the line, however, when the anhydride was flaked and sacked, some anhydride escaped into the workplace air. We measured the anhydride concentration in the air in the surroundings of this end location of the process.
Exposure route:	inhalation, ingestion
Physical form:	vapor/dust
Area sampling data:	Table 3 provides PA sampling data (mg/m^3 +/- SD). To summarize the table, averages over samples for flaking ranged from 0.36 up to 1.49 and for sacking it ranged from 0.23 up to 1.18.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but appears to use high quality analytical techniques that are detailed in the source and would not indicate flaws or errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for Finland, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Metadata such as sample type, exposure type, sampling duration, worker activities are given but not other critical metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling multiple times under different conditions but does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Pfaffli, P. (1986). Phthalic anhydride as an impurity in industrial atmospheres: Assay in air samples by gas chromatography with electron-capture detection. Analyst 111(7):813-817.
HERO ID:	1334569
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Calendering, extrusion, welding
Exposure route:	inhalation, ingestion
Physical form:	Vapor, Dust
Area sampling data:	Table 5 provides conc. of PA in the air during working of PVC plastics (mg/m^3). Averages were 0.0003 for calendering, 0.0003 for extrusion and 0.005 for welding.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but appears to use high quality analytical techniques that are detailed in the source and would not indicate flaws or errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for 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 is more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Metadata such as sample type, exposure type, sampling duration, worker activities are given but not other critical metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling multiple times under different conditions but does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Pfaffli, P. (1986). Phthalic acid excretion as an indicator of exposure to phthalic anhydride in the work atmosphere. International Archives of Occupational and Environmental Health 58(3):209-216.
HERO ID:	63773
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Personal sampling data:	Mean: 0.15 +/- 0.19 mg/m3 for 5 subjects;Mean: 1.63 +/- 0.13 mg/m3 for 2 subjects;10.5 mg/m3 for 1 subject
Exposure duration:	Duration of sampling averaged 60 minutes. It is unclear how many samples were taken for each worker. Workers are expected to be exposed at some level for the 8-hour workday, but it is not clear that the measurements are representative of entire workday exposure.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodologies are well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	Source is applicable to the manufacturing and processing COUs in general, but worker activities are unclear.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old and may not reflect updated practices.
	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 does not provide critical information such as discrete sample durations, worker activities, or exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation: Pfaffli, P., Hameila, M., Keskinen, H., Wirmoila, R. (2002). Exposure to cyclic anhydrides in welding: A new allergen-chlorendic anhydride. Applied Occupational and Environmental Hygiene 17(11):765-767.
HERO ID: 5175072
Conditions of Use: Commercial/industrial - welding

EXTRACTION

Parameter	Data
Worker activity description:	Repair welding of forest harvesters in engineering shop
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	11-21 ug/m^3. In the breathing zone of the welder, the concentration of PA from 10.9 to 20.9 ug/m3 (mean 16.1 ug/m3, SD 3.8, N 5).
Area sampling data:	In the area sample PA was 3.5 ug/m3, which indicated that fume dispersion was not prominent from the welding corner.
Exposure duration:	When the welding of one seam averaged 10 min, six to eight samples were collected into the same sampler. The total sampling time for each integrated sample was 70 min. Altogether, nine samples were collected at the welder's breathing zone outside the worker's welding helmet. One stationary sampling point was chosen for an area sample at a distance of 6 m from the welder to determine whether the welding fumes were distributed more widely.
Number of workers:	2 workers operate at a time
Personal protective equipment:	Standard welding helmet and a fresh-air-supplied respirator.
Engineering control:	Ventilated by active general ventilation and there is a movable local exhaust above the welding station

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely does not contain errors in sampling methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Finland, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to a commercial or industrial use.
	Metric 4:	Temporal Representativeness	Medium	Source is over 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data includes sample type, exposure route, sample durations, number of samples, worker activities, personal protective equipment, engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	Piirilä, P., Keskinen, H., Anttila, S., Hyvönen, M., Pfäffli, P., Tuomi, T., Tupasela, O., Tuppurainen, M., Nordman, H. (1997). Allergic alveolitis following exposure to epoxy polyester powder paint containing low amounts ($<$ 1%) of acid anhydrides. European Respiratory Journal 10(4):948-951.
HERO ID:	5176255
Conditions of Use:	Industrial or commercial use - paints and coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	Paints are used to paint metal
Exposure route:	inhalation
Area sampling data:	0.054 mg/m^3
Exposure duration:	30 min

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely does not contain any errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from UK, an OECD country
	Metric 3:	Applicability	Medium	Data is likely applicable to a industrial or commercial use of paints and coatings
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	One sample provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route and one sampling point but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty

Overall Quality Determination **Low**

Study Citation:	Qu, W., Feng, B., Zhang, L., Zhang, H., Zhang, P., Wang, H., Lin, G., Wang, R. (2019). Application of models for occupational health risk assessment to a resin anchorage production workshop. IOP Conference Series: Materials Science and Engineering 612(5):052055.
HERO ID:	10191617
Conditions of Use:	Processing as a reactant or incorporation into formulation - resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Samples taken in the job positions: Curing Agent Bottling; Cement Filler; and Product Packing
Exposure route:	Inhalation
Personal sampling data:	<0.03 mg/m3 in all 3 job positions: curing agent bottling, cement filler, and product packing (Table 1)
Exposure duration:	8 hrs/day
Exposure frequency:	5 days/wk (equates to ~250 days/yr)
Number of workers:	14 workshop employees
Comments:	Source does not provide information as to the specific function that PA serves in the resin whether it is acting as a reactant or just being incorporated into a formulation.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling methodology stated as ”Specifications of air sampling for hazardous substances monitoring in the workplace” (GBZ 159-2004), inspection method according to GBZ/T 300 series standard. However, it is unclear if method is equivalent to OSHA or NIOSH standards.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Source is from China, a non-OECD country.
	Metric 3:	Applicability	Medium	Source is applicable to an in-scope use, but the worker activities and application of phthalic anhydride within the process are unclear.
	Metric 4:	Temporal Representativeness	High	Source is from the last 10 years.
	Metric 5:	Sample Size	Medium	Source provides a range with uncertain additional statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Source provides information such as exposure type, specific worker positions/activities, exposure duration/frequency. However, sample durations are unknown.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Source addresses variability by sampling in different job positions. Source does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Ramkissoon, C., Gaskin, S., Hall, T., Pisaniello, D., Zosky, G. (2023). Engineered stone fabrication work releases volatile organic compounds classified as lung irritants. Annals of Work Exposures and Health 67(2):288-293.
HERO ID:	11141340
Conditions of Use:	Fabrication of final products or articles

EXTRACTION

Parameter	**Data**
Worker activity description:	Each stone slab was clamped safely in an enclosed perspex cabinet (60 × 80 × 80 cm) fitted with glove compartments; a series of 3-mm wide zipcuts were made into the stone using a hand-held angle grinder fitted with a diamond blade.
Exposure route:	Inhalation
Physical form:	Dust
Area sampling data:	0.32 mg/m3 for one 30-min sample. Engineered stone sample ES10 was used in the inhalation monitoring trial.
Exposure duration:	Sampling was conducted during a 30-min period.
Comments:	Source specifically states that this study was not to assess workplace exposure and the methodology indicates this was a controlled experiment/sampling so may not equate to a true workplace exposure.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is well described however, source specifically states this study was not intended to evaluate workplace exposure so methodology was not attached to personnel to simulate a workplace exposure.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Australia, an OECD country.
	Metric 3:	Applicability	Medium	Source is for an in-scope use however the source explicitly states that this study was not made with the intent to evaluate workplace exposures.
	Metric 4:	Temporal Representativeness	High	Data were collected in the last 10 years.
	Metric 5:	Sample Size	Medium	Uncertain statistics with range for emission factors but only one respirable dust sample stated.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	No other metadata provided besides sample duration.
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:	Ridgway, P., Morris, L., Ogunbiyi, A. O., Brown, R. H., Cocker, J. (1996). Acid anhydrides: Criteria document for an occupational exposure limit.
HERO ID:	830957
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	Exposures during use range from 0.0004 to 1.487 mg.m·3 for full shift exposures. For use of phthalic anhydride, range from 0.1- - 1.2 (mg/m^3) and 0.02 mg/m^3 for process operators and warehousing.
Area sampling data:	For use of phthalic anhydride, road tanker off-loading, samples ranged from 0.5-6.3 mg/m^3.
Comments:	Several studies are referenced in the article for PA exposure, many urine sampling data.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Source is a technical report from the UK. Does not use US sources but does not indicate flaws or issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistcs.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes sample type, TWA data, worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability across different manufacturing scenarios and elaborating on multiple studies for PA exposure. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation: Ridgway, P., Morris, L., Ogunbiyi, A. O., Brown, R. H., Cocker, J. (1996). Acid anhydrides: Criteria document for an occupational exposure limit.
HERO ID: 830957
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation
Personal sampling data:	The first group of data in this table was collected from a major UK manufacturing site and relates mainly to the finishing process (flaking and bagging) at the plant. Three personal exposure measurements (8-hour TWA) were in the range 0.1 to 0.6 mg.m·' for these operations. No personal exposure data were available for routine operation of the manufacturing plant or for road tanker loading. Exposure at these processes was thought to be low During bagging at a manufacturing plant exposures were recorded of up to 4.1 mg.m·3 for a 5-hour exposure.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Source is a technical report from the UK. Does not use US sources but does not indicate flaws or issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are 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	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/orworker activities.
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:	Rietz, B. (1985). The use of HPLC for the analytical determination of diisocyanates and acid anhydrides in the air of working environments. Analytical Letters 18(10):1193-1207.
HERO ID:	2144066
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Manual mixing and filling operations prior to the production of plastics.
Exposure route:	inhalation
Area sampling data:	The four personal samples taken for PA were 0.51, 0.75, 2.53, and 4.90 mg/m3.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is a NIOSH approved method.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Denmark, an OECD country.
	Metric 3:	Applicability	High	Data are for the processing as a reactant in plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are 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	High	Most critical metadata included.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability is addressed by sampling at 3 different sites.

Overall Quality Determination	**High**

Study Citation:	Tongeren, van, M. J., Barker, R. D., Gardiner, K., Harris, J. M., Venables, K. M., Harrington, J. M., Taylor, Newman, A. J. (1998). Retrospective exposure assessment for a cohort study into respiratory effects of acid anhydrides. Occupational and Environmental Medicine 55(10):692-696.
HERO ID:	831018
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Resin operator, filter operator, pilot plant operator
Exposure route:	inhalation
Physical form:	vapor, dust, liquid, solid
Personal sampling data:	Mean exposures (ug/m3) varied by high exposure to low exposure ranging from 1.3 for no exposure to low exposure up to 138 for high exposure operations. Table 1 provides exposure concentrations. Estimated exposures from 1960 to 1969 was 2480 ug/m3 for operators of PA melting pots. Table 3 provides job-time-exposure matrix for PA in factory 1, same for Table 4 but in factory 3, same for Table 5 but in factory 4.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed and does not appear to contain any analytical errors in methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is for UK, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to a condition of use, for manufacturing and processing
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain characteristics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides sample type, exposure type/route, sample durations, worker activities, exposure frequency
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing multiple days across different factories. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Tongeren, van, M. J., Barker, R. D., Gardiner, K., Harris, J. M., Venables, K. M., Taylor, A. J., Harrington, J. M. (1995). Exposure to acid anhydrides in three resin and one cushioned flooring manufacturing plants. Annals of Occupational Hygiene 39(5):559-571.
HERO ID:	831008
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Resin operator, filter operator, warehouseman, maintenance, laboratory worker R&D resin, supervisor, Laboratory worker QC resin, pilot plant operator resin, handling bags, charging, sampling/testing, resin finishing, laboratory work, opening system, delivery LPA (liquid PA)
Exposure route:	inhalation
Physical form:	solid, liquid, dust/vapor
Personal sampling data:	Factories 1 through 4 have PA exposure described on table 2 based on job position and the arithmetic mean (AM), geometric mean (GM), and geometric standard deviation (GSD) as well as %<LoD. Factory 1 had exposures range from 0.5 up to 25.1 ug/m^3 for AM, had ranges from 0.5 to 7.6 (all units in ug/m^3). Factory 3 had AM ranges from 2.5 to 137.7 and GM ranges from 1.6 to 9.4. Factory 4 had AM ranges from 1.8 to 20.1 and GM ranges from 1.2 to 11.9. Workers with highest exposures were resin operators. Table 4 provides task specific exposure to PA (ug/m^3): Values ranged from 5.5 up to 1862.6 depending on the task. The highest PA exposures occurred during charging of solid PA in the reactor vessels (AM: 363.9 ug/m3) and sampling and testing of the reactor mixture (AM: 300.3 ug/m3). Exposure also occurred whenever the enclosed system was opened and solid PA had to be removed (AM: 179.6 ug/m3) and during filtering and drumming of the resin (AM: 103.9 ug/m3). For each task the average time-weighted average (TWA) exposure over 8 h was calculated. In addition, a 10-min TWA was calculated assuming that the exposure happened during only 10 min of the measurement. The highest 8-h TWA occurred during charging of PA into the reactor vessel (8-h TWA: 38.0 ug/m3), whereas the 10-min TWA for this task was almost 2 mg/m3, which is about a factor of 13 below the Short-term Exposure Limit (24 mg/m^3). A literature study is cited for personal sampling which ranged from 0.02 up to 13 mg/m3 for PA production.
Exposure duration:	130 full-shift (8 hrs) samples and 73 task-specific samples
Personal protective equipment:	Multiple forms of PPE were worn when handling chemicals but for PA, respiratory protection was rarely used whilst loading PA or taking samples of the resin. For other chemicals used alongside PA, full respiratory protection (air-fed hood) with disposable suits, rubber gloves and boots were worn.
Engineering control:	PPE required, prevention of spillages and handling of spilt bags. Use of liquid PA enables automatic loading and high exposure to manual loading is avoided. Local exhaust ventilation at loading points

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Some literature data that is cited is from NIOSH, however sampling methodology is laid out in detail and is peer reviewed so likely does not contain errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for UK, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to COUs
	Metric 4:	Temporal Representativeness	Low	Data is greater 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	Contains sample type, exposure frequency, exposure duration, worker activity, and most other metadata
Domain 4: Variability and Uncertainty				

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Study Citation: Tongeren, van, M. J., Barker, R. D., Gardiner, K., Harris, J. M., Venables, K. M., Taylor, A. J., Harrington, J. M. (1995). Exposure to acid anhydrides in three resin and one cushioned flooring manufacturing plants. Annals of Occupational Hygiene 39(5):559-571.
HERO ID: 831008
Conditions of Use: Processing

EVALUATION

Domain	Metric		Rating	Comments
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing across different factories on different days. Does not address uncertainty.

Overall Quality Determination Medium

Study Citation:	Tustin, T., Kundu-Orwa, S., Lodwick, J., Cannon, D. L., McCarthy, R. B. (2022). An outbreak of work-related asthma and silicosis at a US countertop manufacturing and fabrication facility. American Journal of Industrial Medicine 65(1):12-19.
HERO ID:	10113574
Conditions of Use:	Use of Epoxy Resins

EXTRACTION

Parameter	**Data**
Worker activity description:	Casting workers mix and heat raw materials (which includes PA). They then pour the liquid into molds and into ovens for curing.Fabrication workers clean the countertops with saws and routers. Other fabrication workers smooth the countertops.6 workers sampled with job locations stated: 2 in pouring, 2 in sinks, and 2 in stripping
Exposure route:	Inhalation
Physical form:	White dust that appeared to be PA or fine sand in the ambient air.
Personal sampling data:	6 workers in casting sampled for PBZ in mg/m3 and given as an 8-h TWA:#1: 16.5; #2: 6.4; #3: 5.4; #4: 2.6; #5: 2.0; #6 1.7The source notes that one source is above the OSHA PEL of 12 mg/m3 and all are above the 2017 TLV of 0.005 mg/m3.
Exposure duration:	Plant employees work 12 hr/day.
Number of workers:	103 workers in casting department; 97 workers in fabrication, 24 workers in other areas of the plant, and 124 workers outside the plant (i.e. in the business office)
Comments:	Source is about the formulation of epoxy resin countertops. It is unclear what the function of the phthalic anhydride is though in the mix whether it is functioning as a reactant or just being incorporated into the mix.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	OSHA performed personal air sampling using OSHA Method Number 90 for Phthalic Anhydride.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the United States.
	Metric 3:	Applicability	High	Data are applicable to use of phthalic anhydride in epoxy resins.
	Metric 4:	Temporal Representativeness	High	Data are from within the last 10 years.
	Metric 5:	Sample Size	High	Discrete 8-hr TWA personal breathing zone monitoring data provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Data includes nearly all metadata such as sample type, exposure route, exposure durations, worker activities, but lacks exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Source address variability by sampling in different work areas/roles within the casting department. Source does not address uncertainty.

Overall Quality Determination	**High**

Study Citation: U.S. EPA, (1992). A laboratory method to determine the retention of liquids on the surface of hands.
HERO ID: 1064974
Conditions of Use: Applies to multiple COUs: Dermal liquid contact scenarios

EXTRACTION

Parameter	Data
Worker activity description:	Three types of dermal exposure testing with mineral oil, cooking oil, and bath oil:1. Initial wipe of saturated rag - In the initial wipe test, each subject's hands were first thoroughly washed and then the liquids were applied to their hands from a cloth saturated in the liquid. The amount of liquid first retained on the hands was then found by simply calculating the difference between the before and after application weights of the cloth (and holding cup).2. Secondary wipe of saturated rag - The procedures of this test were the same as those of the initial wipe test with the important exception that the secondary wipe tests immediately followed the initial wipe tests with no intervening washing of hands.3. Immersion of hands - In this test, subjects dipped their hands (thoroughly washed) directly into a container holding the liquid and then wiped their exposed hands, first partially then fully, with separate, initially dry, removal cloths. Because an analytical balance of sufficient combined capacity and accuracy did not exist to directly weigh the container of liquid before and after application, the amount of liquid first retained was indirectly estimated by adding the differenced weighing of both partial and full removal cloths (with holding cups) to the previously estimated amount remaining after "full" removal from the initial wipe test. The amount remaining after partial removal was estimated by subtracting the differenced weighing of the partial removal cloth from the amount estimated to be first retained.
Dermal exposure data:	Means of initial wipe retention values (mg/cm2) [Table 4-1]: 1.36 (mineral oil), 2.07 (cooking oil), 1.49 (bathing oil)Means of secondary wipe retention values (mg/cm2) [Table 4-1]:1.22 (mineral oil), 1.72 (cooking oil), 1.34 (bathing oil) Means of immersion retention values (mg/cm2) [Table 4-1]: 10.33 (mineral oil), 6.02 (cooking oil), 5.94 (bathing oil) Means of immersion after partial removal (mg/cm2) [Table 4-1]:1.75 (mineral oil), 1.33 (cooking oil), 1.34 (bathing oil)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodologies are 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	Study was conducted over 20 years ago (1992); however, worker activities assessed in the study are expected to be reasonably representative of current conditions.
	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, and worker activity.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure, as well as uncertainty in the exposure estimates through use of the ANOVA sampling technique.

Overall Quality Determination **High**

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Study Citation:	U.S. EPA, (1992). A laboratory method to determine the retention of liquids on the surface of hands.
HERO ID:	1064974
Conditions of Use:	Applies to multiple COUs: Dermal liquid contact scenarios

EVALUATION

Domain	Metric	Rating	Comments

Study Citation:	Vainiotalo, S., Pfaffli, P. (1990). Air impurities in the PVC plastics processing industry. Annals of Occupational Hygiene 34(6):585-590.
HERO ID:	5175697
Conditions of Use:	Processing - plasticizer in PVC and reactant for DEHP

EXTRACTION

Parameter	**Data**
Worker activity description:	Processing method for worker activities: extrusion, calendaring, hot embossing, welding, injection moulding, compounding, thermoforming, high-frequency welding, spread coating, blow moulding, compression moulding
Exposure route:	inhalation
Personal sampling data:	Table 2 provides the specific processing method and PA concentration data (ug/m^3) mean +/- SD. Extrusion: 0.3 +/- 0.5, Calendaring: 0.2 +/-0.1, Hot embossing: not measured, Welding: 5.0 +/- 2.0, Injection moulding: <0.02, Compounding: not measured, thermoforming: 0.1 +/- 0.05, high-frequency welding: not measured, spread coating: 1.2 +/- 0.2, blow moulding and compression moulding were unplasticized PVC. Although the concentrations were low (<0.02-5.0 ug/m3) highest concentrations during welding.
Engineering control:	Local exhaust ventilation

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so sampling methodology is likely error free.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data from Britain (UK), an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use listed.
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes worker activity, exposure duration, exposure route, personal sampling data, and engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling across multiple plants, does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Vandervort, R., Brooks, S. M. (1977). Polyvinyl chloride film thermal decomposition products as an occupational illness: I. Environmental exposures and toxicology. Journal of Occupational and Environmental Medicine 19(3):188-191.
HERO ID:	59547
Conditions of Use:	Meat wrapping with PVC film, including hot-wire cutting

EXTRACTION

Parameter	**Data**
Worker activity description:	The hand wrapping of meat involves: (1) pulling out a desired length of film; (2) wrapping the film around the tray or cut of meat; (3) severing the film from the supply roll using the hot-wire cut-off; (4) folding the film ends under the package; and (5) sealing the folded ends under the package by touching the package to the heated sealing pad.
Personal sampling data:	During exaggerated thermal cutting: 19 mg/m3 of total particulate containing 75-80% DEHP decomposition product (source notes the process was exaggerated, with higher volume and temperature). During normal operations: 0.35 mg/m3 particulate and 0.14 mg/m3 dioctyl adipate (phthalate decomposition product).
Number of workers:	75,000 - 100,000

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	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, 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	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other metadata.
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 — Medium

Study Citation:	Vermeulen, R., Jonsson, G., B.A., Lindh, C. H., Kromhout, H. (2005). Biological monitoring of carbon disulphide and phthalate exposure in the contemporary rubber industry. International Archives of Occupational and Environmental Health 78(8):663-669.
HERO ID:	531742
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers in 9 rubber manufacturing plants. The workers were from the following departments: mixing, pre-treating, molding, curing, finishing, shipping, and engineering services.
Exposure route:	Inhalation and dermal
Personal sampling data:	Phthalic acid (PA) concentration (ug/L): in inhalable dust – beta (SE) – 0.11 (0.21); in rubber fumes (as cyclohexane soluble matter) – beta (SE) – 0.078 (0.12).
Area sampling data:	no information provided
Dermal exposure data:	Phthalic acid (PA) concentration (ug/L) as dermal as cyclohexane soluble matter – beta (SE) – 0.0064 (0.072).
Number of workers:	Inhalation exposures measured for 62 workers and dermal exposure measured for 66 workers
Personal protective equipment:	Less than 5% of the subjects used any kind of respiratory protection during the measurements. Gloves were used by approximately 45% of the study population.

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	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	The data are more than 10 years but generally, 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	Medium	Monitoring data include most critical metadata, such as sample type and exposure type.
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:	Wernfors, M., Nielsen, J., Schütz, A., Skerfving, S. (1986). Phthalic anhydride-induced occupational asthma. International Archives of Allergy and Applied Immunology 79(1):77-82.
HERO ID:	5176303
Conditions of Use:	Processing - resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Cutting of paper bags containing 25 kg of flaked PA and manually being emptied into chemical reactors. Specific main work operations listed in Table 1: loading of reactors, handling of empty bags, cleaning, assisting loader (including handling of empty bags), General work (including sampling from reactor), in canteen (area sampling)
Exposure route:	inhalation
Physical form:	vapor, dust
Personal sampling data:	TWA in 2 plants were between 3 and 13 mg/m^3 during different direct PA handling operations and less than 0.3 mg/m^3 at other kinds of work. From Table 1 TWA then range (mg/m^3). Plant A - loading of reactors: 4.9 (0.3-15), handling of empty bags: 13 (6.8-23), cleaning: <0.3 (<0.1-0.6); Plant B - loading of reactors: 2.8 (2.3-3.2), assisting loader (including handling of empty bags): 6.1 (1.5-12), Cleaning: 0.3 (<0.1-0.6), General Work (including sampling from reactor): 0.15 (<0.1-0.4), In canteen (area sampling): <0.1 (<0.1-0.2)
Exposure duration:	Sampling periods 3-149 min
Number of workers:	4 plants: 118 workers
Personal protective equipment:	Personal respiration protection equipment used irregularly

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so sampling and analytical methodology likely error free.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Sweden, an OECD country
	Metric 3:	Applicability	High	Applicable to condition of use for processing into resins.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes worker activity, exposure route, physical form, sample duration, number of workers, PPE.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling during multiple days during multiple times of operation. Does not address uncertainty.

Overall Quality Determination	**Medium**

Study Citation:	Yokota, K., Johyama, Y., Yamaguchi, K., Takeshita, T., Morimoto, K. (1999). Exposure-response relationships in rhinitis and conjunctivitis caused by methyltetrahydrophthalic anhydride. International Archives of Occupational and Environmental Health 72(1):14-8. [International archives of occupational and environmental health].
HERO ID:	5175237
Conditions of Use:	Industrial use - hardener for epoxy resin system

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Personal sampling data:	The geometric mean levels of MTHPA determined in the two plants ranged from 4.93 to 68.4 ug/m3 and were considerably lower than the PA control limit. Table 1 provides specific workzones, number of measurements, and airborne concentrations.
Exposure duration:	8-h work shift
Number of workers:	Altogether, 47 (plant A) and 94 (plant B) persons were engaged in monitoring work in the various work zones, did not change job categories, and were continuously exposed during an 8-h work shift. In all, 45 (96%) of the workers in plant A and 66 (70%) of those in plant B agreed to participate in the survey; 30 workers in these plants refused to participate for personal reasons. Altogether, 111 exposed workers were investigated. As control subjects, 25 persons (age 21±54 years; 3 women) from other parts of the workshop and offices with little exposure to MTHPA, if any, were randomly selected in plant A.
Personal protective equipment:	On the other hand, 4 (20%) workers who displayed the symptoms during direct handling of MTHPA had to use respiratory protective equipment.
Comments:	This chemical evaluated is methyltetrahydrophthalic anhydride (MTHPA) which is similar to PA and its exposure levels are compared to what the exposure standards are for PA. It has a similar condition of use so extraction was conducted.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so sampling and analytical methodology likely to contain no errors
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data appears to be from Japan, an OECD country.
	Metric 3:	Applicability	Low	Data is for a chemical similar to PA in an identical condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides exposure duration, exposure frequency, number of workers, exposure route but lacks other important metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by assessing data over a few years on different industrial plants. Does not address uncertainty.

Overall Quality Determination — Medium

Study Citation:	Yokota, K., Takeshita, T., Morimoto, K. (1999). Prevention of occupational allergy caused by exposure to acid anhydrides. Industrial Health 37(3):281-288.
HERO ID:	5177494
Conditions of Use:	Processing - production of resins

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	vapor, dust
Personal sampling data:	TWA for "loader" workers: 6.6 (range: 1.5-17.4) mg/m^3.
Exposure duration:	35 workers classified as "loaders" were exposed for 30 minutes per day.
Number of workers:	Total of 60 workers in the study. TWA data is for 35 workers.
Personal protective equipment:	PPE stated to be used but does not state what kind.
Engineering control:	Local exhaust ventilation should be in place.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains no errors in methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Japan, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is 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	Medium	Contains metadata such as exposure duration, personal sampling data, exposure route, physical form. Little information about worker activities, PPE and engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination	**Medium**

Study Citation:	Frasch, H. F., Bunge, A. L. (2015). The transient dermal exposure II: post-exposure absorption and evaporation of volatile compounds. Journal of Pharmaceutical Sciences 104(4):1499-1507.
HERO ID:	3230538
Conditions of Use:	processing - plasticizer

EXTRACTION

Parameter	**Data**
Exposure route:	dermal
Physical form:	vapor, liquid
Dermal exposure data:	The source is about a model on transient dermal exposure. In the model, the Final Value Theorem is applied to obtain the analytical solutions for the total fractional absorption by the body and evaporation from skin at infinite time following a transient exposure. The solutions depend on two dimensionless variables: , the ratio of evaporation rate to steady-state dermal permeation rate; and the ratio of exposure time to membrane lag time. Simple closed form algebraic equations are presented that closely approximate the complete analytical solutions.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer reviewed and free of mathematical errors, based on sounds approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from US
	Metric 3:	Applicability	Medium	Model could be modified to manufacturing or processing scenario for PA.
	Metric 4:	Temporal Representativeness	High	Model is no more than 10 years old
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 parameters are provided.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	Medium	Variability is addressed by testing with different exposure times as well as liquid and vapor states. Uncertainty is not addressed.

Overall Quality Determination — High

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

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation, dermal
Physical form:	particles of powder, solvent vapors, solvents
Particle size characterization:	Basecoat applications by air atomization had a MMAD of 4-14 um. Application by rotary atomizer generated particles of 25-35 um. In another study, the MMAD of lacquer mist was 6.4+-3.4 um and enamel had a MMAD of 5.7+-2.0 um.
Number of workers:	Half a million workers in the U.S. are included in the application of paint products. Of this number, 200,000 are employed in autobody shops.
Personal protective equipment:	The minimum respirator for all paint applications should be a combination mist-organic vapor air-purifying device. Higher levels of protection including air-supplied hoods or helmets may be necessary on certain systems such as spray application.
Engineering control:	All storage and mixing vessels should be provided with close fitting covers designed with access ports. It should be normal to equip these tanks with integral agitators. All dispensing stations should be provided with collection trays and safety cans. Transfer of solvent should be done by closed-pump systems not by open pouring. Controls in the application of paint systems must include excellent housekeeping, effective ventilation control, and protective clothing. Adequate washing facilities should be available, and eating and drinking should be prohibited.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment 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 the use of paints and coatings, but are a general model, and not for one specific 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	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	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 paint application techniques. Uncertainty isn't addressed.

Overall Quality Determination **High**

Study Citation:	Canada,, Health (2019). Screening assessment carboxylic acid anhydrides group.
HERO ID:	8404079
Conditions of Use:	Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers at a polyester resin production plant in Sweden. Operations with exposure to PA included loading the chemical.
Exposure route:	inhalation
Physical form:	white flakes or needles
Area sampling data:	The TWA during loading of PA at the workplace was 6.6 mg/m3. During the rest of the day workers were exposed to lower levels and the timeweighted average for a full workday was approximately 0.4 mg/m3.
Exposure duration:	Workers were only exposed during loading, which lasted about 30 minutes per day.
Number of workers:	60 exposed workers at the plant.

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 other than 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 is from more than 20 years back.
	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	Medium	Uncertainty is addressed in a table that lists key sources of uncertainty, Variability is not addressed.

Overall Quality Determination — Medium

Study Citation: Fasset, D. W. (1963). Phthalic anhydride. :1822-1823.
HERO ID: 5353579
Conditions of Use: Processing

EXTRACTION

Parameter	**Data**
Exposure route:	dermal, inhalation
Engineering control:	It is apparent that phthalic anhydride handling requires adequate local and general ventilation, careful education of personnel, and medical supervision with placement and follow-up examinations.

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 incorporation into plasticizers in plastic and resin 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	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:	Hours, M., Bertholon, J., Esteve, J., Cardis, E., Freyssinet, C. L., Quelin, P., Fabry, J. (1986). Mortality experience in a polyamide-polyester factory. Scandinavian Journal of Work, Environment and Health 12(5):455-460.
HERO ID:	1598909
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Administration, nylon manufacture, tergal manufacture, maintenance and central laboratory, and mobile workers.
Number of workers:	1900 at any given time, 3837 total since 1962.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	Medium	Data are for fillers in textiles, but contain general information about this COU not for one specific chemical.
	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 (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 in the data collection method. Variability is addressed by dividing samples into group by job, and age.

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 - automotive coating application

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. dermal: Provides methods for modeling exposures to non-volatile liquids Inhalation: Provides methods for modeling exposures to mists
Personal sampling data:	dermal: surrogate measured skin loading conditions inhalation: 8-hr TWA surrogate data. Sampling was PBZ.
Exposure frequency:	250 days/yr
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	The data are from the United States and are representative of the industry being evaluated.
	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	The completed exposure or risk assessment is no more than 10 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 **High**

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

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 expected to be representative of current industry conditions.
	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 adhesives.

Overall Quality Determination — Medium

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

EXTRACTION

Parameter	**Data**
Worker activity description:	unloading, container cleaning, adhesive application, equipment cleaning, curing/drying
Exposure route:	dermal and inhalation. 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:	50-250 days/yr
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, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.
HERO ID:	3840003
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	Formulation of Coatings, Inks, and Adhesives
Worker activity description:	Unloading, container cleaning, sampling, equipment cleaning, filter media changeout, 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:	250 days/yr
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, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID:	5160034
Conditions of Use:	Disposal - landfill

EXTRACTION

Parameter	**Data**
Area sampling data:	In 4 air samples collected over landfills the concentrations of phthalic anhydride were 0.06 ppb, 0.16 ppb, and 2 samples were below the detection limit of < 0.06 ppb.
Comments:	See Table 9 for "reported environmental occurrence of PAD"

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination **High**

Study Citation: OECD, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID: 5160034
Conditions of Use: alkyd and/or saturated polyester resin plants

EXTRACTION

Parameter	**Data**
Personal sampling data:	In 2 alkyd and/or saturated polyester resin plants (cf Chapter 3.1.4), time-weighted average concentrations of phthalic anhydride dust were 2.8 and 4.9 mg/m3 during manual loading of reactors from paper bags, 6.1 and 13 mg/m3 during handling of emptied paper bags, and <0.3 and 0.3 mg/m3 during cleaning, respectively. In one of the plants, also the dust concentration was determined during general work (including sampling from reactor, 0.15 mg/m3) and in the canteen (< 0.1 mg/m3).
Area sampling data:	Also in alkyd and/or saturated polyester resin plants, working place air concentrations of phthalic anhydride were 6.6 mg/m3 (range 1.5 - 17 mg/m3) during phthalic anhydride loading of reactors (Nielsen et al., 1991).
Particle size characterization:	40 - 46 % of the dust was in the respirable dust fraction (Wernfors et al., 1986).

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation:	OECD, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID:	5160034
Conditions of Use:	PVC plastics processing plants

EXTRACTION

Parameter	**Data**
Area sampling data:	In 6 PVC plastics processing plants using PVC containing organic phthalates as plasticizers, the workplace air concentrations of phthalic anhydride (and DEHP in 9 plants) were determined (Vainiotalo and Pfaeffli, 1990). Phthalic anhydride levels ranged from below the detection limit (<0.02 μg/m3) to 5 μg/m3. For comparison, the phthalate levels were up to 100 times higher (< 0.02 - 0.5 mg/m3). Use of heat sealers may therefore expose users of PVC film to phthalic anhydride (SRC, 1995).

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation: OECD, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID: 5160034
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	dermal, inhalation
Area sampling data:	see ”Potential exposure at the workplace” on pg 20 for measurements from multiple sites/processes
Number of workers:	In 1981 - 1983 approximately 81 000workers were potentially exposed to phthalic anhydride in the USA (NIOSH, 2005).
Engineering control:	To protect workers from exposure, several precautionary and protective measures are taken. Sampling, for instance, is performed with specially designed systems and filling operations take place in a closed system with special suction devices. Repair and maintenance work is only carried out on parts of the manufacturing or processing systems which have been emptied. Prior to repair and maintenance the parts are flushed with water or alkali to remove residual substances. Special written permits are required which include a detailed description of the protective measures depending on the work to be done (e.g. full protective clothing and gas filter masks (classification ABEK)) (Bayer Chemicals, 2004).

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario(s) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

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

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 liquids
Exposure frequency:	Exposure frequency: Processing: 203-360 days/yr, Use: 253 days/yr
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	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 that is similar to an occupational scenario within the scope of the risk evaluation but not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally 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	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 additive types.

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:	Industrial/Commercial Use: Paints and Coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	”Auto OEM: robotics operations, paint mixing, paint booth cleaning, inspection, and manual ””touch-up”” paintingAuto refinish: wat sanding, car washing, stripping (paint removal), machine sanding, blowing, buffing, polishing, paint spraying, paint and primer mixing, and inspection”
Exposure route:	dermal and inhalation
Personal sampling data:	Inhalation: Provides methods for modeling exposures to mists”inhalation: Surrogate monitoring data
Dermal exposure data:	”dermal: Provides methods for modeling exposures to non-volatile liquids
Exposure frequency:	”Auto OEM: 250 days/yrAuto refinish: 170 days/yr”
Number of workers:	”Auto OEM: 17 workers/siteAuto refinish: 2-10 workers/site”
Personal protective equipment:	Respirator
Engineering control:	Spray booths, 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 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	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 OEM and refinish applications.

Overall Quality Determination — Medium

Study Citation: U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.
HERO ID: 10293388
Conditions of Use: Ink, toner, and colorant products

EXTRACTION

Parameter	**Data**
Worker activity description:	Prior to a production run, the potential for exposure exists for workers transferring andmixing inks in the ink preparation room. During the production run, inhalation and dermal exposures can occur when workers handle ink cans and operate the press. (149/392)
Exposure route:	inhalation, dermal (122/392)
Exposure duration:	Report assumed that workers work 7.5 hours/day. (38/392)
Exposure frequency:	Report assumed that workers work 250 days/yr. (38/392)
Number of workers:	The flexographic inc sector employs about 30,000 people. (33/392) Over 60% of flexography companies have less than 20 employees (61/392).
Personal protective equipment:	The use of eye protection, head protection, foot protection, and hand protection is required by OSHA. (105/392)
Engineering control:	Employeesat flexography sites must have adequate hazard training. There must be a contingency plan for chemical spills and emergencies. Electrical grounding is recommended when using machinery. Chemicals that are flammable should be labeled and stored in appropriate spaces. Rags and towels used to wip up chemicals should be considered hazardous waste. Workers should be discouraged from eating near presses. Loose clothing and jewelry should be avoided. MSDS should be placed in an easily accessible location. Equipment guards should be installed on process machinery. (104/392)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.(EPA)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are not chemical-specific, but are for ink products, 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 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 is addressed by comparing different ink types and their effects on exposure/release information. Uncertainty is not addressed.

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**
Worker activity description:	Container unloading (liquids and solids), container cleaning, equipment cleaning, laboratory analyses, disposal of laboratory chemicals
Exposure route:	Dermal, Inhalation; dermal: Provides methods for modeling exposures to non-volatile and volatile liquids and solidsInhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids
Physical form:	Liquid or solid
Exposure duration:	8-12 hr/day
Exposure frequency:	250 days/yr
Number of workers:	3 workers/facility and 3 ONUs/facility
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.
Engineering control:	Fume hood

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:	Liquid or solid
Area sampling data:	Inhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids.
Dermal exposure data:	Dermal: Provides methods for modeling exposures to non-volatile and volatile liquids and solids.
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.

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	High	The completed exposure or risk assessment is generally no more than 10 years old.
	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: Provides methods for modeling exposures to volatile and non-volatile liquids.
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.

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.

Overall Quality Determination — High

Study Citation:	U.S. EPA, (2014). Generic scenario draft on the use of additives in plastic compounding.
HERO ID:	3827195
Conditions of Use:	Plastics Compounding

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading and charging additives to process, container cleaning, equipment cleaning, and compounding processes
Exposure route:	dermal and inhalation
Personal sampling data:	Provides methods for modeling exposures to both solids and volatile liquids
Dermal exposure data:	dermal: Provides methods for modeling exposures to both solids and non-volatile liquids
Exposure frequency:	148-264 days/yr
Number of workers:	24 workers/site
Engineering control:	Forced ventilation

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	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 plastic and additive types.

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:	Unloading, container cleaning, sampling, equipment cleaning, filter media changeout, packaging
Exposure route:	dermal and inhalation
Personal sampling data:	Inhalation: Provides methods for modeling exposures to volatile liquids and solids”
Dermal exposure data:	”dermal: Provides methods for modeling exposures to non-volatile liquids and solids
Exposure frequency:	235-350 days/yr
Number of workers:	25-40 workers/site
Personal protective equipment:	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

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 multiple coating applications, and multiple chemical functions

Overall Quality Determination High

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (compounding) – generic scenario for estimating occupational exposures and environmental release – Draft.
HERO ID:	6311218
Conditions of Use:	Processing as a intermediate for Plastic material and resin manufacturing; Processing as a reactant as a plastic in Plastic material and resin manufacturing; incorporation into formulation, mixture, or reaction product as a plasticizer for Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Unloading and charging additives to process, container cleaning, equipment cleaning, and compounding processes
Exposure route:	dermal and inhalation
Personal sampling data:	Provides methods for modeling exposures to both solids and volatile liquids
Dermal exposure data:	Provides methods for modeling exposures to both solids and non-volatile liquids
Exposure duration:	8 hr/day
Exposure frequency:	250 days/yr
Number of workers:	24 workers/site
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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	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 plastic types, additive types, and worker activities.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID:	6311220
Conditions of Use:	Industrial/Commercial Use: Textiles, apparel, and leather manufacturing

EXTRACTION

Parameter	**Data**
Worker activity description:	Worker activities include weighing, mixing, dyeing, drying, and buffing.
Exposure route:	Dermal, Inhalation
Physical form:	Liquid or solid
Personal sampling data:	”Inhalation: Exposures estimated in weighing, mixing, and buffing; exposure during dyeing and drying considered negligible. Inhalation exposures based on dye concentration in mixture and concentration of mixture in air.
Dermal exposure data:	Dermal: If a solid, estimated dermal exposure in mg/day from weighing the dye is 3,100*concentration of chemical. If a liquid, estimated dermal exposure in mg/day from mixing and filling operations is 1,800*concentration of chemical.”
Exposure duration:	Exposure duration ranges between 1.5-8 hrs/day based on worker activity.
Exposure frequency:	Calculation for days of operation
Number of workers:	<7 workers exposed per site

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state 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	Medium	Uncertainty not addressed. Variability addressed by considering both liquid and solid physical forms and different leather types.

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	6311221
Conditions of Use:	Formulation and Use of Printing Inks

EXTRACTION

Parameter	**Data**
Worker activity description:	PROC: unloading, cleaning, packagingUSE: Printing operations, unloading
Exposure route:	dermal and inhalation
Personal sampling data:	PROC: Inhalation: Provides methods for modeling exposures to volatile liquids and solidsUSE: Inhalation: Provides methods for modeling exposures to volatile liquids and solids
Dermal exposure data:	PROC: dermal: Provides methods for modeling exposures to non-volatile liquidsUSE: dermal: Provides methods for modeling exposures to non-volatile liquids
Exposure frequency:	PROC: 250 days/yrUSE: 250 days/yr
Number of workers:	PROC: 13-22 workers/siteUSE: 16-43 workers/site
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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	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 printing applications, and multiple chemical functions

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385709
Conditions of Use:	Flexographic Printing

EXTRACTION

Parameter	**Data**
Worker activity description:	Transferring and mixing inks, adjusting ink cans at the press, operating the press.
Exposure route:	dermal and inhalation.
Area sampling data:	Inhalation: Provides methods for modeling exposures to volatile liquids.
Dermal exposure data:	Dermal: Provides methods for modeling exposures to non-volatile liquids.
Exposure duration:	4-7.5 hrs/shift.
Exposure frequency:	300 days/yr.
Number of workers:	27 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 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	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 multiple worker activities.

Overall Quality Determination **Medium**

Study Citation: U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID: 6385710
Conditions of Use: Formulation and Use of Printing Inks

EXTRACTION

Parameter	Data
Worker activity description:	PROC: Unloading, formulation (dispersion and milling), equipment cleaning, packaging. Workers are likely to encounter both inhalation and dermal exposure during handling of raw materials and ink products as well as equipment cleaning.USE: Unloading, printing operations and ink drying, equipment cleaning. Inhalation exposure among production workers is likely to occur as a result of potential emissions with major contributions coming from ink handling and ink mist generation from printing equipment. Dermal exposure to inks and cleaning solvents are expected during material unloading and cleaning of the printing equipment.
Exposure route:	Inhalation and dermal
Physical form:	PROC: Liquid, solid particulateUSE: Liquid, mist
Number of workers:	See Table 2-2: Total number of workers is 64,973, with the number of workers for each printing type varying from ~13,000 to ~225,000

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	The GS is more than 10 years 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	Low	Uncertainty not addressed. Variability not addressed.

Overall Quality Determination — Medium

Study Citation: U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID: 6385717
Conditions of Use: Industrial/Commercial Use: Tanning and curing

EXTRACTION

Parameter	Data
Worker activity description:	Production workers
Exposure route:	Dermal, Inhalation
Personal sampling data:	Inhalation: negligible vapor inhalation; provides equations and methods for determining inhalation exposure from particulates for chemicals in solid form"
Dermal exposure data:	"Dermal: 900 mg/day * concentration of chemical in original formulation
Exposure frequency:	up to 350 operating days/year
Number of workers:	"Total of approximately 13,400, with 80% of the tanneries employing less than 50 employees. Average of 42 employees per site, and assumed that 75% of tannery employees are production workers."

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality information/data/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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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	Medium	Variability addressed by considering different types of tanning (chromium and tannins), but uncertainty is not addressed.

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:	Commercial Use: Furniture Coating Application

EXTRACTION

Parameter	**Data**
Worker activity description:	unloading, spray application, equipment cleaning
Exposure route:	dermal and inhalation
Physical form:	liquid
Personal sampling data:	Inhalation: Provides methods for modeling exposures to mists.
Dermal exposure data:	dermal: Provides methods for modeling exposures to non-volatile liquids.
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	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	Low	Assessment is based on data 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	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 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:	Processing: Manufacture of Textiles, Apparel, and Leather

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: 1,300-3,900 mg/day"
Number of workers:	3-6 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 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	Low	Assessment is based on data 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	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 finishing agent types

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385753
Conditions of Use:	Industrial/Commercial Use: Paints and coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	Dermal exposures during measuring and pouring operations
Exposure route:	Dermal, Inhalation
Physical form:	Solid and liquid components in electrodeposition formulation
Personal sampling data:	”Inhalation: references ””CEB models”” for volatile chemicals
Dermal exposure data:	Dermal: exposure based on model for two-hand contact, with surface area and quantity remaining on skin multiplied by bath concentration of chemical”
Exposure frequency:	Assume 250 days/yr
Number of workers:	Assume 10 workers/site

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	Low	Assessment is based on data 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	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 is addressed by discussing different types of exposure but uncertainty is not addressed.

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:	Exposure from Unloading and Charging Compounded Resin:Plastics are transported as pellets, sheets, films or pipes (Kirk-Othmer), which consist of large particles sizes (although some dust may be generated during transportation). Additives are incorporated into the plastic material. Some surface contact may occur; however, dermal exposure is non-quantifiable.Exposure from Converting Processes: Not expected, converting processes typically take place at high temperatures.Exposure from Converting Equipment Cleaning: Dermal Exposure = liquid amount on skin x area of skin x # of incidents x fraction of chemical in additive x fraction of additive in resin x fraction of resin in waterExposure from Trimming Processes: Additives are incorporated into the plastic material. Some surface contact may occur; however, dermal exposure is non-quantifiable.
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.

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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 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.
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, (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
Personal sampling data:	inhalation exposure negligible due to low vapor pressure
Dermal exposure data:	Pure lube: dermal exposure to both hands from routine emersion at 1% concentration: 91 mg/dayGeneral Automotive: dermal exposure to both hands from routine emersion at 1% concentration: 65 mg/day
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/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	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 multiple additive types and worker activities.

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 to both hands from transfer of additive at 10% concentration: 390 mg/day
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/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	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 multiple additive types and worker activities.

Overall Quality Determination **Medium**

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

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 to both hands from transfer of additive at 100% concentration: 3900 mg/day
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/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	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 multiple additive types and worker activities.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (1994). Generic scenario: Melt-blend processing of powder coatings.
HERO ID:	8726955
Conditions of Use:	Powder coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	powder transfers from one vessel or process stage to the next
Exposure route:	Dermal, Inhalation
Physical form:	Solid components in formulation
Exposure frequency:	Assume 250 days/yr
Number of workers:	25 to 30 workers/shift/site

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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:	U.S. EPA, (1994). Generic scenario: Formulation of latex/emulsion coatings.
HERO ID:	8726956
Conditions of Use:	Processing Latex/Emulsion Coatings

EXTRACTION

Parameter	**Data**
Worker activity description:	component loading and trransfer operations, addition of mix tanks, final transfer of the latex formulation into cans or other containers, and disposal and handling of the solid and liquid wastes
Exposure route:	Dermal, Inhalation
Physical form:	Liquid or solid
Personal sampling data:	Inhalation: Provides methods for modeling exposures to volatile liquids and solids"
Dermal exposure data:	dermal: Provides methods for modeling exposures to non-volatile liquids and solids
Number of workers:	1 worker/site

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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	Medium	Uncertainty not addressed. Variability addressed by considering different chemical physical forms.

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

EXTRACTION

Parameter	**Data**
Worker activity description:	Workers can be exposed to airborne dust when bags of phthalic anhydride are loaded into reaction kettles.
Exposure route:	Inhalation and Dermal
Physical form:	Dust
Personal protective equipment:	Workers using a raw material with phthalic anhydride manage exposure risk through procedures and appropriate PPE. Typical PPE for handling raw materials with the chemical include safety glasses, chemical resistant gloves and long sleeve clothing. Workers may also use full-face respirators, Tyvek body suits and chemical resistant gloves.
Engineering control:	Typical engineering controls include air handling equipment to pull any airborne particulates into a dust collector.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Data sources are not provided.
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 is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	No sample data presented for PPE or engineering control use in the workplace.
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:	Anonymous, (1990). Phthalic anhydride. Dangerous Properties of Industrial Materials Report 10:84-96.
HERO ID:	5177378
Conditions of Use:	Manufacturing or processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation, ingestion
Physical form:	solid flakes or liquid
Personal protective equipment:	Coveralls or rubber apron; rubber shoes or boots; chemical goggles or face shield; Bureau of Mines organic vapor respirator (Type AB); gauntlet-type leather or rubber gloves.
Engineering control:	Can be stored in bags or have molten anhydride in tank cars and tank trucks. Store in ventilated area away from sources of flame. Use gasproof light sockets for incandescent bulbs only. Use spark resistant tools and avoid contact with moisture. Where possible, automatically transfer PA from drums or other storage containers to process containers. Workers should change clothing after contact with PA. Eye wash fountains should be located in close proximity to handling of PA as well as shower facilities. Use vacuum or wet methods to reduce dust during clean up.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is not peer reviewed however nearly all referenced information comes from EPA or OSHA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from US.
	Metric 3:	Applicability	High	Data is applicable to PPE and engineering controls needed when handling PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample size is qualitative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides PPE, engineering control, exposure route and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	Carbide and Carbon Chemicals Corporation, (1992). Initial submission: letters regarding adverse health effects suffered by employees exposed to phthalic anhydride with cover letter dated 092992.
HERO ID:	5160453
Conditions of Use:	Processing - produces di-octyl phthalate

EXTRACTION

Parameter	**Data**
Worker activity description:	General plant laborers act as a crew of about 12 men for several months at a time. They unload sacks of PA from the box cars and transport them by truck to a warehouse. Deliveries to the unit are made almost daily so an adequate supply for production is maintained in the unit. Periodically at the unit the still is charged. ”To charge” the still, two men break about 250 of these sacks into a hopper. This is usually done on every shift. Exposures at these times are considerable, for when the bags are knifed open and dumped on the grating there is a cloud of dust which rises in spite of the suction hood.
Exposure route:	inhalation. ingestion
Physical form:	vapor, dust
Number of workers:	12 men
Personal protective equipment:	Protective coveralls, vapor proof goggles, dust respirators and full face masks are used at various times as conditions require them. Men shower after shifts.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report is a TSCA submission, study not conducted by government agency but likely to not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Report is directly applicable to condition of use
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	Samples are qualitative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Documents results, but underlying methods, sources and assumptions are not transparent
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Graham, J. J. (1970). Fluidized bed phthalic anhydride process. Chemical Engineering Progress 66(9):54-58.
HERO ID:	5178930
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Engineering control:	Engineering controls are implemented within the process to keep the concentrations of naphthalene and phthalic acid are not within the flammability limits, they reduce ignition sources and keep the reactor temp away from the auto-ignition temperature of the components. Flammable gases are inerted.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data and sound methods but is not from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from US.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by any statistics, just a process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Report documents results, and assumptions. Sources are provided and likely come directly from manufacturer. Provides process description, unit operations, process diagram.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Hines, C. J., Hopf, Nilsen, N. B., Deddens, J. A., Calafat, A. M., Silva, M. J., Grote, A. A., Sammons, D. L. (2009). Urinary phthalate metabolite concentrations among workers in selected industries: A pilot biomonitoring study. Annals of Occupational Hygiene 53(1):1-17.
HERO ID:	1005742
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Worker activity description:	Worker activity specifically mentioned for PA exposure is while taking or analyzing in-process samples or while performing maintenance.
Comments:	Source contains information primarily for other phthalates and briefly mentions PA when mentioning work processes at participating companies. Source is also a urinary metabolite source.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely does not contain errors in analytical techniques.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	Low	Data in source is directly applicable to conditions of use, however sampling data is urinary metabolite data.
	Metric 4:	Temporal Representativeness	Medium	Data is greater than 10 years old.
	Metric 5:	Sample Size	Low	Data for other phthalate chemicals is represented by a range with uncertain statistics. For PA, no sampling data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Monitoring data includes sample type, exposure type but no sampling completed for PA.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Address variability by testing across different industries. Does not address uncertainty.

Overall Quality Determination — Medium

Study Citation: Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID: 5353592
Conditions of Use: Manufacturing, processing - any type of handling of PA.

EXTRACTION

Parameter	Data
Worker activity description:	PA handling - putting into bags, moving to storage, loading and unloading of tank cars
Exposure route:	inhalation, dermal
Physical form:	solid, liquid, dust, vapor
Personal protective equipment:	Workers should be supplied with proper PPE, be familiar with location of safety showers, fire extinguishers and hose lines. Be trained in rescue work and in an approved method for applying artificial respiration. Eye protection (chemical safety goggles): Cup type or rubber framed goggles equipped with approved impact resistant glass lenses should be worn whenever there is danger of phthalic anhydride coming in contact with the eyes. Goggles should be carefully fitted by adjl.Jsting the nose piece and head band to ensure maximum protection and comfort. Spectacle type safety goggles can be used as well: Metal or plastic rim safety spectacles with un- 7 perforated side shields which can be obtained with prescription safety lenses may be used where continuous eye protection is desirable. These types, however, should not be used where complete eye protection against chemicals is needed. Respiratory protection: self contained breathing apparatus which permits the wearer to carry a supply of oxygen or air compressed in the cylinder, and the self-generating type which produces oxygen chemically, allow for greater mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air or oxygen supply carried. No cylinder (or compressed) oxygen should be used in tanks or other confined spaces. Positive Presmre Ho&e Mask& supplied by externally lubricated blowers. Since these masks depend on a remote air supply, they should be used only where conditions will permit safe escape in the event of air supply failure. Care must be taken to locate the blower air source in an area which is free of air contaminants. Air-line Mask& supplied by plant compressed air are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. Such masks should be used only in conjunction with a suitable reducing or demand-type valve, excess pressure relief valve, and filter. The compressed air should be checked frequently to make certain that harmful gases from the decomposition of the lubricating oil used in the compressor, or impure air supply, are not present. Industrial Canister Type Gas Masks, equipped with full face pieces and approved by the U.S. Bureau of Mines, fitted with the proper canister for absorbing phthalic anhydride vapor, will afford protection against concentrations not exceeding 2 per cent by volume when used in accordance with the manufacturer's instructions. The oxygen content of the air must not be less than 16 per cent by volume. The masks should be used for relatively short exposure periods only. They may not be suitable for use in an emergency since, at that time, the actual vapor concentration is unknown and it may be very high. The wearer must be warned to leave the contaminated area immediately on detecting the odor of a harmful vapor; this is an indication that the mask is not functioning properly or that the vapor concentration is too high. Head protection: Safety or "hard" hats should be used for protection against accidental liquid leaks, falling tools, or other objects. Brimmed felt hats may be substitued for safety hats where the danger of falling objects is remote. Foot protection: Leather or rubber safety shoes with builtin steel toe caps are recommended. Rubbers may be worn over leather safety shoes. If leather shoes become wet with phthalic acid they should be removed immediately to avoid burns of the feel Such shoes must not be worn again until they have been washed thoroughly and dried. Body, skin and hand protection: Rubber or leather gloves and rubber aprons should be available to, and be worn by, workers handling phthalic anhydride. The gloves and aprons should be washed frequently.

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Study Citation:	Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID:	5353592
Conditions of Use:	Manufacturing, processing - any type of handling of PA.

EVALUATION

Domain	Metric	Rating	Comments
Engineering control:			Building design: The building and partitions should be of fire resistant construction. Ample emergency exits from buildings should be provided. Fire doors should open outward and be of the approved type with heavy hinges so that the doors will not be blown off in the event of an explosion. All rooms in which phthalic anhydride is stored should be fire resistant and be provided with adequate ventilation. Explosion venting should be provided in the general construction of buildings in which the material is handled or stored. The ratio of venting to building volume should be checked by a competent engineer to determine the required venting area. Equipment design: The design of phthalic anhydride installations is specialized. The technical problems of designing such equipment, devising standard operating procedures, and providing such features as are necessary for safe and economical operation should be handled by qualified engineering, technical and safety personnel. Subsequent maintenance work and changes in equipment or procedures should conform with the r equirements of the process as regards safe and economical operation. System types: Because of the fume, fire and explosion hazards of phthalic anhydride all operations should be handled in closed systems where possible. Ventilation: For indoor operations, special equipment ventilation and general building or area ventilation should be provided as necessary to remove any and all escaping vapor. Local ordinances must be consulted as well as other authoritative guides which are designed to eliminate fire and explosion hazards and to afford maximum protection to both workers and property. Air Analysis: Oxygen Content of Tanks and Other Equipment. The vapor spaces of subject vessel should be sampled regularly and analyzed for the oxygen content. A choice of analytical equiPment is available. The oxygen content should not exceed 10% by volume to prevent burning of the phthalic anhydride vapors. Electrical Equipment: Vaporproof or explosionproof equipment: All electrical wiring, motors and other equipment installed or used where phthalic anhydride is stored should be as prescribed by the National Electrical Code. Grounding: Phthalic anhydride flakes can develop static charges during passage through conveyors, elevators, etc. Such materials handling equipment should be electrically grounded (See National Fire Codes ”Combustible Solids, Dusts, Chemicals and Explosives”). All tanks intended for the storage of phthalic anhydride should be electrically grounded to safely dissipate electrical charges due to lightning or ’static. Fires involving molten or solid phthalic anhydride can be fought with carbon dioxide or dry chemical. Water is also very effective on flake or phthalic anhydride dust (suplimate), and is the most practical extinguishing agent on large fires of this type. It should be borne in mind that the wetting of solid phthalic anhydride forms phthalic acid. Steam is also an effective extinguishing agent for fighting molten phthalic anhydride fires in tanks. Handling-general: Phthalic anhydride should be discharged from tank cars and trucks only when adequate lighting is provided. A check should be made to ensure the tank storage will hold contents of the tank car or tank truck. The storage should be vented before connecting the unloading line. No naked flame of any kind should be permitted near the tank car or truck unloading area for any purpose whatsoever. An incandescent electric light with gasproof socket and connections, or a portable approved flashlight, may be used with safety. Both should bear the approved label of Underwriters Laboratories for use in Class 1 Group D atmosphere, as should any electric motors. Smoking should be strictly forbidden in the unloading area. All tools used in the unloading operation should preferably be of the spark resistant type, and they should be kept free of oil, grit, and dirt. Tank car or truck fittings should never be struck with tools or other hard objects. A hammer and chisel should never be used (a) in loosening dome fittings, (b) in connecting or disconnecting the tank car or truck to or from lines of any kind, and (c) at any time or place where the tank car or truck is filled or under discharge pressure. Tank cars: Unloading operations should be conducted by carefully ’ instructed, reliable employees under adequate supervision. The tank car should be attended by the unloader throughout the entire period of unloading or while it is connected. It should not be allowed to stand with unloading connections attached after the unloading is completed. The train or engine crew should accurately spot the car at the unloading line. The unloading track should be level. It is considered good practice that derails be placed at one or both ends of the unloading track approximately one car-length from the car being unloaded, unless the· car is protected by a closed and locked switch or gate. The hand-brake should be set and the wheels blocked at the time the car is placed for 9 unloading. Metal ”CAUTION” signs should be placed fore and aft of the car. These should be fastened to · the track, preferably near the entering switch, as a warning to persons and switching crews approaching the car. These signs must not be removed until the car has been unloaded and all fittings disconnected. Signs should be of size not less than 12” by 15” painted blue and bearing the legend in white: ”STOP-TANK CAR CONNECTED”; the Gothic letters in the word ”STOP” being 4” high, and the others, 2” high. Enameled signs with stands are standard equipment available from safety equipment dealers. If a blue light is used with a stop sign at night, it should meet the requirements of the National Electrical Code for hazardous locations. Under no circumstances should kerosene or other type lanterns with open flames be permitted within the vapor area. When preparing to unload a tank car it is advisable to have a .standard procedure established in writing. The shipper’s instructions for unloading should always be followed, and all caution markings on both sides of tank or dome should be observed. The MCA Manual Sheet TC-4 ”Recommended Practice for Unloading Flammable Liquids from Tank Cars” may also be used as a guide to assist unloaders in performing this operation safely. Before any connection or contact is made between a car and the unloading line or any other unloading equipment, the tank car should be grounded and bonded (electrically interconnected), as described in the MCA Manual Sheet TC-4. It is recommended that, tank cars be unloaded through dome connections rather than through bottom outlets. Tank cars in phthalic anhydride service are insulated and equipped with heating coils or steam jackets. Because a tank car is usually several days in transit the contents may be partially or completely solidified on arrival. It is necessary, therefore, to thaw the car by use of the steam heating coils. To prevent rupture of the car when heat is applied to these main coils a means is provided for melting a vent through the car’s entire depth. These devices for melting a vent consist either of a lance installed through the dome and extending to the bottom of the car, or a lance installed in th~ bottom of the car and extending to the dome, or of external coils welded to the car and extending the entire distance around the sides. Some of these lance or vent coils have independent steam connections. If this is the case, steam must be applied to these for a short period before being turned into the main coils or jacket. When the lance coils are interconnected with the main coils, the piping is so arranged as to apply heat first to the lance coils. Coil caps should be removed cautiously when preparing to make the steam hookup because it is possible for coils to break

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Study Citation: Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID: 5353592
Conditions of Use: Manufacturing, processing - any type of handling of PA.

Domain		Metric	EVALUATION Rating	Comments

Domain		Metric	EVALUATION Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data from not frequently used sources but is an industry trade group for the Manufacturing Chemists Association.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing, processing, storage, or just generic handling of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1956)
	Metric 5:	Sample Size	Low	Characterized by qualitative data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains information regarding engineering controls for multiple steps through PA handling from manufacturing, to transportation to storage. Includes PPE, waste treatment, exposure route.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Addresses variability by providing handling methods for multiple stages of use for PA. Addresses uncertainty through multiple different uses of different PPE and engineering controls effectiveness.

Overall Quality Determination — Medium

Study Citation:	NCBI, (2020). PubChem Database: Compound Summary: Phthalic acid.
HERO ID:	7274473
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Exposure route:	Occupational exposure to phthalic acid may occur through dermal contact with this compound at workplaces where phthalic acid is produced as a by product through hydrolysis of phthalic anhydride and phthalic acid esters.
Number of workers:	NIOSH (NOES Survey 1981-1983) has statistically estimated that 19,695 workers (2862 of these are female) are potentially exposed to phthalic acid in the US(1).
Personal protective equipment:	Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO2) with a dust/mist filter. (NTP, 1992). Protective gloves. Safety spectacles. Suitable clothing such as rubber hand protection is recommended.

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 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 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	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	Low	The report does not address variability or uncertainty.

Overall Quality Determination — Medium

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:	Commercial application

EXTRACTION

Parameter	**Data**
Exposure route:	Dermal
Physical form:	Liquid, Solid
Dermal exposure data:	Overall, direct transfer from the hands to the oral cavity was significantly higher (mean TE = 51.6) than indirect transfer from the hands to the oral cavity via the perioral area by licking the lips (mean TE = 11.5). The results suggested higher TEs for liquids than for solids and that hand to-mouth TEs may increase with water solubility. Transfer from bare arms to the perioral area was higher than from arms covered by cotton sleeves for both liquids and powders. Specific details are provided in various tables in the paper.
Comments:	TABLE III. Estimated Olive Oil Transfer Efficiencies (TE)TABLE IV. Data Summary from Task 1: Experiments of Direct and Indirect Hand-To-Mouth TransferTABLE V. Data Summary from Task 2: Experiments of Direct and Indirect Glove and Hand-To-Mouth TransferTABLE VI. Data Summary from Task 4: Experiments Involving Wiping the Perioral Area with the Arm or a Cotton Sleeve

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and techniques 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 that is similar to an occupational scenario within the scope of the risk evaluation. Not specific to PAD/PA.
	Metric 4:	Temporal Representativeness	High	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	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination **High**

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

EXTRACTION

Parameter	**Data**
Exposure route:	Inhalation, Ingestion
Physical form:	White solid (flake) or clear colorless liquid (molten)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	NIOSH POCKET GUIDE
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 that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4:	Temporal Representativeness	Medium	Report more than 10 years old, but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size is not applicable to data evaluated.
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	N/A	Variability and uncertainty are not applicable to data evaluated.

Overall Quality Determination — Medium

Study Citation:	NIOSH, (2019). NIOSH pocket guide to chemical hazards: Phthalic anhydride.
HERO ID:	8407241
Conditions of Use:	General Use (can apply to more than 1 COU)

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation, ingestion, and dermal
Physical form:	White solid (flake) or a clear, colorless, mobile liquid (molten) with a characteristic, acrid odor.
Personal protective equipment:	Air-purifying respirator with a high-efficiency particulate filter, self-contained breathing apparatus with a full facepiece

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	U.S. NIOSH publication
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 addresses general safety for any occupational scenario involving exposure.
	Metric 4:	Temporal Representativeness	High	Dated less than 10 years ago.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Document does not include sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination — High

Study Citation:	NIOSH, (1978). Occupational health guideline for phthalic anhydride.
HERO ID:	8408508
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation, dermal, ingestion
Physical form:	White solid with a characteristic choking odor.
Personal protective equipment:	impervious clothing, gloves, face shields (8 inch Minimum) and other appropriate protective clothing
Engineering control:	process enclosure, general dilution ventilation, LEV

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	The report is over 40 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:	NIOSH, (1994). Table of Immediately Dangerous to Life or Health Concentrations (IDLH): Phthalic anhydride.
HERO ID:	8673772
Conditions of Use:	General Information (applies to more than 1 COU)

EXTRACTION

Parameter	**Data**
Exposure route:	inhalation
Physical form:	White solid (flake) or a clear, colorless, mobile liquid (molten) with a characteristic, acrid odor

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Information originates from NIOSH.
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	Source discusses general information which applies to more than 1 condition of use.
	Metric 4:	Temporal Representativeness	Low	Report is over 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Report includes clear documentation of sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination **High**

Study Citation:	OECD, (2024). Emission Scenario Document on chemicals used in hydraulic fracturing.
HERO ID:	12974717
Conditions of Use:	Lubricants and functional fluids

EXTRACTION

Parameter	**Data**
Number of workers:	9 workers and 2 ONUs per well based on NAICS code213112 (Support Activities for Oil and Gas Operations) - reported in Table 5.3

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The emission scenario document uses high quality data 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	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	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	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation: Park, C., Sheehan, R. J. (2000). Phthalic acids and other benzenepolycarboxylic acids. :1-45.
HERO ID: 679796
Conditions of Use: Manufacture

EXTRACTION

Parameter	**Data**
Personal protective equipment:	Goggles, a face shield, and heavy leather gauntlets should be worn by workers handling phthalic anhydride.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is high-quality document. Data are well-sourced.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	U.S. Source
	Metric 3:	Applicability	High	Source discusses manufacturing, which is in scope.
	Metric 4:	Temporal Representativeness	Low	Source appears to be from 2000.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source clearly documents the source of the data contained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination — High

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:	Formulation of paint and varnish

EXTRACTION

Parameter	**Data**
Number of workers:	This Bureau of Census publication lists the number of plants in various size ranges such as 1 to 3 employees, 4 to 7 employees, etc. The total number of employees in any plant size can also be computed and expressed as a percentage of total employment in the Paint and Varnish Industry. For example, as shown by arrows on Figure 31, 30% of the plants in the industry employ less than 8 people, 30% of the industry employees work in plants that have a plant employee size of less than 50, and this plant size accounts for 78% of the industry plants. // Page 196: 66,100 total employees.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The data methodology is known or expected to be accurate and is known to cover all 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 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	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	The report addresses variability and uncertainty in the results. Uncertainty is well characterized

Overall Quality Determination **High**

Study Citation:	Schwab, R. F., Doyle, W. H. (1970). Hazards in phthalic anhydride plants. Chemical Engineering Progress 66(9):49.
HERO ID:	5180284
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Engineering control:	Temperature controls are used in the process to prevent overheating of reactor. Accomplished by immersing the catalyst packed tubes in a molten salt bath. Composition of the contents in the process are to prevent a combustible mixture from the LFL and UFL. Dust collectors and large bins should be outdoors and provide for explosion relief using a vent ratio of 3-4 sq ft/100 cu ft of volume protected. Group G electrical equipment is necessary in areas where dust does or may exist.
Comments:	Source is essentially one giant process description for preventions against explosions in the production of PA.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report is peer reviewed so likely contains data up to standards.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Study conducted by US.
	Metric 3:	Applicability	High	Directly applicable to condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1960s and 1970s)
	Metric 5:	Sample Size	Low	Characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Provides sources, results, and assumptions as well as very detailed descriptions of the process and many of the unit operations associated with it.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at differences between different processes of making PA. Does not address uncertainty.

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 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, (2020). 2020 CDR: Commercial and consumer use.
HERO ID: 10366189
Conditions of Use: Manufacture and Import

EXTRACTION

Parameter	**Data**
Physical form:	Provides physical form.
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:	This document provides updates to the parameters used for dermal exposure estimates. Updated parameters are listed below:Routine, direct handling of solids with 2 handsResulting dermal contact: up to 3,100 mgRoutine contact with surfaces, 2 hands, solidsResulting dermal contact: up to 1,100 mgRoutine immersion, 2 hands, liquidsSurface area: 1,070 cm^2Amount retained on skin: 1.3-10.3 mg/cm^2Resulting dermal contact: up to 11,000 mgRoutine contact, 2 hands, liquidsSurface area: 1,070 cm^2Amount retained on skin: 0.7-2.1 mg/cm^2Resulting dermal contact: up to 2,200 mgIncidental contact, 2 hands, liquidsSurface area: 1,070 cm^2Amount retained on skin: 0.7-2.1 mg/cm^2Resulting dermal contact: up to 2,200 mgIncidental contact, 1 hand, liquidsSurface area: 535 cm^2Amount retained on skin: 0.7-2.1 mg/cm^2Resulting dermal contact: up to 1,100 mg

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	High	Data are applicable to all COUs involving dermal contact.
	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, (2004). Use of additives in foamed plastics – generic scenario for estimating occupational exposures and environmental releases – Draft.
HERO ID:	6304171
Conditions of Use:	Flexible and Rigid Polyurethane Foam Manufacture

EXTRACTION

Parameter	**Data**
Worker activity description:	transfer from shipping containers, operation/supervision of the foam mix head/dispenser, foam production, transfer/handling of foamed articles
Exposure route:	dermal and inhalation
Physical form:	no information available
Particle size characterization:	no information available
Exposure duration:	8 hr/day
Exposure frequency:	250 days/yr
Number of workers:	<50 workers/site
Personal protective equipment:	no information available

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	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	Medium	Uncertainty not addressed. Variability addressed by considering multiple foam types.

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (2011). Exposure factors handbook: 2011 edition.
HERO ID:	786546
Conditions of Use:	Dermal exposure scenarios (Applies to most COUs)

EXTRACTION

Parameter	**Data**
Dermal exposure data:	Surface area of two adult male hands: 1070 cm2 (mean)Surface area of two adult female hands: 890 cm2 (mean)Surface area of two adult male arms: 3140 cm2 (mean)Surface area of two adult female arms: 2370 cm2 (mean)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The handbook uses high quality data 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 applicable to occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The handbook 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	High	Handbook clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	The handbook addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	Agaev, A. S., Nadzhafov, Y. B., Kobylkina, T. N. (1976). Cleanup of emissions from phthalic anhydride production. Chemistry and Technology of Fuels and Oils 12(11-1):873-875.
HERO ID:	5179383
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Contact section (decontamination unit), Distillation section crystallizers; Stripping stills during cleaning
Release quantity:	Quantity discharged for contact section is 50,400 kg/hr, with 49 mg/m^3 being PA. For crystallizers it is 1500 kg/hr with 1100 mg/m^3 being PA. And for stripping stills it says 300 mg/m^3 are PA.
Waste treatment methods and pollution control:	From the results of these experiments, it was established that an aluminum/copper/chromium oxide catalyst of the K-670 type could be used at temperatures of 500-550 C and a space velocity of 15,000 h -1 to remove 97-98% of the phthalic and maleic anhydrides from the gas/air discharges. A full-scale commercial test of this method indicated that, with phthalic anhydride, maleic anhydride, and naphthoquinones in the off gas in amounts totaling as much as 5 g/m 3, treatment at a temperature of 400~ with a space velocity of 10,000-15,000 h -I gave an 85%cleanup of the off gas, and treatment at 500-550 C brought the cleanup to 98%.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data referenced is from Russia, a non-OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to the manufacture of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1970s)
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes description of some unit operations, release media, some waste treatment information and source of release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

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:	Processing

EXTRACTION

Parameter	**Data**
Release quantity:	The annual statewide industrial emissions from facilities reporting under the Air Toxics Hot Spots Act in California based on the most recent inventory were estimated to be 11,442 pounds of phthalic anhydride (CARB, 2000).

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed and conducted by California EPA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data from USA.
	Metric 3:	Applicability	High	Data is within 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	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 ofthe release.
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:	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:	Spraying, indoor, incineration, volatilesAir Release Factor: 20.8%Water Release Factor: 0%Soil Release Factor: 0%Waste Release Factor: 5%Spraying, indoor, volatilesAir Release Factor: 95%Water Release Factor: 0%Soil Release Factor: 0%Waste Release Factor: 5%Spraying, indoor, non-volatilesAir Release Factor: 1.5%Water Release Factor: 0%Soil Release Factor: 0%Waste Release Factor: 10-52%Spraying, indoor, powderAir Release Factor: 2%Water Release Factor: 1%Soil Release Factor: 0%Waste Release Factor: 3-30%
Release frequency:	225 days/year
Waste treatment methods and pollution control:	Incineration

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:	CEPE, (2020). SpERC fact sheet: Professional application of coatings and inks by spraying.
HERO ID:	10442902
Conditions of Use:	Paints and coatings, Ink, toner, and colorant products

EXTRACTION

Parameter	**Data**
Description of release source:	Professional application of coatings and inks by spraying
Release or emission factors:	Spraying, indoor, volatilesAir Release Factor: 97%Water Release Factor: 0%Soil Release Factor: 0%Waste Release Factor: 3%Spraying, indoor, non-volatilesAir Release Factor: 0%Water Release Factor: 0%Soil Release Factor: 0%Waste Release Factor: 10-60%Spraying, outdoor, volatilesAir Release Factor: 98%Water Release Factor: 2%Soil Release Factor: 0%Waste Release Factor: 0%Spraying, outdoor, non-volatilesAir Release Factor: 0%Water Release Factor: 2%Soil Release Factor: 2%Waste Release Factor: 9-30%
Release frequency:	Indoor: 365 days/yrOutdoor: 225 days/yr
Waste treatment methods and pollution control:	Incineration, sewage treatment plant

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 specific to the chemical.
	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:	Curran, M. A., Turner, R. J. (1988). Incineration of three RCRA wastes at the U.S. EPA's combustion research facility (CRF).
HERO ID:	5177408
Conditions of Use:	Disposal - incineration

EXTRACTION

Parameter	**Data**
Waste treatment methods and pollution control:	The gases leaving the afterburner enter a venturi scrubber, followed by a packed tower, a carbon bed, and a high-efficiency particulate air (HEPA) filter in series (Figure 1). The carbon and HEPA filter are required by Arkansas since the CRF is an experimental facility and may not always be operated at optimum conditions. Sodium hydroxide is added to the scrubbing system (venturi and packed tower) to maintain a pH greater than 7. Makeup water is added at a rate of 5 to 10 gallons per minute, and the water system is blown down continuously at a rate of 2.0 to 2.5 gallons per minute.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by EPA so likely accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Medium	Controlled study for PA release from incinerator but can likely be applied to other sites that use a similar method.
	Metric 4:	Temporal Representativeness	Low	Greater than 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics, lots of data is qualitative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides release media, waste treatment method and activity causing it.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	Dempsey, C. R., Thurnau, R. C. (1991). Pilot-scale evaluation of incinerating listed wastes from specific sources. Water Science and Technology 24(12):255-265.
HERO ID:	5177794
Conditions of Use:	PA manufacturing - disposal of waste

EXTRACTION

Parameter	**Data**
Description of release source:	Incineration of distillation bottom tars from the production of phthalic anhydride from naphthalene
Release quantity:	Particulate emissions were determined in the stack gas and averaged 371 mg/dscm which is above hazardous waste performance standard at the time of 180 mg/dscm.
Waste treatment methods and pollution control:	The primary air pollution control system consisted of a venturi-scrubber and a packed-column scrubber which is typical of what might be utilized on an actual commercial or industrial incinerator. The redundant air pollution control system consisted of a carbon-bed adsorber and a HEPA filter. This was in place to allow investigations that would test the failure limits of a conventional system without emitting unacceptable levels of organics and particulates to the atmosphere. Table 3 summarizes the design characteristics of the main system elements. Average removal efficiency exceed 99.9999%. No PA detected in either the kiln ash or scrubber blowdown.
Comments:	Phthalic anhydride assigned hazardous waste number K024. Various EPA methods are stated to be used. Semivolatiles analyzed by EPA Method 8270. Volatiles by Method 8000. Samples of packed tower scrubber exit gas volatiles collected by Method 0030 and analyzed by Method 8000. Samples for the semivolatile collected using modified Method 5, Method 0010, and analyzed Method 3540 and Method 8270. Method 5 used for particulate conc.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by EPA so methodology likely to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to disposal methods that would exist or be used for PA manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is greater 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	Provides nearly all associated metadata with releases, includes release media, process, unit operation, and activity for source of release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing multiple different flow rates under three different test run conditions. Does not address uncertainty.

Overall Quality Determination — High

Study Citation:	DOE,, WA (2020). Priority consumer products report to the Legislature: Safer products for Washington implementation phase 2.
HERO ID:	10454465
Conditions of Use:	Plastic and rubber products

EXTRACTION

Parameter	**Data**
Description of release source:	Phthalate air and dust emissions from vinyl flooring.
Release quantity:	0.17 metric tons (374 pounds) of phthalates are released to the environment from vinyl flooring. (in Washington state)

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	The data are from the United States.
	Metric 3:	Applicability	Low	The release data are for an occupational scenario within the scope of the risk evaluation but the release data is for Washington state only. Also, data is not chemical-specific.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 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	The release data study does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Dong, H., Jiang, L., Shen, J., Zhao, Z., Wang, Q., Shen, X. (2019). Identification and analysis of odor-active substances from PVC-overlaid MDF. Environmental Science and Pollution Research 26(20):20769-20779.
HERO ID:	5432879
Conditions of Use:	Lab study - can be applied to processing using PVC and adhesives.

EXTRACTION

Parameter	**Data**
Description of release source:	Release source is steady state emission of VOCs from PVC-overlaid MDF which comes primarily from adhesives.
Release or emission factors:	Release factors: VOCs released from PVC-overlaid MDF Table 4. Mass conc. 6.97 and 9.64 ug/m^3. Sampling time was 8 hours. This source is a lab study.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so sampling and analytical methodology is likely very accurate
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	Data is not for an occupation scenario but has information that can be used to determine airborne exposure data of production of PVC-overlaid MDF
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2019)
	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	Lab study provides parameters of sampling time, sampling frequency, release source and emission factors.
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: 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:	Disposal from chemical plants, refineries, paper mills, and waste treatment facilities in concentrated regions in Texas.
Release quantity:	Releases & Transfers of High Priority Chemicals (Port Arthur, TX Area) 2012-2018 (lbs): Air = 171.8; Total = 171.8; Incoming Waste Transfer = 852,904.0; % of Nationwide Total (releases) = 0.011; % Nationwide Total (Incoming Waste Transfers) = 7.871Releases & Transfers of High Priority Chemicals (Houston, TX Area) 2012-2018 (lbs): Air = 29,550.63; Underground Injection Wells = 97,426.0; Total = 126,976.63; Offsite Transfer = 1,714,083.49; Incoming Waste Transfer = 1,116,624.71; % of Nationwide Total (releases) = 7.930; % Nationwide Total (Offsite Transfers) = 15.819; % Nationwide Total (Incoming Waste Transfers) = 10.305Releases & Transfers of High Priority Chemicals (Mossville, LA Area) 2012-2018 (lbs): Incoming Waste Transfer = 3,606.27; % Nationwide Total (Incoming Waste Transfers) = 0.033Releases & Transfers of High Priority Chemicals in Cancer Alley, 2012-2018 (lbs): Air = 123,603.10; Total = 123,603.10; Offsite Transfer = 3,510,695.36; Incoming Waste Transfer = 3,320,451.40; % of Nationwide Total (releases) = 7.719; % Nationwide Total (Offsite Transfers) = 30.644; % Nationwide Total (Incoming Waste Transfers) = 32.400
Release or emission factors:	See release quantity information.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Releases are reported from Toxics Release Inventory (TRI) and expected to cover all release sources reported to TRI.
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 was collected in past 10 years.
	Metric 5:	Sample Size	High	Discrete release data provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides annual release data for various media, but additional metadata is not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability throughout various facilities and regions are considered. However, measurement uncertainty is not addressed.

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: Plastic product manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	The primary sources of emissions at plastic products manufacturing facilities are the pieces of equipment (e.g., extruder hopper, die head, sander) used to handle raw materials and produce the final product. These are typically the locations where chemical reactions occur, liquid solvents and solvent blends are exposed to the atmosphere, solid resin is heated and melted, and additives are introduced. In addition to emissions generated directly from primary production processes associated with plastic products manufacturing, there may be additional emissions produced by secondary processes at these facilities. Emission sources from these secondary processes include storage tanks, equipment leaks, wastewater treatment, combustion sources, and cleaning and surface coating operations. (17/72)
Release or emission factors:	Report provides multiple methods to estimate emissions from plastic and resin manufacturing. (Sections 4 and 5, 29/72)
Waste treatment methods and pollution control:	Emissions from plastic products manufacturing may be reduced either through process modifications or by using add-on control devices. Process modifications include the use of alternative raw materials such as alternative blowing agents for foam or switching to non-HAP containing additives. Process modifications also refer to the use of modified equipment or operating practices such as covering storage piles. In addition, keeping the die temperature close to the resin melting temperature and reducing the residence time of the heated resin in air will help reduce emissions. There are many types of add-on control devices that could potentially be employed at plastic products manufacturing facilities to control emissions of VOC, HAPs, and PM. These would typically be most appropriate for contained streams with pollutant concentrations high enough for add-on control devices to be cost effective. It is expected that VOC and organic HAP emissions could be controlled by incineration, adsorption, absorption, or condensation. Incineration and carbon adsorption have been identified as technologies currently in use at polystyrene foam manufacturing facilities. PM emissions generated from finishing operations, including cutting and grinding, are typically controlled by cyclones or fabric filters. (21/72)

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	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation, but data is general and not chemical-specific.
	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	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as 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.

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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: Plastic product manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Overall Quality Determination		**Medium**	

Study Citation:	Fawcett, R. L. (1970). Air pollution potential of phthalic anhydride manufacture. Journal of the Air Pollution Control Association 20(7):461-465.
HERO ID:	28937
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Process off-gas constitutes the greatest potential for air pollution. Consists of large volumes of air contaminated with small quantities of organic vapor and particulates and carbon monoxide. Volumes will range from less than 200 scf to over 500 scf per pound of product, with the fluid bed process having the lower rates and fixed bed processes the higher rates. Gas emission temps from dry recovery condensers will approximate 120-140 F. In the case of the wet recovery methods, the exhaust is saturated with water vapor at 150-160 F, resulting in the emission of a large white plume as the moisture condenses in the stack and ambient air. Process venting during refining may contain between 10 and 20% of the amount of total organics that are in the process off-gases on a weight per unit time bases. Jet exhaust from the vacuum refining and residue stills, and the batch dumping are significant points of emissions sources. Flaking and bagging can have releases.
Release or emission factors:	Emission concentration provided on page 2, for PA it is 40-200 ppm/hr. Some portions of the document are not readable due to poor scanning.
Waste treatment methods and pollution control:	Off-gas control. Normal stack heights alone frequently have not been sufficient to prevent complaints when atmospheric conditions were not conducive to good dispersion. Plants with process off-gas stacks rising from 150 to 170 ft above grade have found that under existing topography and/or meteorological variations, stack gas dispersion alone., without abatement equipment, would not consistently prevent unsatisfactory conditions. Scrubbing is used. Recent testing of a water scrubber handling 29,500 scfm of phthalic anhydride off-gases has shown it to be capable of removing in excess of 99% of all organic acids, but has poor aldehyde removal. Waste waters from the plant scrubber noted required between 300 and 400 lb/hr of NaOH to effect neutralization of the acids removed from the gas stream. Between 500 and 700 lb/hr of Chemical Oxygen Demand is removed from the off-gases, this requires waste water treatment at the plant. Incineration with direct flame incineration or catalytic with large heat-recuperative exchangers. Reported catalytic efficiencies as low as 40-60% combustion of the contaminants. Important for success is the pre-heat temps, catalyst type and quantity, space velocity of the process gases through the catalyst bed, and protection of the catalyst from the possibility of poisoning or deactivation through fouling. Vendors guarantee at least 90% combustion of organic contaminants.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely does not contain errors in methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1970)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes description of release source, release media, specific processes or unit operations of release, pollution controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability in different pollution control measures and their efficiency based on a number of factors. Does not address uncertainty.

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Study Citation: Fawcett, R. L. (1970). Air pollution potential of phthalic anhydride manufacture. Journal of the Air Pollution Control Association 20(7):461-465.
HERO ID: 28937
Conditions of Use: Manufacturing

EVALUATION

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

Study Citation: Hughes, T. W., Jefcoat, I. A. (1979). Phthalic anhydride plant air pollution control. :394-404.
HERO ID: 5177569
Conditions of Use: Domestic manufacturing

EXTRACTION

Parameter	Data
Description of release source:	A source assessment of PA manufacture indicated that this industry is a source of particulates, nitrogen oxides, sulfur oxides, carbon monoxide, and hydrocarbons from its o-xylene and naphthalene-based processes. Based on the source assessment, determined that hydrocarbon emissions, particularly maleic anhydride and phthalic anhydride, from the main process vent represent a potential air pollution problem. This is true even though uncontrolled emissions are being reduced by up to 96.5% using thermal incineration.

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Study Citation: Hughes, T. W., Jefcoat, I. A. (1979). Phthalic anhydride plant air pollution control. :394-404.
HERO ID: 5177569
Conditions of Use: Domestic manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Waste treatment methods and pollution control:	In 1977, PA industry was using thermal incineration and wet scrubbing to control volatile organic compound emissions from their plants. Table II shows the types of controls employed and control efficiencies of 80%, 96.5% while wet scrubbing results in efficiencies of 96% to 96.5%. Alternative methods for controlling PA emissions from switch-condenser off-gas includes: thermal incineration with heat recovery, catalytic incineration with feed gas preheating, wet scrubbing with waste disposal, wet scrubbing with maleic anhydride recovery, carbon absorption with waste incineration, and process modification. Thermal incineration with waste heat recovery was being used at 2 plants with control efficiency of 96.5%. It is believed that 99% control can be obtained in this type of control device by either increasing the combustion temp by 110 C to 860 C or by increasing the residence time by about 55%. Increased combustion temps will increase control device's consumption of natural gas auxiliary fuel by approximately 11% and the nitrogen oxide emissions by approximately 14%. A catalytic incineration system was developed by a European PA manufacturer for use in connection with its new manufacturing process. It incorporates a feed gas preheating device and is said to be self-sufficient in energy balance. The gas preheating is obtained in a gas-gas heat exchanger using the exothermic oxidation of the carbon monoxide and the organics as the heat source. The catalyst was developed specifically to treat the off-gas from the new manufacturing process. Although gas preheating is usually considered as a means for fuel savings, it becomes a necessity when treating the PA condenser off-gas. This is due to the occasional presence of PA dust which, without preheating to vaporize, will possibly cause burning or explosion in the catalytic incinerator. This becomes possible when hot spots are developed in the catalyst bed which have a temp in excess of the 655 C autoignition temp of PA. A schematic diagram for the wet scrubber system is presented in Fig 2. Note that waste disposal is included in the system. This is necessary because wet scrubbing produces a secondary pollution problem caused by the discharge of the purge liquor. If this liquid discharge is not properly handled, an air pollution problem is just traded for a water pollution problem. PA and MA are hydrolyzed to the corresponding acids upon absorption into the scrubbing liquor. To concentrate the purge liquor for easier disposal (by minimizing the volume of the effluent stream), a certain degree of scrubbing liquor recycling is necessary. The means of purge liquor disposal considered in this study included incineration and MA recovery. The scrubber consists of two states, each of which contains a conventional fluid-bed packing on a supporting rid. The two stages are separated by a cone-shaped deflector plate and collection tray. The unit is designed to operate between 35 C and 40 C with an organic removal efficiency of 98% to 99%. This high efficiency is possible because most of the organics are solid at the scrubber operating conditions. The liquid purge discharged from the wet scrubber contains about 20 wt% maleic acid, 10 wt% phthalic and 1 wt% benzoic acid (based on the scrubbing of the waste gas from an o-xylene-based plant). This concentrated liquid waste can be disposed of by using a thermal incinerator. The liquid purge stream is atomized immediately before entering the combustion area of the incinerator by either a steam or an air stream. Fuel gas and combustion air (25% in excess of the stoichiometric amount) are introduced into the incinerator in a conventional manner to provide an operating temperature of 760 C to 870 C. Heat recovery can be achieved by means of a coil which can be used either to preheat the combustion air or to generate steam. The maleic anhydride recovery process is another alternative for the disposal of the scrubber waste liquor resulting from wet scrubbing of the condenser off-gas. The technologies of recovering the MA contained in the scrubber waste liquor have been developed by UCB and BASF separately. The recovery process basically consists of three sections: concentration, dehydration, and distillation. According to one process developer, the MA which is recovered by this process meets the norms of purity of the standard MA obtained by catalytic oxidation of hydrocarbons. Such a product can be substituted for standed MA in all its outlets. Impurities present in the scrubber purge liquor are separated by the recovery process as anhydrous melt of PA, citraconic anhydride, benzoic acid, and a little maleic anhydride. It was indicated that this melt can be pumped and burned in the same way as a normal heavy fuel. The carbon adsorption/incineration system can be separated into two areas: one for adsorption-regeneration and the other for disposal (i.e. incineration) of organics (adsorbate) which are desorbed upon regeneration of the carbon bed. There are three vessels (carbon beds) in the adsorption-regeneration area; two are in operation while the third is being regenerated. Control efficiencies of 99% are possible. If the organic vapor or mixture has not been previously handled by the equipment manufacturer or carbon supplier, dynamic tests of the material must be run before design conditions can be determined. A new process for the production of PA from o-xylene has been developed by Rhone-Poulene Industries of France. The flow diagram for this new process is very similar to that for the conventional process, with the following differences: no sulfur dioxide is required in the reactor feed to maintain catalyst activity. Hence, this source of pollution is eliminated. The switch-condenser off-gas is controlled by means of a catalytic incinerator which was developed for this particular use. The control system is energetically self-supported due to low temperature combustion and a lower air-to-o-xylene feed ratio as compared with the BASF process (22/1 vs 25/1) The 22/1 air-to-o-xylene ratio enables a high steam recovery efficiency and use of a steam turbine for air compression. Conventional plants purchase electricity to drive an electric motor for air compression. The liquid waste stream from the distillation section is further processed to produce solid pellets, which are disposed of by burning. The process developer claims that the catalytic incinerator incorporated in the process enables a complete oxidation into CO_2 and H_2O of all the polluting substances contained in the waste gas. The information supplied by the developer indicate the following control efficiencies for PA plant emissions used the catalytic incinerator: CO - 100%, MA 97%, PA 100%, miscellaneous 100%.		

EVALUATION

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Study Citation: Hughes, T. W., Jefcoat, I. A. (1979). Phthalic anhydride plant air pollution control. :394-404.
HERO ID: 5177569
Conditions of Use: Domestic manufacturing

EVALUATION

Domain		Metric	Rating	Comments
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by EPA so likely accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	Medium	Sample size is characterized by control efficiencies which vary by pollution control method.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Includes most metadata for release exposures. process, unit operation, activity for exposure.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple pollution control methods to achieve 99% efficiency. Does not address uncertainty.

Overall Quality Determination High

Study Citation:	Kawamoto, K., Park, K. A. (2006). Calculation of environmental concentration and comparison of output for existing chemicals using regional multimedia modeling. Chemosphere 63(7):1154-1164.
HERO ID:	6957413
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Release quantity:	According to Figure 2, about 80,000 kg/yr of phthalic anhydride is released to air, 150,000 kg/yr are released to water, and 75,000 kg/yr are released to soil.
Release or emission factors:	4.6E-03 mg/kg uptake media/day

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	High	Data are for the disposal of phthalic anhydride wastes, 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	Medium	Variability is addressed by running the emissions analysis for a prefecture of Japan and for the whole country. Uncertainty isn't addressed.

Overall Quality Determination	**High**

Study Citation:	Li, X. (2018). Chemical emissions from plastic manufactured in water infrastructure.
HERO ID:	5489083
Conditions of Use:	Maintenance and repair - resin manufacturing

EXTRACTION

Parameter	**Data**
Release quantity:	PA conc. in standing water at one of three NY sites was 9.5 +/- 0.1 (ug/L)
Comments:	Says 6th layer is coated with PA but chemical composition does not list any data for PA conc. at 6th layer. Marked for process description but only states small differences between the process of CIPP systems.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Study is not peer reviewed but appears to contain high quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Medium	Data is close to an occupational scenario such as resin manufacturing but appears to be a somewhat unorthodox method of this type of manufacturing since it is maintenance and repair.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old
	Metric 5:	Sample Size	Medium	Range of data with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains a very short process description, and release media.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing across multiple sites. Does not address uncertainty.

Overall Quality Determination — Medium

Study Citation: Mersiowsky, N. (2002). Long-term fate of PVC products and their additives in landfills. Progress in Polymer Science 27(10):2227-2277.
HERO ID: 6826007
Conditions of Use: Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Phthalates leach from consumer PVC products in landfills
Release quantity:	In Western Europe, 1,874,000 tons/year of PVC waste are disposed of. 29 ktons/year of phthalates are disposed of from cables, and 116 kton/year of phthalates are disposed of from floorings.
Release or emission factors:	Phthalates emissions in European landfill leachates: PA: maximum of 18,900 ug/l
Waste treatment methods and pollution control:	The paper suggested that phthalates are completely biodegradable to biogas in a stable mature landfill. Steps to reduce plasticizer waste include improving knowledge about formulations and use of additives by manufacturers, improving knowledge about fate of additives in post-consumer waste, reviewing critical applications and research alternatives, employing the precautionary principle if there is reasonable doubt, and executing a substitution policy only after careful assessment of the alternatives.

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 disposal of phthalate wastes, 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 (medians, minimums and maximums, 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	Medium	Uncertainty is addressed in the life cycle assessment methods. Variability is not addressed.

Overall Quality Determination — High

Study Citation: Midwest Research Institute, (1984). Performance evaluation of full-scale hazardous waste incinerators - Volume I (excutive summary) contract no. 68-02-3177 (43).
HERO ID: 1269556
Conditions of Use: disposal - air/water releases.

EXTRACTION

Parameter	**Data**
Description of release source:	Release source is aqueous or organic waste from a rotary kiln incinerator. All PA waste appears to be aqueous waste from sampling. Source of release as well is stack emissions from the incinerator.
Release quantity:	Sampling shows aqueous waste of 17 ug/g, 71 ug/g and 47 ug/g. Stack emissions show PA being at <0.8 ng/L and <0.9 ng/L (output rate of <0.0008 g/min)
Waste treatment methods and pollution control:	Incineration. Water quench section and two packed scrubbers with caustic addition to adjust pH. The gases pass through a two-stage ionizing wet scrubber and into a 200 hp induced draft fan that discharges into the stainless steel stack. All liquid effluents are recycled to the two ponds, with makeup provided by nearby lake water. Only effluent from the incinerator, other than the stack, is the ash discharged from the rotary kiln.
Comments:	Source is about incinerator performances. The only incinerator that has recorded data for PA is in Section C.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is a TSCA submission, conducted by EPA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to environmental releases.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes metadata such as release media, release frequencies, unit operations, processes.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by doing multiple test runs over different days but does not address uncertainty.

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

EXTRACTION

Parameter	**Data**
Release quantity:	PDF PG. 4 ”We estimate approximately 44 million tons (Mt) of plastic waste was managed through landfilling, combustion, and recycling in 2019.”
Waste treatment methods and pollution control:	PDF Pg. 1”Of the estimated 44 Mt of plastic waste managed in 2019 domestically, approximately 86% was landfilled, 9% was combusted, and 5% was recycled.”

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 disposal, an in-scope occupational scenario; however, the data are not chemical specific.
	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	Medium	Variability addressed by discussing multiple plastic waste types, but uncertainty is not addressed.

Overall Quality Determination — Medium

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 6811 Phthalic anhydride.
HERO ID:	10171484
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	Phthalic anhydride's production and use as an intermediate in the manufacture of plasticizers, polyester resins, alkyd resins,pigments, dyes, agricultural, pharmaceutical and other commercial chemicals may result in its release to the environmentthrough various waste streams. Phthalic anhydride is released directly to the atmosphere in fly ash from incinerator emissions,diesel exhaust, oak smoke and pyrolysis products. Phthalic anhydride may be formed in the ambient atmosphere via photolysisof o-tolualdehyde. If released to air, a vapor pressure of 5.17X10-4 mm Hg at 25 °C indicates phthalic anhydride will existprimarily as a vapor in the atmosphere.
Release quantity:	Gross estimate of discharge 5,000 tons/yr; waste treatment and disposal sources. (P. 26/50)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Release data methodology not described in summary, but data source is from US EPA.
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	Data collected more than 20 years ago.
	Metric 5:	Sample Size	Low	Release data samples not provided.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Estimated release only, no additional metadata provided.
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:	NCBI, (2020). PubChem Database: Compound Summary: Phthalic acid.
HERO ID:	7274473
Conditions of Use:	Wastewater treatment

EXTRACTION

Parameter	**Data**
Release or emission factors:	In a comprehensive survey of wastewater from 4000 industrial and publicly owned treatment works (POTWs) sponsored by the Effluent Guidelines Division of the U.S. EPA, phthalic acid was identified in discharges of the following industrial categories (positive occurrences, median concn in ppb): leather tanning (3; 8.8), nonferrous metals (5; 5.0), paint and ink (6; 69.8), printing and publishing (1; 126.2), organics and plastics (5; 269.5), textile mills (3; 46.1), plastics and synthetics (6; 78.3), auto and other laundries (3; 22.9), pesticides manufacture (2; 2986.4), explosives (18; 29.5), foundries (7; 11.8), aluminum (3; 7.4), electronics (6; 60.6), organic chemicals (19; 32.3), mechanical products (2; 11.3), publicly owned treatment works (4; 3.3)(1). The highest effluent concns, and the only ones >1 ppm were 5969 ppb and 4761 ppb in the pesticides manufacture and organics and plastics industries(1). Effluent samples from the Kimberly-Clark Terrace Bay Mill in 1981 contained 0.16 and 0.56 mg/L of phthalic acid(2). Phthalic acid was found in effluent from advanced wastewater treatment plants in Lake Tahoe CA, Orange County CA, Dallas TX, and Washington DC (Blue Plains plant)(3). Phthalic acid was found at concns of 566.9 ug/L of fuel burned from motor vehicle traffic in a Los Angeles roadway tunnel(4). Phthalic acid was found in automobile exhaust: 1982 Toyota Corolla 15 nmol/cu m; 1971 Mercedes Benz 214 nmol/cu m(5).

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 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	Data 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.
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: 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. Releases to air and water.
Release or emission factors:	Emission factors: Stack Air: 0.02-2.2 kg total organic carbon (TOC)/tonne throughput Fugitive Air: 0.00023-0.228 kg TOC/hr/source Water: 0.019-3.06 wt% of vessel

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	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, 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 addressed by presenting emission factors for multiple scenarios but uncertainty is 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:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Release source comes from the production of PA via O-xylene or via Naphthalene. Total estimated capacity MMlbs/yr of PA via o-xylene or naphthalene: Current - 720, 603; By 1980 - 1800, 528
Release quantity:	Release source via PA production o-xylene or naphthalene (MMlbs/yr). Estimated current air emissions: hydrocarbons - 0.1, 0; particulates - 5.1, 1.9; oxides of nitrogen - 0.3, 0; sulfur oxides - 2.6, 0; carbon monoxide - 43.6, 45; Total - 51.7, 47; Total weighted - 422, 160. List of estimated emissions in 1980: hydrocarbons - 0.3, 0; particulates - 13.2, 0; oxides of nitrogen - 0.8, 0; sulfur oxides - 6.8, 0; carbon monoxide - 113, 0; Total - 134, 0; Total weighted - 1100, 0. Estimated total emissions by 1980: 186, 47; total weighted - 1522, 160.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Conducted by EPA so known to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is directly applicable to production of PA
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1974)
	Metric 5:	Sample Size	Medium	Range from current production to estimated future production/emissions
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains release media, release frequency, and method of emissions via manufacturing.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Addresses variability by changing emissions and capacity from 1974 to 1980. Addresses uncertainty in bias of information as well as addressing the accuracy of its 1980 emissions/production predictions having a chance of reaching those predictions by 1985 if they are not reached by 1980.

Overall Quality Determination — High

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:	Formulation of paint and varnish

EXTRACTION

Parameter	**Data**
Description of release source:	pg 30. Air pollutant emissions are primarily the fugitive type and consist of evaporation losses of the volatile portion of the vehicle from the milling operation and from various product holding tanks and packing stations. There are also some fugitive particulate emissions that result from handling and emptying of pigment or extender bags into the grinding and dispersion mills. In some plants these loading areas are hooded and bags and pigment dusts are passed to a central collection station. At this station bags are removed for refuse disposal and the pigment dust is collected in a fabric filter and recycled into primer or other dark paint mixes. // Waste materials ccnstitute a major source of potential liquid pollutants. These include spoiled batches, residues and solvent and aqueous solutions for washing equipment. // Most solid waste, with the exception of that which can be considered part of an air pollution emission, is incorporated into the liquid wastes described in the previous section. These include pigment particulate and latex emulsion as well as the non-volatile portion of the film former which would be left if the paint or resin were allowed to dry. // During resin production, Particulate phthalic anhydride (PA) is also emitted from the kettle and concentration levels vary depending on cycle time, type of cook, method of charging and type of PA used. Charging of liquid PA rather than dry solid PA significantly reduces the emission rate.
Release quantity:	Source contains information on hydrocarbon, organics, and particulate emissions, and waste solvent, resin, and paint, but nothing specific to this chemical
Release or emission factors:	Waste resin and paint account for less than 0.5% of shipments.
Waste treatment methods and pollution control:	pg 115. In some cases, efforts are made to collect fugitive emissions by use of local exhaust systems. More frequently, however, they are exhausted from the building by general building exhaust fans which ventilate areas having the highest contaminant concentration. // The best control device for pigment and resin particulate is a fabric collector. The principal part of the system is the bag house or fabric filter. It is by far the best control device and is ideally suited for this application. Collection efficiency of the submlcron pigment particulate (0.05 to 0.25J.L) is very high, in the range of 99.9%. // The best control technique for gaseous emission from the paint and varnish industry is oxidation or combustion of the organic pollutants to C02 and H20. This is the only control technique currently being used that has proven effective for all cases. Three general methods are employed to oxidize waste gases, as follows: Flame Incineration or Direct Combustion, Thermal Combustion or Oxidation, and Catalytic Combustion or Oxidation. Thermal afterburners can also be effective for combustible particulate, such as phthalic anhydride, though the proper operating conditions may be considerably different than those for vapors. // Wet scrubbers can be relatively effective for the control of phthalic anhydride particulate and very heavy organics if properly designed. Efficiencies will run between 85 to 95% at pressure drops ranging from 4 to 8 in. w.c. // The use of refrigerated condenser systems has sometimes been proposed as an air pollution control device.

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	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: programs, E.O. (1974). Air pollution control engineering and cost study of the paint and varnish industry.
HERO ID: 6580284
Conditions of Use: Formulation of paint and varnish

EVALUATION

Domain		Metric	Rating	Comments
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:	Ramkissoon, C., Gaskin, S., Hall, T., Pisaniello, D., Zosky, G. (2023). Engineered stone fabrication work releases volatile organic compounds classified as lung irritants. Annals of Work Exposures and Health 67(2):288-293.
HERO ID:	11141340
Conditions of Use:	Fabrication of final products or articles

EXTRACTION

Parameter	**Data**
Release or emission factors:	Source states % composition of stone emissions attributable to PAD (Table 1). 12 samples ranging from 25.7% to 85.4%. ES10 contained 61% PAD, and this material was used in the inhalation monitoring study.
Comments:	Source specifically states that this study was not to assess workplace exposure and the methodology indicates this was a controlled experiment/sampling so may not equate to a true workplace exposure.

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	Source is from Australia, an OECD country.
	Metric 3:	Applicability	Medium	Source is for an in-scope use however the source explicitly states that this study was not made with the intent to evaluate workplace exposures.
	Metric 4:	Temporal Representativeness	High	Data were collected in the last 10 years.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclearif analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	No other metadata 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:	Seewald, N. (2001). Accidents: Reichhold's plant leaks phthalic anhydride in New Jersey. Chemical Week 163(32):9.
HERO ID:	5175784
Conditions of Use:	Storage - accidental release

EXTRACTION

Parameter	**Data**
Description of release source:	Spilled molten PA out of a storage tank in Newark, NJ. Contained in a protective dike surrounding the storage tank.
Release quantity:	150,000 lbs of molten PA
Comments:	Source is of a specific event of PA release that was self contained.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The data likely does not contain an error but is not for workplace conditions of release or exposure. The release data methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Low	Data is not applicable to a condition of use.
	Metric 4:	Temporal Representativeness	Medium	Data is from August 2001, less 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	Underlying methods, data sources and information about the cause of the release is not provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination: Low

Study Citation:	Sergeev, A. P. (1975). Problem of phthalic anhydride production. Koks i Khimiya (USSR) 6(6):35-37.
HERO ID:	5178792
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	The hydraulic resistances of the other equipment in series with the reactors are small and can easily be restored by cleaning or washing out any resin deposits. To avoid spontaneous resin ignition, the deposits must be removed regularly from the coolers and gas pipelines by washing with 6 percent alkali solution, rinsing with water and finally oxidizing the resin residues to ash with air heated to 380 C.
Release quantity:	For small-capacity equipment, the amount of waste is small; each evaporator retains 60-100 Liter of resinified product which must be drained out and the volume of effluent is only 30 m3 at-most from an entire block of four units. For larger capacity equipment, the volume of resinified product to be drained from each evaporator is 3 m3 and each block of two units produces 100 m3 of washing effluent. All the effluent and solid wastes must be transported to dumps in special container lorries, which are not available at the plant.
Release frequency:	In small-capacity equipment, a block of four units requires washing and ashing every 15 days. The time loss is 8 h. A special team is employed to carry out the washing and cleaning operations. Such frequent washing stoppages cannot be considered for large-capacity equipment. The stoppage period is extended to 30-32 h.

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	Low	The data are from a non-OECD country, and locality-specific factors may impact (e.g., potentially greater differences in regulatory emission limits, industry/ process technologies) releases relative to the U.S., or the country of origin is not specified.
	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	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release data do not include any needed metadata to understand what the data represent.
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:	Tur, M. Y., Huang, J. C. (1997). Treatment of phthalic waste by anaerobic hybrid reactor. Journal of Environmental Engineering 123(11):1093-1099.
HERO ID:	6814457
Conditions of Use:	Disposal - Treatment of Phthalic waste

EXTRACTION

Parameter	**Data**
Description of release source:	The manufacture of phthalic anhydride from o-xylene releases phthalic acid into the wastewater.
Waste treatment methods and pollution control:	A hybrid reactor with an upflow anaerobic sludge blanket and a bioreactor was used to treat wastewater containing phthalic acid. The chemical oxygen demand removal efficiency was nearly 95%, and 89.5% of the phthalic acid was converted to methane.

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 the production of phthalic anhydride, 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, throughputs, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and waste treatment provided but missing release quantities and emission factors.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by varying waste loading levels. Uncertainty is not addressed.

Overall Quality Determination — Medium

Study Citation: U.S. EPA, (1977). Phthalic anhydride plant air pollution control. :115.
HERO ID: 10182527
Conditions of Use: Manufacture

EXTRACTION

Parameter	Data
Description of release source:	condenser offgas
Release quantity:	Source provides composition of offgas, production capacity, and % removal efficiency which could all be used to calculate the release quantity of phthalic anhydride (p. 33-36)
Waste treatment methods and pollution control:	direct thermal incineration with either feed gas preheating or steam generation for waste heat recovery result in total organic removal with 80-96.5% efficiency. Other controls include wet scrubbers for the offgas and incinerators for the scrubber purge liquor with 96% efficiency. Another option is wet scrubber and a biological waste treatment facility. Or wet scrubber only (p.13). To achieve 99% removal efficiency, recommended add-on technology is thermal incinerator/steam generation, wet scrubber/MAN recovery, and carbon absorber/waste incineration. P. 37-75 Discusses control technology in detail.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report 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 manufacture of phthalic anhydride, 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 (1975)
	Metric 5:	Sample Size	High	Statistical distribution of samples is 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 High

Study Citation: U.S. EPA, (2023). 2020 National Emissions Inventory (NEI) Data (August 2023 version).
HERO ID: 11347319
Conditions of Use: All

EXTRACTION

Parameter	**Data**
Description of release source:	Provides annual release quantities on a per-site basis for air emissions, including fugitive air and stack air.
Release frequency:	NEI provides annual operating time.
Waste treatment methods and pollution control:	NEI provides control information.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Submitters provide general method used to calculate emissions, but details not provided.
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	NEI includes industries included in the scope.
	Metric 4:	Temporal Representativeness	High	NEI data were reported for the year 2020.
	Metric 5:	Sample Size	Medium	Universe is limited to units subject to NESHAP with threshold potential to emit, although states may have different requirements; statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	NEI includes release media and generally also includes daily and annual operating time, specific unit/process that is the source of release, and presence of engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	NEI does not address variability or uncertainty in submitter provided data.

Overall Quality Determination High

Study Citation: U.S. EPA, (2023). Toxics Release Inventory (TRI) data: Phthalic anhydride, reporting years 2019-2023.
HERO ID: 13006354
Conditions of Use: All

EXTRACTION

Parameter	Data
Description of release source:	Provides annual release quantities on a per-site basis for specific release media, including fugitive air, stack air, water, land, energy recovery, recycling, treatment, etc.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Methodology used by submitters to estimate release data is not known.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	TRI is U.S. based data.
	Metric 3:	Applicability	High	TRI includes industries included in the scopes of multiple chemicals.
	Metric 4:	Temporal Representativeness	High	TRI data are from 2019 - 2023.
	Metric 5:	Sample Size	Medium	Due to reporting requirements, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	TRI only includes release media but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	TRI does not address variability or uncertainty in submitter provided data.

Overall Quality Determination **Medium**

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:	Manufacturing, Processing: Plastic Manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	PAD Production: The major contributor of emissions is the reactor and condenser effluent which is vented from the condenser unit. Product storage in the liquid phase results in small amounts of gaseous emission. Particulate, sulfur oxides (for o-xylene-based production), and carbon monoxide make up the emissions, with carbon monoxide comprising over half the total.Plastic Manufacturing: The major sources of air contamination in plastics manufacturing are the raw materials or monomers, solvents, or other volatile liquids emitted during the reaction; sublimed solids such asphthalic anhydride emitted in alkyd production; and solvents lost during storage and handling of thinned resins.
Release or emission factors:	Emission factors for manufacturing phthalic anhydride are provided for different processes.
Waste treatment methods and pollution control:	The most efficient (96 percent) system of control is the combined usage of a water scrubber and thermal incinerator. A thermal incinerator alone is approximately 95 percent efficient in combustion of pollutants for o-xylene-based production, and 80 percent efficient for naphthalene-based production. Thermal incinerators with steam generation show the same efficiencies as thermal incinerators alone. Scrubbers have a 99 percent efficiency in collecting particulates, but are practically ineffective in reducing carbon monoxide emissions. In naphthalene-based production, cyclones can be used to control catalyst dust emissions with 90 to 98 percent efficiency. Product storage in the liquid phase results in small amounts of gaseous emissions. These gas streams can either be sent to the main process vent gas control devices or first processed through sublimation boxes or devices used to recover escaped PAN. Flaking and bagging emissions are negligible, but can be sent to a cyclone for recovery of PAN dust. Exhaust from the cyclone presents no problem.

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	Data are from the United States.
	Metric 3:	Applicability	High	Release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data. Emission factors for various processes.
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	Medium	The release data study provides only limited discussion of the variability in the determinants of release, but no discussion of theuncertainty in the release results.

Overall Quality Determination **Medium**

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 - NEI data contains multiple industries

EXTRACTION

Parameter	**Data**
Release quantity:	Emissions are site-specific from 0 to ~140,600 pounds
Release frequency:	NEI provides annual operating time
Waste treatment methods and pollution control:	NEI provides control information

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Submitters provide general method used to calculate emissions, but details not provided
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	NEI includes industries included in the scope
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data indicate that the data should to be representative of current operations, equipment, and activities. The release data were collected after the most recent federal regulatory action (e.g., NESHAP for air release or effluent limit guideline (ELG) for water release) or update or are no more than 10 years old, whichever is shorter. If no federal regulation is established, the data are generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Universe is limited to units subject to NESHAP with threshold potential to emit, although states may have different requirements; statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	NEI includes release media and generally also includes daily and annual operating time, specific unit/process that is the source of release, and presence of engineering controls.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	NEI does not address variability or uncertainty in submitter provided data

Overall Quality Determination	**High**

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:	Manufacture

EXTRACTION

Parameter	**Data**
Description of release source:	The major contributor of emissions is the reactor and condenser effluent which is vented from the condenser unit.
Release or emission factors:	Emission factors for PAN are included in Table 6.5-1. Emission factors are provided for emissions of particulates, SOx, Non-methane VOC, and CO.
Waste treatment methods and pollution control:	The most efficient (96 percent) system of control is the combined usage of a water scrubber and thermal incinerator. A thermal incinerator alone is approximately 95 percent efficient in combustion of pollutants for o-xylene-based production, and 80 percent efficient for naphthalene-based production. Thermal incinerators with steam generation show the same efficiencies as thermal incinerators alone.Scrubbers have a 99 percent efficiency in collecting particulates, but are practically ineffective in reducing carbon monoxide emissions. In naphthalene-based production, cyclones can be used to control catalyst dust emissions with 90 to 98 percent efficiency.

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 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	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 unit operation, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The release data study provides limited discussion of the variability in the control technologies used, uncertainty is not discussed.

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:	Though phthalic anhydride is not specifically mentioned, the group of articles provide information on various types of coating on metal and non-mental surfaces. As for example, sources of can coating VOC emissions include the coating area and the oven area of the sheet base and lithographic coating lines, the 3-piece can side seam and interior spray coating processes, and the 2-piece can coating and end sealing compound lines. Emission rates vary with line speed, can or sheet size, and coating type. On sheet coating lines, where the coating is applied by rollers, most solvent evaporates in the oven. For other coating processes, the coating operation itself is the major
Release or emission factors:	Though phthalic anhydride is not specifically mentioned, the group of articles provide information on various types of coating on metal and non-mental surfaces. Emission factor for different processes that are applicable for phthalic anhydride are provided.
Waste treatment methods and pollution control:	Incineration and the use of waterborne and low solvent coatings both reduce organic vapor emissions. Other technically feasible control options, such as electrostatically sprayed powder coatings, are not presently applicable to the whole industry. Catalytic and thermal incinerators both can be used. Primers, backers (coatings on the reverse or backside of the coil), and some waterborne low- to medium-gloss topcoats have been developed that equal the performance of organic solvent borne coatings for aluminum but have not yet been applied at full line speed in all cases. Waterborne coatings for other metals are being developed. Available control technology includes the use of add-on devices like incinerators and carbon adsorbers and a conversion to low solvent and ultraviolet curable coatings. Thermal and catalytic incinerators both may be used to control emissions from 3-piece can sheet base coating lines, sheet lithographic coating lines, and interior spray coating. Incineration is applicable to 2-piece can coating lines. Carbon adsorption is most acceptable to low temperature processes which use a limited number of solvents. Such processes include 2- and 3-piece can interior spray coating, 2-piece can end sealing compound lines, and 3-piece can side seam spray coating.Low solvent coatings are not yet available to replace all the organic solvent borne formulations presently used in the can industry. Waterborne basecoats have been successfully applied to 2-piece cans. Powder coating technology is used for side seam coating of non-cemented 3-piece cans. Ultraviolet curing technology is available for rapid drying of the first 2 colors of ink on 3-piece can sheet lithographic coating lines.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	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	The release data study does not address variability or 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
Overall Quality Determination		**Medium**	

Study Citation: U.S. EPA, (1995). AP-42: Chapter 11.1 - Hot mix asphalt plants.
HERO ID: 7315971
Conditions of Use: Formulation of asphalt

EXTRACTION

Parameter	Data
Description of release source:	Emissions from HMA plants may be divided into ducted production emissions, pre-production fugitive dust emissions, and other production-related fugitive emissions. Pre-production fugitive dust sources associated with HMA plants include vehicular traffic generating fugitive dust on paved and unpaved roads, aggregate material handling, and other aggregate processing operations. Fugitive dust that may escape collection before primary control generally consists of PM with 50 to 70 percent of the total mass less than 74 μm. A description of the sources of release for stack and fugitive air is provide for each type of processing operation.
Release or emission factors:	Table 11.1-1 presents emission factors for filterable PM and PM-10, condensable PM, and total PM for batch mix HMA plants. Particle size data for batch mix HMA plants, based on the control technology used, are shown in Table 11.1-2. Table 11.1-3 presents filterable PM and PM-10, condensable PM, and total PM emission factors for drum mix HMA plants. Particle size data for drum mix HMA plants, based on the control technology used, are shown in Table 11.1-4. Tables 11.1-5 and -6 present emission factors for CO, CO2, NOx, sulfur dioxide (SO2), total organic compounds (TOC), formaldehyde, CH4, and VOC from batch mix plants. Tables 11.1-7 and -8 present emission factors for CO, CO2, NOx, SO2, TOC, CH4, VOC, and hydrochloric acid (HCl) from drum mix plants. The emission factors for CO, NOx, and organic compounds represent normal plant operations without scrutiny of the burner design, operation, and maintenance. Information provided in Reference 390 indicates that attention to burner design, periodic evaluation of burner operation, and appropriate maintenance can reduce these emissions. Table 11.1-9 presents organic pollutant emission factors for batch mix plants. Table 11.1-10 presents organic pollutant emission factors for drum mix plants. Tables 11.1-11 and -12 present metals emission factors for batch and drum mix plants, respectively. Table 11.1-13 presents organic pollutant emission factors for hot (asphalt) oil systems.

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	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 this chemical.
	Metric 4:	Temporal Representativeness	Low	Report is more than 10 years old but less than 20 years old. But, emission factors were developed from data which is generally 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	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release.
Domain 4: Variability and Uncertainty				

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Study Citation: U.S. EPA, (1995). AP-42: Chapter 11.1 - Hot mix asphalt plants.
HERO ID: 7315971
Conditions of Use: Formulation of asphalt

EVALUATION

Domain	Metric		Rating	Comments
	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: U.S. EPA, (2021). National analysis TRI dataset (TRI): Data used for TSCA risk evaluations, reporting year 2019.
HERO ID: 8347325
Conditions of Use: All

EXTRACTION

Parameter	**Data**
Release quantity:	Provides release quantities on a per-site basis for specific release media, including fugitive air, stack air, water, land, energy recovery, recycling, treatment, etc.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Methodology used by submitters to estimate release data is not known.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	TRI is U.S. based data.
	Metric 3:	Applicability	High	TRI includes industries included in the scopes of multiple chemicals.
	Metric 4:	Temporal Representativeness	High	TRI data are from 2019.
	Metric 5:	Sample Size	Medium	Due to reporting requirements, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	TRI only includes release media but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	TRI does not address variability or uncertainty in submitter provided data.

Overall Quality Determination — Medium

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: All

EXTRACTION

Parameter	**Data**
Release quantity:	Total on-site disposal or other releases in 2017 = 276,979 lbs; Total off-site disposal or other releases in 2017 = 46,924 lbs; Total on and off-site disposal or other releases in 2017 = 323,903 lbs.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Methodology used by submitters to estimate release data is not known.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	TRI is U.S. based data.
	Metric 3:	Applicability	High	TRI includes industries included in the scopes of multiple chemicals.
	Metric 4:	Temporal Representativeness	High	TRI data are from 2017.
	Metric 5:	Sample Size	Medium	Due to reporting requirements, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	TRI only includes release media but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	TRI does not address variability or uncertainty in submitter provided data.

Overall Quality Determination — Medium

Study Citation:	Vandervort, R., Brooks, S. M. (1977). Polyvinyl chloride film thermal decomposition products as an occupational illness: I. Environmental exposures and toxicology. Journal of Occupational and Environmental Medicine 19(3):188-191.
HERO ID:	59547
Conditions of Use:	Meat wrapping with PVC film, including hot-wire cutting

EXTRACTION

Parameter	**Data**
Release quantity:	10 ppm phthalic anhydride was emitted after 30 sec of heating a 10 mg DCHP sample. 113 ppm phthalic anhydride was emitted after 60 sec of heating a 10 mg DCHP sample.

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	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	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	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 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	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:	Wei, Z., Zhou, F., Chen, S., Zhao, H. (2022). Composition, properties, and utilization of fumaric acid sludge by-produced from industrial phthalic anhydride wastewater treatment. Polymers 14(23):5169.
HERO ID:	12191625
Conditions of Use:	Disposal - WWTP

EXTRACTION

Parameter	**Data**
Description of release source:	Release source is described in process description (see General Engineering Assessment for process description).
Release or emission factors:	See use volume on General Engineering Assessment for release factor based on production volumes.2 samples described in Table 6:1st sample - mass (g): 1.0046; volume of sample (mL): 10; Instrument Reading (mg/L): 235.13; Content (%): 0.2342nd sample - mass (g): 1.0071; volume of sample (mL): 10; Instrument Reading (mg/L): 245.96; Content (%): 0.244
Waste treatment methods and pollution control:	See process description on General Engineering Assessment for description on how PA gets to waste site.The main method of Fumaric Acid Treatment (FAS) treatment is to separate and purify fumaric acid from FAS. However, the separation and purification process are complex. Firstly, the anhydride wastewater was put into the acid tank for settlement; after settlement, activated carbon was added for decolorization, and then thiourea was added for transposition reaction, and the crude fumaric acid was obtained after filtration. Activated carbon and the crude fumaric acid solid were added to distilled water, heated to boiling to completely dissolve the crude fumaric acid solid, and heated reflux was added to filter out the activated carbon. After cooling to room temperature, the high-purity fumaric acid can be obtained after filtration and drying.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is described well and expected to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from China, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to an in-scope use, disposal through WWTP.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	Metric 5:	Sample Size	High	Samples are fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include type of release media and how the process waste ends up at the WWTP and from what type of process it comes from.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Source does not address variability or uncertainty.

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:	manufacturing

EXTRACTION

Parameter	Data
Release quantity:	1980 emissions: 9,000 metric tons. Reported sources of PA are from waste treatment in manufacturing and can be contributed to 23% of emissions in this category.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer reviewed and appears to be free of errors in its analytical technique.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to emission releases.
	Metric 4:	Temporal Representativeness	Low	Source is greater than 20 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Approach, equations, values are all transparent and clear.
Domain 4: Variability and Uncertainty				
	Metric 6:	Metadata Completeness	High	Addresses variability across different emission scenarios through the area and point source categorization. Address uncertainty as well in it

Overall Quality Determination **High**

Study Citation:	Canada,, Health (2019). Screening assessment carboxylic acid anhydrides group.
HERO ID:	8404079
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Release quantity:	Phthalic anhydride has been reported to be released in quantities of 90 kg/yr in 2015 in Canada.

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 Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for the disposal of phthalic anhydride wastes, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data is from more than 10 years back.
	Metric 5:	Sample Size	Low	Data is characterized with 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 is addressed in a table that lists key sources of uncertainty, Variability is not addressed.

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 - automotive coating application

EXTRACTION

Parameter	**Data**
Description of release source:	Container cleaning, equipment cleaning, coating application (overspray). Media: air, land
Release or emission factors:	Container cleaning: 0.6%, Equipment Cleaning: 2%, Spray Coating: 35-80%
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	incineration. Prep stations, spray booths, or enclosed spray coating areas, general or local exhaust ventilation with dry filters: 96%

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	The data are from the United States and are representative of the industry being evaluated.
	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	Document is less 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 coating types.

Overall Quality Determination — High

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, miscellaneous operations, material storage, leaks, spills USE: Application losses, equipment residues, drum residues. Releases to water, air, land.
Release or emission factors:	Release/Emission Factors: PROC: Equipment residues: 0.5-1% (organic solvent-borne); 0.5-1% (water-borne); 0.5-1% (powder) Raw material packaging residues: 0.2-5% (organic solvent-borne); 0.2-5% (water-borne); 0.5% (powder) Air Emissions: 0.07-3.6% (organic solvent-borne); 0.03-2.25% (water-borne) Dust Emissions: 0.5-1% (organic solvent-borne); 0.5-1% (water-borne); 0.5-1.5% (powder) Flaking/crushing/transfer (powder only): 0.5-1.5% Cyclone Emissions (powder only): 2-5% Extruder waste (powder only): 1% USE: Equipment residues: 5% (wood); 1% (coil); 5% (aerospace); 5% (rail) container residues: 0.5% (wood); 3% (decorative); 1.5% (metal); 0.5-3% (coil) Application: 20-70% (wood spray); 1% (wood roll/curtain); 1% (decorative); 20-50% (automotive OEM); 50-60% (auto refinishing); 3% (metal); 35% (marine); 32% (aerospace); 10-25% (rail) Process scrap: 1% (metal) Quenching: 0.25% (coil) Sanding: 2% (rail) Volatiles only: 100% of chemical not released elsewhere.
Waste treatment methods and pollution control:	incineration. Vessel extraction, LEV (95-97% capture efficiency for dusts), area ventilation, condensers, carbon adsorption, condensation, biological treatment, thermal incineration, catalytic incineration, air scrubbers (99% efficiency)

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 - formulation of adhesives

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. Releases to water, air and land.
Release quantity:	Provides models for estimating various fugitive air releases. Release days/yr: days/yr equal to number of bt/yr
Release or emission factors:	Release/emission factors: Unloading solids: 0.5%, Container cleaning: 1% (solids), 0.2% (bulk liquids) 0.6% (small containers for liquids) 3% (drums for liquids), Compounding Volatiles: 0.002-0.05%, Equipment Cleaning: 2%, Off-spec: 1% of batches are off-spec
Waste treatment methods and pollution control:	Incineration. Baghous filters:>99% Cyclones/mechanical collectors: 80-99%

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	Medium	The completed exposure or risk assessment is 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	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 - adhesive application

EXTRACTION

Parameter	Data
Description of release source:	container cleaning, unloading, equipment cleaning, application losses, curing/drying, trimming. Releases to water, air, and land.
Release or emission factors:	Container cleaning: 0.2% (bulk liquids) 0.6% (small containers for liquids) 3% (drums for liquids) Equipment Cleaning: 1-2% Application losses: 0% (syringe/bead), 10-80% (spray), 2-10% (roll/curtain) Curing: 100% of chemical not released elsewhere (volatiles only) trimming: 4%
Release frequency:	50-365 days/yr
Waste treatment methods and pollution control:	incineration. thermal oxidizers (catalytic and thermal) and, to a lesser extent, carbon adsorbers and solvent recovery condensers as the most common control device Efficiencies: 0-100%

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	Medium	The completed exposure or risk assessment is ore 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	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 Automotive Lubricants

EXTRACTION

Parameter	**Data**
Release quantity:	Provides models for estimating various air releases.
Release or emission factors:	Provides models for estimating various air releases.

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	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ processtechnologies) may impact exposures or releases relative to the U.S.
	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	The completed exposure or risk assessment is 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	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination — Medium

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

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. Releases to water, air, and land.
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	Unloading solids: 0.5%Container cleaning: 1% (solids), 0.2% (bulk liquids) 0.6% (small containers for liquids) 3% (drums for liquids)Compounding Volatiles: 0.002-0.05%Equipment Cleaning: 1%Filter wastes: 1-4%
Release frequency:	250
Waste treatment methods and pollution control:	Incineration. Baghous filters:>99% Cyclones/mechanical collectors: 80-99%

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:	Processing - plastics compounding and converting

EXTRACTION

Parameter	**Data**
Description of release source:	Release during product use. Release to air.
Release or emission factors:	Emission factors provided for various additives based on measured and estimated 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 a frequently used source.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario but contains general emission factors.
	Metric 4:	Temporal Representativeness	Medium	The completed exposure or risk assessment is more than 10 years 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	High	Variability addressed by presenting emission factors for multiple additive types. Uncertainty is addressed in methodology for measuring emissions.

Overall Quality Determination — Medium

Study Citation: OECD, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID: 5160034
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Release quantity:	In 2000, according to the current Official Emission Declaration, virtually no phthalic anhydride (< 25 kg/a) was emitted into the atmosphere (Bayer Chemicals, 2004).
Waste treatment methods and pollution control:	The exhausts from manufacturing and processing are connected to thermal exhaust purification plants and air washing units. Thus, at Bayer Chemicals, during production virtually no phthalic anhydride is emitted into the atmosphere. // The wastewater from manufacturing and processing is led to Bayer-owned industrial wastewater treatment plants (Bayer Chemicals, 2004).

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

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

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. Releases to water, air, and land.
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	Release/Emission Factors: PROC: Container cleaning: 0.2% (bulk liquids), 0.6% (small containers for liquids), 3% (drums for liquids) Equipment Cleaning: 1% USE: Container cleaning: 0.2% (bulk liquids), 0.6% (small containers for liquids), 3% (drums for liquids) Disposal: 97-99.8%
Release frequency:	Processing: 203-360 Use: 253
Waste treatment methods and pollution control:	PROC: incineration USE: incineration. PROC: incineration, LEV, scrubbers, physical/chemical treatments, ultrafiltration, oxidation, evaporation/distillation, oil/water separation, dissolved air flotation, and biological treatment USE: incineration, scrubbers

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	The data are from the United States and are representative of the industry being evaluated.
	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	The data are 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	Medium	Release data include most critical metadata.
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

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:	Releases to water, air, land. // Filling/emptying: 0.05-70 kg/tonne 0.21-0.61% (solids); Storage (breathing losses): 0.01-13.1 kg/m3 storage capacity-yr; Fugitive emissions from leaking seals, connectors and flanges: 0.01-1.67 g/h; Storage of solids in open systems: 0.12-20 kg/tonne; Container residuals: <1% (road tankers), 0.19-0.63% (rail tankers), 1% (drums), 0.3% (IBCs); Fugitive emissions during container cleaning: 1.07-311 g/container (road tanker), 0.3-2,350 g/container (rail and ship tanker); Disposal: 0.01% (drums), 0.3% (IBCs), 0.0025-0.25 kg/bag (solids)
Waste treatment methods and pollution control:	Vapor balancing

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	The data are from an OECD country other than the U.S.
	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	Data is 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	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	Uncertainty not addressed. Variability addressed by considering multiple chemical forms, containers and storage system types.

Overall Quality Determination	**Medium**

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

EXTRACTION

Parameter	**Data**
Description of release source:	"Auto OEM: blowdown, sludge processing, generated sludge, stack air releasesAuto refinish: air filter waste from overspray, stack air"
Release or emission factors:	"Auto OEM: Spray coating: 35%Equipment cleaning: 1%Container cleaning: 0.2-4%Auto refinishing: Spray coating: 75%Equipment cleaning: 1%Container cleaning: 0.6-4%"
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:	"Auto OEM: Paint booth removal efficiency: 92.9-99.8%Solids removal in Water booth: 90%Auto refinishing: 87-99.8% paint booth removal efficiency"

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	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 OEM and refinish applications.

Overall Quality Determination	**Medium**

Study Citation:	U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.
HERO ID:	10293388
Conditions of Use:	Ink, toner, and colorant products

EXTRACTION

Parameter	**Data**
Description of release source:	Report assumed that 30% of volatile compounds released to air would be uncaptured emissions, and 70% would be stack emissions. (38/392)Fugitive emissions escape from the printing process from a long web run between presses, and exit the facility through windows and doors. (45/392)
Release or emission factors:	The calculated amount of volatilized solvent-based inks was 6.23 g/sec. The average stak emissions were 0.216 g/sec, and fugitive emissions were 1.87 g/sec. The calculated amount of volatilized water-based inks was 0.347 g/sec. The average stak emissions were 0.250 g/sec, and fugitive emissions were 0.105 g/sec. The calculated amount of volatilized UV-cured inks was 0.438 g/sec. The average stak emissions were 0.304 g/sec, and fugitive emissions were 0.141 g/sec. (147/392)
Waste treatment methods and pollution control:	Report assumes that solvent-based ink releases would pass through a catalytic oxidizer with a destruction efficiency of 95%, but that water-based or UV-cured ink sytems would not utilize an oxidizer. (45/392) An extensive list of pollution prevention techniques is presented on PDF page 320/392.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.(EPA)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are not chemical-specific, but are for ink products, 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	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 different ink types and their effects on exposure/release information. Uncertainty is not addressed.

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 disposal; Release media: Water, air, landfill
Release or emission factors:	Transfer operation losses of solids: 0.5%Container Cleaning (liquids in small containers): 0.6%Container Cleaning (solids): 1%Labware equipment cleaning (liquids): 2%Labware equipment cleaning (solids): 1%laboratory waste disposal: 100%
Release frequency:	260 day/yr
Waste treatment methods and pollution control:	Labware rinsed with water. Non-hazardous chemicals to landfill. laboratory chemicals or solvents used to clean labware may be considered hazardous. hazardous waste must be disposed of by incineration or to designated hazardous waste landfillslocal ventilation, accurate labeling of wastes, using secondary containment for hazardous wastes, and contacting specialty disposal companies

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:	Transfer losses of solid chemicals: 0.5%Container cleaning (liquids): 0.2%Equipment Cleaning (liquids): 2% Equipment Cleaning (solids): 1%
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:	Filters used for fugitive dust emissions are disposed of in landfills or by incineration. Wastewater is treated on-site or sent off to a POTW.Automated pumps and containment systems are used to control emissions. Containment methods include bunds, kerbs, drip trays or any other systems that will prevent a spilled product escaping are recommended.

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	High	The completed exposure or risk assessment is generally 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 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:	Container unloading (volatiles): EFs provided in Table 4-2.Container cleaning (liquids): 0.2%Equipment cleaning (liquids): 2%Combustion: All remaining chemical (calculated with mass balance)
Release frequency:	365 days/year.
Waste treatment methods and pollution control:	Fuel is combusted in engines.Controls for Liquified Petroleum Gas combustion at industrial sites include retrofit systems that implement low-NOx burners and flue gas recirculation. In terms of loading losses and equipment leaks, typical control techniques include submerged loading, storage tanks with internal floating roofs, carbon adsorption, and leak detection and repair systems. These techniques have an efficiency anywhere between 58-99%.To minimize combustion emissions, many vehicle and machine engines now include combustion improvement technologies like advanced variable geometry turbocharger with inter cooling, ultrahigh injection pressures, electronic fuel injection and control, exhaust gas recycle with temperature management, onboard diagnostics, catalytic exhaust converters (aftertreatment systems), lean de-NOx catalyst, and regenerative diesel particulate filter.

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, (2014). Generic scenario draft on the use of additives in plastic compounding.
HERO ID: 3827195
Conditions of Use: Plastics Compounding

EXTRACTION

Parameter	**Data**
Description of release source:	Unloading containers, spillage, Container cleaning, dusts and fugitive emissions from compounding, equipment cleaning
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	Unloading solids: 0.1-0.5%Spillage: 0.01%Container cleaning: 1% (solids), 0.2% (bulk liquids) 0.6% (small containers for liquids) 3% (drums for liquids)Compounding dusts: 0.01-0.05%Compounding Volatiles: 0.002-0.05%Equipment Cleaning: 2%
Release frequency:	148-264 days/yr
Waste treatment methods and pollution control:	WWT: settling or clarification, neutralization, sludge treatment and/or dewatering, biological treatment, chemical precipitation, phase separation, adsorption.Air: Mechanical separation, settling or clarigication, scrubbers, incineration/thermal destruction, condenser, adsorptionSolid waste streams: Settling or clarification, stabilization or chemical fixation prior to disposalNon-aqueous liquid waste streams: stabilization or chemical fixation prior to disposal, incineration/thermal destructionEfficiency: 0-100% depending on treatment method

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 multiple plastic and additive types.

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:	Unloading containers, container cleaning, dispersion and blending operations, sampling, equipment cleaning, filter wastes, loading, off-spec coating
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	”Unloading: 0.5% (solids)Container cleaning: 0.2% (bulk liquids), 0.6% (small containers for liquids), 3% (drums for liquids); 1% (solids)Equipment cleaning: 2%Filter wastes: 0.02%Off-spec: 0.85-1.2% of all batches are off-spec”
Release frequency:	235-350
Waste treatment methods and pollution control:	Incineration, on-site WWT, baghouse filters, cyclone/mechanical collectors”Baghous filters:>99%Cyclones/mechanical collectors: 80-99%”

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 multiple coating applications, and multiple chemical functions

Overall Quality Determination	**High**

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (compounding) – generic scenario for estimating occupational exposures and environmental release – Draft.
HERO ID:	6311218
Conditions of Use:	Processing as a intermediate for Plastic material and resin manufacturing; Processing as a reactant as a plastic in Plastic material and resin manufacturing; incorporation into formulation, mixture, or reaction product as a plasticizer for Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Unloading containers, spillage, Container cleaning, dusts and fugitive emissions from compounding, equipment cleaning
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	’Unloading solids: 0.1-0.5%Container cleaning: 1% (solids), 0.2% (bulk liquids) 0.6% (small containers for liquids) 3% (drums for liquids)Compounding dusts: 0.21-0.65%Compounding Volatiles: 0.002-0.05%Equipment Cleaning: 2%
Release frequency:	250 days/yr
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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	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 multiple plastic types, and additive types.

Overall Quality Determination — High

Study Citation: U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID: 6311220
Conditions of Use: Industrial/Commercial Use: Textiles, apparel, and leather manufacturing

EXTRACTION

Parameter	**Data**
Description of release source:	Air releases considered negligible based on low vapor pressures for most dye chemicals. Water releases expected from exhausted dyebath solution. Land releases from container residue and scrap/off-spec material.Either wastewater or landfill (no incineration)
Release or emission factors:	”Release based on degree of exhaustion, which ranges form 60-95% (calculated as dye not exhausted on leather)1.1% of PV released to landfill”

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	Low	Assessment is based on data 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	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 not addressed. Variability addressed by considering both liquid and solid physical forms and different types of releases.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	6311221
Conditions of Use:	Formulation and Use of Printing Inks

EXTRACTION

Parameter	**Data**
Description of release source:	PROC: Packaging disposal, material transfer, ink processing, equipment cleaningUSE: disposal/cleaning of ink container, cleaning printing equipment, ink drying
Release or emission factors:	PROC: Container cleaning: 0.3%-3% (liquids), 1% (solids)Equipment Cleaning: 0.07-2%USE: Container cleaning: 0.3-3%Equipment cleaning 0.07-2%Drying: 0.02-1.25 lb VOC/lb ink
Release frequency:	PROC: 250 days/yrUSE: 250 days/yr
Waste treatment methods and pollution control:	Incineration
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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	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 printing applications, and multiple chemical functions

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385709
Conditions of Use:	Flexographic Printing

EXTRACTION

Parameter	**Data**
Description of release source:	Equipment cleaning, fugitive air, stack air.
Release or emission factors:	Fugitive air: 30%Stack air: 5% (solvent-based ink); 70% (UV-cured and water-based inks)
Release frequency:	300 days/yr.
Waste treatment methods and pollution control:	Incineration

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	Low	Assessment 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:	U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385710
Conditions of Use:	Formulation and Use of Printing Inks

EXTRACTION

Parameter	**Data**
Description of release source:	PROC: Packaging disposal, material transfer, ink processing, equipment cleaning. VOC and particulate emissions are expected from the unloading of raw materials into the dispersion tank. Additional VOC emissions are expected as a result of heat-up losses and surface evaporation during the dispersion and milling operations as well as during the loading of the final ink product into receiving containers. Additional environmental releases are expected from waste streams associated with container and equipment cleaning.USE: disposal/cleaning of ink container, cleaning printing equipment, ink drying. A large portion of the releases from the printing industry are associated with VOC emissions. These come from the volatile components in the printing inks as well as from various solvents that are used for equipment cleaning. Air emissions are likely to result from unloading inks into the ink reservoirs on the printing press, the generation of ink mist during high speed printing operations, and fugitive emissions from various source points in the printing process(e.g. ink reservoirs, drying ovens). Additional environmental releases of chemicals contained in printing inks can result from residual ink wastes from container cleaning, and disposal of rags and solvents used to wipe down and clean printing equipment.
Release quantity:	PROC: See Table 2-4 for 2007 TRI data. Air releases = 190,832 lb/yr, Surface water releases = 29 lb/yr, POTW/Wastewater releases = 823 lb/yr, Land releases = 5,561 lb/yr, Other disposal = 51,303 lb/yr.USE: See Table 2-5 for 2007 TRI data based on the type of printing. Depending on the type of printing, Air releases = 14,150 to 5,865,923 lb/yr, Surface water releases = 0 to 275 lb/yr, Wastewater releases = 0 to 3,200 lb/yr, Land releases = 11 to 18,619 lb/yr, Other disposal = 1,767 to 210,010 lb/yr.
Waste treatment methods and pollution control:	PROC: See Table 2-3. Condensers, adsorption devices, dust collectors, floating roofs on storage tanks, catalytic incinerators, thermal incinerators, venturi scrubbers, enclosed oxidizing flames, covered mixing tanks, enclosed mills, use of pastes (not particulates), product reformation. USE: Flexography - enclosed doctor blade systems which eliminate the fountain roller and fountain, thereby reducing evaporation losses.

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	The GS is more than 10 years 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	Low	Uncertainty not addressed. Variability not addressed.

Overall Quality Determination — Medium

Study Citation: U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID: 6385717
Conditions of Use: Industrial/Commercial Use: Tanning and curing

EXTRACTION

Parameter	Data
Description of release source:	All process water containing tanning agent(s) is treated and sent to POTW and/or released to the environment. Land releases are due to PMN chemical residue that remains in the shipping containers.
Release or emission factors:	”Air releases are expected to be negligible. Standard estimate for residue in the container is 1% (solid) or 3% (liquid) of the production volume. Water releases can be assumed to include up to 100% of the production volume of the chemical. Equations included in the document. Effluent guidelines applicable to tanning industry.”
Release frequency:	up to 350 operating days/year

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality information/data/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	Low	Assessment is based on data 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	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 not addressed. Variability addressed by considering various release scenarios and release media.

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:	Commercial Use: Furniture Coating Application

EXTRACTION

Parameter	**Data**
Description of release source:	container cleaning, equipment cleaning, coating application (overspray), volatile air emissions
Release or emission factors:	Container cleaning: 3%Equipment Cleaning: 2%Application losses: 35-75% (spray)Volatile: 100% of chemical not released elsewhere
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	spray booths with dry filters: 90-99%

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	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 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: Processing: Manufacture of Textiles, Apparel, and Leather

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	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	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 finishing agent types

Overall Quality Determination Medium

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385753
Conditions of Use:	Industrial/Commercial Use: Paints and coatings

EXTRACTION

Parameter	**Data**
Description of release source:	Release of paint solids to wastewater. Air releases if volatile. Landfill/incineration releases from filter inefficiencies and container residues.
Release or emission factors:	”Water releases 0.5%. Suggests ””CEB models”” for air releases if vapor pressure greater than 0.001 torr. Releases to landfill/incineration given as 6.5% of PV based on transfer efficiency and percentage lost as container residue. ”
Release frequency:	Water releases occur either continuously or on a periodic/monthly basis

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	Low	Assessment is based on data 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	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 not addressed. Variability addressed by considering releases to different media.

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:	Container Residue from Compounding Transport Container - Standard CEB estimate for solid container residue is 1% loss.Dust Generation from Converting Activities Released to Water or Landfill - 0.01% loss of daily use rate, OECD 2003, based on estimates for filler additives.Fugitive Air from Converting Activities Released to Water or Air - A release of 0.25% of the daily use rate is estimated (OECD 2003, loss rates are based on high (0.25%), medium (0.05%), and low (0.01%) volatility at 200C for typical plasticizers in open processes such as calendaring, blown film, and spread coating).Residual from Converting Equipment Cleaning - The release is based on CEB standard estimate for equipment cleaning of entire process (2% loss of daily use rate) released to water.Trimming Waste - Waste generated from trimming, filing, and grinding (off-spec products are reground and reintroduced into the converting process) are estimated to be 2.5-10% of production.
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:	Finished plastic items have a typical expected lifetime. After use, plastic items in the consumer market are released back into the environment. Used plastic articles are disposed to land or incineration or they are recycled. According to EPA's Office of Compliance Sector Notebook for the Rubber and Plastics Industry approximately 1% of plastics are recycled. A more recent report from EPA's Office of Solid Waste estimates 5.5% of plastics is recycled. The OECD Emissions Scenario Document on Plastic Additives estimates that 8% of plastics are recycled and 17% of plastics are incinerated for thermal recovery in the UK.

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				

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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 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: 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/site/yr from incineration9,257 kg/site/yr to land

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	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 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/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	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 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: Manufacture

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/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	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 multiple additive types.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (1994). Generic scenario: Melt-blend processing of powder coatings.
HERO ID:	8726955
Conditions of Use:	Powder coatings

EXTRACTION

Parameter	**Data**
Description of release source:	grinding and classifying, pre-grinding processes, extruded waste material
Release or emission factors:	2.5% total release split between air and solids for disposal

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	Low	Assessment 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	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:	U.S. EPA, (1994). Generic scenario: Formulation of latex/emulsion coatings.
HERO ID:	8726956
Conditions of Use:	Processing Latex/Emulsion Coatings

EXTRACTION

Parameter	**Data**
Description of release source:	equipment cleaning, drying of latex wastes, off-spec and QC samples, unused raw materials, filters, volatiles from mixing
Release or emission factors:	”Waste solids: 1-2%Air: 100% (volatiles)Water: 10 gal cleaning fluid/bt”
Waste treatment methods and pollution control:	Water, air, incineration, landfillbaghouse/filter efficiency of 99%

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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:	Akram, M., Salman, M., Farooq, U., Saleem, U., Tahir, S., Nazir, H., Arsalan, H. M. (2020). Phthalate-functionalized Sorghum bicolor L.; an effective biosorbent for the removal of Alizarin Red S and Bromophenol blue dyes from simulated wastewater. Desalination and Water Treatment 190:383-392.
HERO ID:	6965794
Conditions of Use:	Industrial Use: Water Treatment Products

EXTRACTION

Parameter	**Data**
Waste treatment methods and pollution control:	By adding phthalic anhydride to Sorghum (a biosorbent), this mixture was able to remove a maximum of 99.39% and 96.16% of two different dyes from agricultural wastewater. (4/10)

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	The data are from a non-OECD country.
	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 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	Medium	Variability is addressed by comparing the removal rates in 2 different substrates but uncertainty is not addressed.

Overall Quality Determination	**High**

Study Citation: APR, (2020). U.S. post-consumer plastic recycling data.
HERO ID: 11360400
Conditions of Use: Recycling

EXTRACTION

Parameter	**Data**
Release quantity:	4,803.8 million pounds of post-consumer plastic material sourced in the U.S. is recycled, which accounts for 57.1% of all bottles, 20.5% of all films, and 0.3% of all other plastics used.
Waste treatment methods and pollution control:	Recycling

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 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	Medium	Variability addressed by describing the different plastic products that are recycled, but uncertainty is not addressed.

Overall Quality Determination — High

Study Citation:	Loveless, R. W., Atkins, J. R. (1961). Waste disposal planning using consultant's services at American Cyanamid's Bridgeville Pennsylvania plant. Engineering Extension Series, no. 106 :183-194.
HERO ID:	5177555
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Description of release source:	American Cyanamid's Bridgeville, Pennsylvania plant that produced phthalic anhydride from naphthalene.
Waste treatment methods and pollution control:	A water treatment system is incorporated into the plant. Here, wastewater was neutralized before being sent to the county sanitary collection site.

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 the disposal of phthalic anhydride 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	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	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:	Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID:	5353592
Conditions of Use:	Manufacturing, processing - any type of handling of PA.

EXTRACTION

Parameter	**Data**
Description of release source:	Spills or leaks in storage.
Waste treatment methods and pollution control:	Empty bags are best disposed of by burning in an incinerator designed for the purpose. Persons handling the empty bags should use caution to prevent phthalic anhydride dust from accumulating in enclosed space where a fire hazard may be created. Personal protective equipment as recommended in should be used. Because phthalic anhydride in contact with water, forms a solution of phthalic acid which attacks ordinary iron and mild steel, tanks which have contained this chemical are usually cleaned by the use of aqueous solutions of sodium hydroxide. When this is done all the safety precautions regarding the handling of caustic soda as outlined in the MCA Chemical 12 Safety Data Sheet SD-9, Caustic Soda, should be observed. All cleaning and repair work should always be done under the direction of thoroughly trained foremen who are familiar with the hazards involved and the safeguards ·nece.ssary for the performance of the work. Such foremen should make sure that all sources of ignition have been eliminated from the vicinity of the tank or equipment. The tank agitator should be disconnected or: the motor_ switch locked open and provided with a warning tag. Because the vapor pressure of phthalic anhydride is_ very low at room temperature, merely allowmg the tank or other equipment to cool to room temperature will eliminate hazardous concentrations of phthalic anhydride vapor. But before any tank or piece of equipment is ~ntered for repair work or cleaning, and at mtervals during such work, its air content should be tested for oxygen deficiency and for presence of harmful vapors. If the results of the tests show insufficient oxygen or the presence of harmful vapors, the tank must be ventilated and the test repeated. When the test results show the tank is safe to enter, an inspection tag should be attached stating the date, time and that the tank is safe to enter. Should the work in the tank be interrupted for any reason for an appreciable period of time the above test procedure should be repeated and a new tag attached. Special ventilation is recommended during the time persons are working in the tank. Electrical blower equipment should conform to the National Electrical Code. Fan blades should be nonsparking. Before any person enters a tank of any kind he should make sure that it can be left by the original entrance. Before a foreman directs men to enter a tank he should inspect its interior for traces of gas. This foreman should be equipped with a hose-type mask, and life line; and another person should be on guard during the inspection. If harmful vapor is found, the ventilating and testing procedure outlined in 8.5 above should be repeated. The intake of the hose lines leading into the tank should be kept in a vapor-free, uncontaminated area. When work is started, one man stationed on the outside of the tank should keep the man or men inside under constant observation, and an additional man should be nearby and available to aid in rescue work if any person in the tank is overcome. All burning or welding on the outside of tanks or equipment which has contained phthalic anhydride should be done only after such tanks or equipment have been cooled down and purged thoroughly (to reduce the oxygen content to less than 10% by volume). All openings should be closed in equipment in the area adjacent to the welding or burning operations. All necessary openings in the tank being worked on should be shielded or covered to prevent welding or burning sparks from entering the tank. Phthalic anhydride wastes are acidic and may be disposed of by dumping in a special area isolated from all oper~tions and where no contamination of a drinking water supply will be involved

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data from not frequently used sources but is an industry trade group for the Manufacturing Chemists Association.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing, processing, storage, or just generic handling of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1956)
	Metric 5:	Sample Size	Low	Characterized by qualitative data.

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Study Citation: Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID: 5353592
Conditions of Use: Manufacturing, processing - any type of handling of PA.

EVALUATION

Domain	Metric		Rating	Comments
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains information regarding engineering controls for multiple steps through PA handling from manufacturing, to transportation to storage. Includes PPE, waste treatment, exposure route.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Addresses variability by providing handling methods for multiple stages of use for PA. Addresses uncertainty through multiple different uses of different PPE and engineering controls effectiveness.

Overall Quality Determination — Medium

Study Citation:	U.S. EPA, (2004). Use of additives in foamed plastics – generic scenario for estimating occupational exposures and environmental releases – Draft.
HERO ID:	6304171
Conditions of Use:	Flexible and Rigid Polyurethane Foam Manufacture

EXTRACTION

Parameter	**Data**
Description of release source:	Container residues, equipment residues, release of auxiliary blowing agents (ABAs), scrap or off-spec product disposal
Release quantity:	no information available
Release or emission factors:	Equipment Cleaning: 2%ABAs: 0.0035-100%Scraps/off-spec: 12-30%

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 multiple foam types.

Overall Quality Determination High

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: Manufacture

EXTRACTION

Parameter	Data
Description of release source:	The major contributor of emissions is the reactor and condenser effluent which is vented from the condenser unit.
Release or emission factors:	Emission factors for PAN are included in Table 6.5-1. Emission factors are provided for emissions of particulates, SOx, Non-methane VOC, and CO.
Waste treatment methods and pollution control:	The most efficient (96 percent) system of control is the combined usage of a water scrubber and thermal incinerator. A thermal incinerator alone is approximately 95 percent efficient in combustion of pollutants for o-xylene-based production, and 80 percent efficient for naphthalene-based production. Thermal incinerators with steam generation show the same efficiencies as thermal incinerators alone.Scrubbers have a 99 percent efficiency in collecting particulates, but are practically ineffective in reducing carbon monoxide emissions. In naphthalene-based production, cyclones can be used to control catalyst dust emissions with 90 to 98 percent efficiency.

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 and are generally accepted by the scientific community, and associatedinformation 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	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	Data not based on sampling
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	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination — High

Study Citation:	Ishikawa, T., Natori, Y., Liberis, L., Pantelides, C. C. (1997). Modelling and optimisation of an industrial batch process for the production of dioctyl phthalate. Computers & Chemical Engineering 21(Supplement):S1239-S1244.
HERO ID:	5167474
Conditions of Use:	Processing - used as a reactant for di-octyl phthalate

EXTRACTION

Parameter	**Data**
Process description:	Figure 1 provides a flowsheet. Dioctyl phthalate (DOP) is formed by the diesterification of phthalic anhydride (PA) and 2- ethylhexanol (2EH). The two main reactions taking place are as follows: Monoester formation (A) This results in the formation of (mono) octyl phthalate (MOP): PA + 2EH –> MOP This reaction is irreversible and very fast. Diester formation (B) : MOP + 2EH ~ DOP + H20. This reversible reaction can proceed via both a catalytic route involving a homogeneous catalyst and a non-catalytic path, and is consequently characterized by rather complex kinetics. In practice, in order to increase the rate of the DOP formation by reaction (B), an excess amount of 2EH is used. The achievable conversion is limited by equilibrium considerations. However, by removing the water formed during the diesterification reaction, it is, in fact, possible to achieve almost complete conversion of the limiting reactant. This idea forms the basis of the industrial process described below. The plant is designed around a kettle reactor, suitable for the production of different plasticisers. A simplified schematic of the process is shown in figure 1. The operation of the plant involves a sequence of steps. The most important of these are as follows: Feeding: The preheated fresh 2EH together with the PA and homogeneous liquid catalyst are fed to the reactor. The fresh 2EH may be partially replaced by 2EH recovered from the previous batch cycle (see below) which is also charged to the reactor via the preheater. Esteriflcation: The contents of the reactor are continuously stirred and heated with steam supplied to the jacket of the reactor. This causes an evaporation of most of the water formed by the esterification, together with some of the alcohol (i.e., the two most volatile components). This overhead vapour is totally condensed and allowed to separate into two liquid phases in the overhead reflux drum. The aqueous phase is removed from the system while the alcohol rich phase is recycled back to the reactor. A separator unit placed between the reactor and the condenser (see figure 1) is used to improve the effectiveness of 2EH/water separation. Stripping: At the end of the esterification stage, the reactor contains primarily a mixture of DOP with excess 2EH. The latter is removed in the overhead vapour by further heating. In contrast to the step above, the alcohol rich phase recovered in this manner from the reflux drum is not recycled to the reactor but is instead stored in a separate 2EH recovery tank for use in subsequent batches (see Feeding step above). Chemical Additions: Any unreacted MOP and catalyst still left in the reactor are neutralised and decomposed respectively through the addition of further chemicals and hot water. Dehydration and Vacuum Stripping: The DOP product in the reactor is brought up to the desired final product purity by removing the remaining water and 2EH by steam stripping the reactor contents under vacuum. During this period, steam is simultaneously sparged directly into the reactor and fed to the reactor jacket.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Model is peer reviewed and likely to be free of mathematical errors and based on scientifically sound approaches or methods.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Report from UK, an OECD country.
	Metric 3:	Applicability	High	Applicable to occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Greater than 20 years old.
Domain 3: Accessibility/ Clarity				
	Metric 5:	Metadata Completeness	High	Model approach, equations and parameter values are transparent and clear.
Domain 4: Variability and Uncertainty				

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Study Citation:	Ishikawa, T., Natori, Y., Liberis, L., Pantelides, C. C. (1997). Modelling and optimisation of an industrial batch process for the production of dioctyl phthalate. Computers & Chemical Engineering 21(Supplement):S1239-S1244.
HERO ID:	5167474
Conditions of Use:	Processing - used as a reactant for di-octyl phthalate

EVALUATION

Domain	Metric		Rating	Comments
	Metric 6:	Metadata Completeness	Medium	Addresses variability in its decision for rates of addition, supply, pressure profile, etc. when it comes to model calculations. Does not address uncertainty.

Overall Quality Determination	**Medium**

Study Citation: Canada,, Health (2019). Screening assessment carboxylic acid anhydrides group.
HERO ID: 8404079
Conditions of Use: Import

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”In 2011, reported Canadian imported quantities of phthalic anhydride were < 12,550,000 kg. In Europe, phthalic anhydride is reported to be manufactured and/or imported in the European Economic Area in quantities ranging from 100,000 to 1,000,000 tonnes (100,000,000 to 1,000,000,000 kg) per 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	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	Data are for importing, 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 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 in a table that lists key sources of uncertainty, Variability is addressed by summarizing different countries.

Overall Quality Determination High

Study Citation:	Canada,, Health (2019). Screening assessment carboxylic acid anhydrides group.
HERO ID:	8404079
Conditions of Use:	Consumer Products

EXTRACTION

Parameter	Data
Chemical concentration:	PA was reported to be present in a total of 263 children's products from 2012-2016. A majority of the products listed in the database reported concentrations of phthalic anhydride at less than 500ppm (0.05%); 220 of the 263 identified products reported phthalic anhydride at less than or equal to 1000ppm (0.1%). Concentrations of phthalic anhydride in nail polish products were reported at 30%. Phthalic anhydride was also reported in 7 body wash products at a concentration range of less than or equal to the practical quantification limit of 100 ppm ($\leq$ 0.01%) and 1 lip care product at equal to or greater than 1000 ppm but less than 5000 ppm (0.1% $\leq$ 0.5%),

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	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	Data are for consumer use of personal care products, which is similar to the formulation of personal care products.
	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	High	Uncertainty is addressed in a table that lists key sources of uncertainty, Variability is addressed by summarizing different studies.

Overall Quality Determination	**High**

Study Citation:	Fasset, D. W. (1963). Phthalic anhydride. :1822-1823.
HERO ID:	5353579
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Over 237 million pounds of phthalic anhydride esters were produced in 1958.
Process description:	Phthalic anhydride is produced by air oxidation of naphthalene or a-xylene.

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 incorporation into plasticizers in plastic and resin 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	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:	Hours, M., Bertholon, J., Esteve, J., Cardis, E., Freyssinet, C. L., Quelin, P., Fabry, J. (1986). Mortality experience in a polyamide-polyester factory. Scandinavian Journal of Work, Environment and Health 12(5):455-460.
HERO ID:	1598909
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The facility produces 51,000 tons/year of polyamide and 55,000 tons/year of polyester for the textile industry.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	Medium	Data are for fillers in textiles, but contain general information about this COU not for one specific chemical.
	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 (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	High	Uncertainty is addressed in the data collection method. Variability is addressed by dividing samples into group by job, and age.

Overall Quality Determination **Medium**

Study Citation:	NTP, (2000). NTP-CERHR expert panel report on di(2-ethylhexyl) phthalate. GRA and I(GRA and I):120.			
HERO ID:	679847			
Conditions of Use:	Production of plasticizers			
		EXTRACTION		
Parameter		**Data**		
Process description:		DEHP is produced through reacting 2-ethylhexanol with phthalic anhydride. The reaction is either conducted in the presence of an acid or metal catalyst or at a high temperature.		
		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 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. The assessment 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	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 assessment does not address variability or uncertainty.
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 - Automotive Coating Application

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)
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 layers 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 adjusting the use rate based on the type of coating product used. 250 days/yr.
Number of sites:	32,296 refinishing shops
Chemical concentration:	15-25%

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	The data are from the United States and are representative of the industry being evaluated.
	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	Less than 10 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 **High**

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-assisted 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 - formulation of adhesives

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	15.8-4,990 million kg adhesive/yr
Process description:	Unloading raw materials from containers into mixing vessel, mixing, packaging/on-site storage
Throughput:	Batch size: 4000 kg or 1,000 gallons of adhesive/bt; Operating days/yr and batches/day: equal to the number of batches. 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 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 - adhesive application

EXTRACTION

Parameter	Data
Production, import, or use volume:	1,500 - 9,100,000 kg adhesive/site-yr
Process description:	unloading, dilute and mix (optional), application (roll, spray, curtain, bead/syringe), drying/curing, product finishing
Throughput:	Operating days/yr and batches/day: 50-365 days/yr. Provides methodology for estimating throughput based on the amount of adhesives 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 Automotive Lubricants

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	800,000 tonnes/yr UK
Process description:	Processing: Unloading raw materials, blending, intermediate storageUse: Unloading lube oil, removing spend 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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ processtechnologies) may impact exposures or releases relative to the U.S.
	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	The completed exposure or risk assessment is 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	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination **Medium**

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:	Op days: 250 days/yr. 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:	Processing - 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, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID:	5160034
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	In 2000, the world wide production volume of phthalic anhydride is estimated to be about 3,232,000 tonnes, with the following regional distribution (tonnes): Western Europe 770,000; Eastern Europe 171,000; USA 485,000; Mexico, South and Central America 249,000; Japan 302,000; Middle East 75,000; other Asia 1,156,000; and others 24,000. (pg 53)
Life cycle description:	Phthalic anhydride is an important intermediate in the chemical industry. The major subsequent product groups are plasticizers (56 %), unsaturated polyester resins (17 %), alkyd resins (17 %), and other uses (10%). Phthalic anhydride is also used as an intermediate in the production of pigments and dyes, agricultural, pharmaceutical, and several other chemical products. Phthalic anhydride containing materials are used in coatings applications for home appliances, automobiles, medical devices and furniture. (pg 6)
Process description:	On contact with water, phthalic anhydride is rapidly hydrolyzed to phthalic acid. Phthalic anhydride forms white flakes or needles with a melting point of about 132 °C. Phthalic anhydride is produced by oxidation of o-xylene or naphthalene. At the Bayer sites phthalic anhydride is manufactured in closed systems (Bayer Chemicals, 2004).
Chemical concentration:	Purity of the commercial product: $\geq$ 99.8 % (Maleic anhydride $\leq$ 0.05 %, Benzoic acid $\leq$ 0.1 %, Phthalic acid $\leq$ 0.1 %, Naphthoquinone)

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment 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. 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	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

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Study Citation:	OECD, (2005). SIDS Initial Assessment Report: Phthalic anhydride. :213.
HERO ID:	5160034
Conditions of Use:	Manufacturing

EVALUATION

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

Study Citation: OECD, (2011). Emission scenario document on the chemical industry.
HERO ID: 6306753
Conditions of Use: Manufacture, processing, use - manufacture, formulation of processing aids, processing as a reactant, use of processing aids

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	N/A - This metric is not applicable to the data being extracted (process description only)
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 - This metric is not applicable to the data being extracted (process description only)

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 Use

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	6.3 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 spend oil and replacing with new oil, disposing/recycling of used oil
Throughput:	Op days/yr and batches/yr: Processing: 203-360 days/yr Use: 253 days/yr. 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

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	11 million tonnes shipped via rail tankers; 30 million tonnes shipped via pipelines
Process description:	On-site storage of chemicals, filling of containers, transport to distributors/downstream users/consumers, containers with residual chemical transported to recycling/cleaning or disposal 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	Medium	The completed exposure or risk assessment 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. 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 multiple chemical forms, containers and storage system types.

Overall Quality Determination — Medium

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

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	”Auto OEM: 166,00 cars painted/yrAuto refinish: 70-2,000 L paints/yr”
Process description:	Pretreatment (wash) of car body, E-coat (dip), oven/cure, primer (spray), oven/cure, basecoat (spray), oven/cure, clearcoat (Spray), oven/cure
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	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	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 OEM and refinish applications.

Overall Quality Determination Medium

Study Citation: U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.
HERO ID: 10293388
Conditions of Use: Ink, toner, and colorant products

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Flexographic printing consumed more than 513 million lbs of ink in 2000. (33/392)
Throughput:	Report assumed that the average print speed is 500 feet per minute. (38/392)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.(EPA)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are not chemical-specific, but are for ink products, 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 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 is addressed by comparing different ink types and their effects on exposure/release information. Uncertainty is not addressed.

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**
Production, import, or use volume:	Provides methodology to estimate annual use rate.
Life cycle description:	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
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
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, annual throughput - 40,639 total establishments
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 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%.

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	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).

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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

EVALUATION

Domain	Metric		Rating	Comments
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.

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, (2014). Generic scenario draft on the use of additives in plastic compounding.
HERO ID: 3827195
Conditions of Use: Plastics Compounding

EXTRACTION

Parameter	Data
Process description:	Polymer pellets/resins received, blending/compounding into masterbatch, extrusion/shaping, packaging.
Throughput:	Provides methodology for estimating throughput based on the amount of plastic produced, and the concentration of the chemical additive in the plastic. 148-264 days/yr.
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the amount of plastic produced, and the concentration of the chemical additive in the plastic.
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	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 plastic and additive types.

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**
Production, import, or use volume:	1.6-16 million kg coatings/site-yr
Process description:	Unloading solid/liquid components from tank cars, totes, drums, or sacks and from filter replacement –> pre-mixer (pigment dispersion), grinder (pigment dispersion), blending tank, filter, packaging235-350 days/yr
Throughput:	Provides methodology for estimating throughput based on the amount of coatings produced, and the concentration of the chemical in the coating
Chemical concentration:	Provides conc. estimates based on chemical function and coating 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 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 coating applications, and multiple chemical functions

Overall Quality Determination High

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (compounding) – generic scenario for estimating occupational exposures and environmental release – Draft.
HERO ID:	6311218
Conditions of Use:	Processing as a intermediate for Plastic material and resin manufacturing; Processing as a reactant as a plastic in Plastic material and resin manufacturing; incorporation into formulation, mixture, or reaction product as a plasticizer for Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	provides the North American Production (lb/yr) of the types of Thermoplastics from 2003 -p. 3
Process description:	Polymer pellets/resins received, blending/compounding into masterbatch, extrusion/shaping, packaging
Throughput:	'Provides methodology for estimating throughput based on the amount of plastic produced, and the concentration of the chemical additive in the plastic
Number of sites:	'Provides methodology for estimating number of sites based on chemical PV, the amount of plastic produced, and the concentration of the chemical additive in the plastic
Chemical concentration:	'Provides conc. estimates based on additive function in various plastics, not chemical specific.
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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 multiple plastic and additive types.

Overall Quality Determination **High**

Study Citation:	U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID:	6311220
Conditions of Use:	Industrial/Commercial Use: Textiles, apparel, and leather manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Leather is generally dyed in wooden drums or rotating vessels. A dye bath is prepared by adding a dye stuff to the dyeing equipment; surfactants and other auxiliaries may also be added. The bath temperature may range from 0 degree to 60 degree C. The leather is brought into the drum or rotating vessel, and the leather is dyed by gentle agitation for approximately 10 minutes. There are also semi continuous processes ((multimac) dyeing machine) for leather dyeing.
Throughput:	A batch consists of between 450 and 900 kg of leather with a typical value of 680 kg. This batch size corresponds to between 40 and 80 grain leather sides, and between 100 and 200 suede leather sides, based on a weight of 11kg/side of grain leather and 4.5 kg/side of suede leather. The amount of formulated dyestuff used per batch is 6.8 kg for the grain leather sides, and 20 kg for the suede leather sides. Calculation for use rate per batch."annual amount of active colorant in the dyestuff solution used ranges from 200-2,500 kg/tannery, with an average use rate of 1,000 kg/tanneryThe total number of hides dyed at each facility typically averages 1,000 sides/day"
Number of sites:	315 tanneries in the United States, and 80% perform dyeing operations. Number of sites calculated based on PV and should not exceed 252 tanneries.
Chemical concentration:	Amount of active chemical in the formulated dyestuff (% active chemical of interest) is typically 50% for powdered dyes and 15% for liquid dyes (most dyes used in leather dyeing are acid dyes)

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state 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	Medium	Uncertainty not addressed. Variability addressed by considering both liquid and solid physical forms and different leather types.

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	6311221
Conditions of Use:	Formulation and Use of Printing Inks

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	11.9-373.8 million kg ink/yr (depending on printing application)
Process description:	PROC: Vehicle consisting of resin, solvent, drying agents, and resn plasticizing oils is prepared, pigment blended into vehicle, fed to dispersing mill, raw ink let down with additional solvent and other additives, packaged for sale.USE: Provides descriptions for lithography, gravure, flexography, letterpress, digital priting, and screen printing.
Throughput:	Provides methodology for estimating throughput based on the amount of ink produced, and the concentration of the chemical in the ink for both PROC and USE
Number of sites:	PROC: 13-239 (depending on printing application)USE: 454-18,622 (depending on printing application)
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.
Comments:	QC Note: This GS/ESD is an older version and may not provide the most up to date information

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	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 printing applications, and multiple chemical functions

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385709
Conditions of Use:	Flexographic Printing

EXTRACTION

Parameter	**Data**
Process description:	ink received in drums, charged to ink chamber, flexographic press, ink in substrate product
Throughput:	1,800 kg ink/site-day
Chemical concentration:	1-10%, general additive concentration not chemical or function 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 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	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	Low	Variability and uncertainty are not addressed.

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385710
Conditions of Use:	Formulation and Use of Printing Inks

EXTRACTION

Parameter	**Data**
Life cycle description:	It was estimated that approximately 97% of all industrial end use printing activities can be categorized within five different printing processes: lithography, flexography, gravure, letterpress and screen printing
Process description:	PROC: Vehicle consisting of resin, solvent, drying agents, and resn plasticizing oils is prepared, pigment blended into vehicle, fed to dispersing mill, raw ink let down with additional solvent and other additives, packaged for sale.USE: Provides descriptions for lithography, gravure, flexography, letterpress, digital priting, and screen printing.
Number of sites:	See Table 2-2: A total of 4,221 sites from 2007 data
Chemical concentration:	Of the reviewed 15 chemicals, 8 chemicals were manufactured or imported in 100% concentration; 7 chemicals were manufactured or imported in concentrations $< 100\%$.

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 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	The GS is more than 10 years 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	Low	Uncertainty not addressed. Variability not addressed.

Overall Quality Determination **Medium**

Study Citation:	U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID:	6385717
Conditions of Use:	Industrial/Commercial Use: Tanning and curing

EXTRACTION

Parameter	**Data**
Process description:	”The first steps of the process are referred to as beamhouse operations, which include trimming, soaking, fleshing, and unhairing. These operations take place for both chrome and vegetable tanning. Next, tanyard processes take place,which include bating, pickling, tanning, wringing, and splitting. Lastly, finishing processes include conditioning, staking, dry milling, buffing, spray finishing, and plating. Process flow diagram and additional details provided in GS document. ”
Throughput:	up to 350 operating days/year
Number of sites:	up to 315 sites

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality information/data/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	Low	Assessment is based on data 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	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 is addressed by discussing both chrome tanning and vegetable tanning process but uncertainty is not addressed.

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:	Commercial Use: Furniture Coating Application

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	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	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 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:	Processing: Manufacture of Textiles, Apparel, and Leather

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	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	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 finishing agent types

Overall Quality Determination	**Medium**

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385753
Conditions of Use:	Industrial/Commercial Use: Paints and coatings

EXTRACTION

Parameter	**Data**
Process description:	"The process consists of pre-treatment of the article to be painted, painting of the article, and rinsing of the product. Example of specific steps include degreasing article, rinsing article, electrodeposition of article in dip tank with liquid formulation, recycling dip tank liquid, water rinsing article with recycling of rinsate, and drying/baking article. "
Throughput:	Dip times range from just seconds to 3 minutes for large piecesAssume 250 days/yr
Number of sites:	Number of sites calculated for automobile and appliance manufacture separately based on PV, transfer efficiency, use rates, and product throughputs
Chemical concentration:	Approximate composition of paint used for electrodeposition is: 84% deionized water, 0.6% surfactants, 0.3% defoamers, 2.0% crosslinkers, 4% solvents, 2% pigments, 1 % grind vehicle, and 6.1 % main vehicle. Solids composition typically ranges from 5.5% to 15%.

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	Low	Assessment is based on data 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	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 not addressed. Variability addressed by considering both automotive and appliance applications and different chemical functions.

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, (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	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	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 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	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	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 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:	Manufacture

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	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	Low	Assessment is based on data greater than 20 years old (1994)
	Metric 5:	Sample Size	Low	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, (1994). Generic scenario: Melt-blend processing of powder coatings.
HERO ID:	8726955
Conditions of Use:	Powder coatings

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	133.5 MM lbs of powder coatings/yr
Process description:	weigh raw materials, dry pre-mix, melt mixing, cooling and flaking, grinding, classification, packaging
Throughput:	Assume 250 days/yr, 700-2,000lb coating/hr
Number of sites:	38 facilities
Chemical concentration:	Provides conc. estimates based on the chemical function and type of coating (thermoset vs thermoplastic), not chemical specific.

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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	Medium	Uncertainty not addressed. Variability addressed by considering different coating types and chemical functions

Overall Quality Determination **Medium**

Study Citation: U.S. EPA, (1994). Generic scenario: Formulation of latex/emulsion coatings.
HERO ID: 8726956
Conditions of Use: Processing Latex/Emulsion Coatings

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	450 MM gals of latex coatings/yr
Process description:	Pigment dispersion, mixing, add latex, QC check, hold and re-check QC, dispense and package
Throughput:	1000-5000 gal/bt
Number of sites:	1000

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	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations 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	Medium	Uncertainty not addressed. Variability addressed by considering different chemical functions

Overall Quality Determination Medium

Study Citation: 3M, (2023). Safety Data Sheet (SDS): 3M Aerospace Sealant AC-770 B-2.
HERO ID: 10176505
Conditions of Use: Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	$<$ 1 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation:	A/S,, J.I. (2023). Safety Data Sheet (SDS): Junckers Rustic Oil, Clear.
HERO ID:	6301644
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	< 0.15 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

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: Paints, coatings, sealants and adhesives

EXTRACTION

Parameter	**Data**
Life cycle description:	Phthalic anhydride is used to manufacture plasticizers, that are then used in synthetic resins. In turn, these synthetic resins are raw materials used to formulate paints, coatings, sealants and adhesives, for both industrial and consumer markets. More specifically, phthalic anhydride is used as a monomer in synthetic resins such as glyptal, alkyd resins, and polyester resins. Polyester resins are used in OEM, refinish and industrial coatings.
Chemical concentration:	Phthalic anhydride is commonly used as the acid component of a condensation reaction to produce alkyds and polyesters. Phthalic anhydride is largely consumed in reaction. Manufacturers of raw materials state that only trace amounts of free phthalic anhydride will be present in raw material used to formulate products. In effect, generally only residual amounts would be present in formulated products such as paints, coatings, sealants and adhesives. Some formulators note that certain specialty products may contain amounts above 10%.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Data sources not provided.
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 is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample data regarding concentrations of PAD are not presented.
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:	Agaev, A. S., Nadzhafov, Y. B., Kobylkina, T. N. (1976). Cleanup of emissions from phthalic anhydride production. Chemistry and Technology of Fuels and Oils 12(11-1):873-875.
HERO ID:	5179383
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	PA is produced commercially by the oxidation of o-xylene or naphthalene with atmospheric oxygen at temps of 400-450 C over a vanadium catalyst. A PA production unit consists of a contact session, where the feedstock is oxidized, and a distillation section, where the crude PA is treated, distilled, and bagged. The off gases from the contact section are passed through a scrubber and then discharged to the atmosphere.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data referenced is from Russia, a non-OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to the manufacture of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1970s)
	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: Anonymous (1997). Tenders out for Qatar ethylene dichloride project. Chemical Week 159(40):30.
HERO ID: 5441338
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	This article indicates supply of 2 phthalic anhydride plants to clients in China. Each plant will be designed to produce 40,000 m.t./yr, using Wacker technology. Output will be used in plasticizer production. [pg 3 of 3]
Life cycle description:	PAD output will be used in plasticizer production.

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 for China, a non-OECD country.
	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 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	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 Low

Study Citation:	Anonymous, (2019). Phthalic anhydride: Worldwide markets to 2023. Focus on Catalysts 2019(3):3.
HERO ID:	5176763
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The largest share of phthalic anhydride consumption is for the production of plasticizers, which accounted for around 36% of the total in volume terms. According to a recently conducted research about the global phthalic anhydride market, as an overall, it is projected to reach approximately 4,837,000 tonnes by the end of 2023, increasing at a CAGR of around 2%/y in the period 2017-2023. Regionally, the largest global phthalic anhydride market was North East Asia, which accounted for about 40% of the total in volume terms. In comparison, Africa was the smallest global phthalic anhydride market during the analyzed period and is expected to remain such in the medium term.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The report uses data from a source not typically used for production assessments. All quantifiable production/consumption data are for countries outside the US. Does not specify techniques to verify this data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Most data is either in terms of global use or specific to certain continents. Does not specify countries for quantifiable data.
	Metric 3:	Applicability	Medium	Data is for global use, includes use volumes.
	Metric 4:	Temporal Representativeness	High	Source is less than 10 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Only provides the data source website.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty in the data.

Overall Quality Determination **Low**

Study Citation:	Anonymous, (1998). Zaklady Azotowe Kedzierzyn (ZAK; Kedzierzyn, Poland) plans to build a new phthalic anhydride (PA) plant at its Kedzierzyn complex. Chemical Week 160(8):18.
HERO ID:	5178368
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	50,000 m.t./year plant. Capacity raised to 205,000 m.t./year. 2-ethyl alcohol will account for 165,000 m.t./year of the total capacity.
Process description:	Two alternative production methods: one using ortho-xylene, the other naphthalene feedstocks.
Throughput:	50,000 m.t./year plant
Comments:	Source is just a short memo about upgrading plant capacity.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	The assessment or report uses information that does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for Poland, an OECD country.
	Metric 3:	Applicability	Medium	Report contains information of PV for manufacturing for a particular plant only.
	Metric 4:	Temporal Representativeness	Low	Greater than 20 years old.
	Metric 5:	Sample Size	Low	Characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Data sources are not described but can be inferred.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1997). Phthalic anhydride - BASF restarts production. European Chemical News 68(1785):11.
HERO ID:	5178623
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Throughput:	110,000 tonne/yr at German plant

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	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to 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	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	Low	Distribution of samples is qualitative or characterized by no 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 report does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1984). 9-1 air ratio improves phthalic-anhydride process. Process Engineering 65(4):11.
HERO ID:	5178647
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	This plant near Milan was currently capable of producing 75,000 tons/yr of phthalic anhydride
Process description:	Process improvements have been achieved for making phthalic anhydride using o-xylene feedstock. Reduces air/o-xylene ratio from 20:1 down to about 9:1. This results in energy savings, the possibility of recovering over 50% of crude phthalic anhydride in the liquid phase, and the potential for debottlenecking existing reactors by about 30% through increased catalyst productivity. Until now a concentration of about 70 g/Nm^3 (corresponding to an air/o-xylene ratio of 18:1) has been considered the threshold limit which should not be exceeded if explosion risk downstream of the reactor is to be avoided. The new technology has been tested and can be implemented.
Throughput:	New technology allows to reduce air/o-xylene ratio from 20:1 to 9:1. Explosion limit before was 18:1.
Number of sites:	1 plant is implementing the new technology

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report is from a news article, likely comes from manufacturer or technology manufacturer so it is accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source originally published in Cornell journal, however the use of the technology is based in Europe and OECD countries, such as Italy, Germany, and Netherlands.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing of PA.
	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	Does not provide source of data but it can be inferred. Does not provide specific information about the new technology, unit operations, and other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Low

Study Citation:	Anonymous, (1973). Improved phthalic anhydride reactor. Process Technology Proceedings 18(11):419.
HERO ID:	5178654
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	25,000 metric tons of PA per annum using this process.
Process description:	Design innovations incorporated into a fixed-bed PA reactor, include easy catalyst loading, good heat transfer and precise temp control. Overall process is claimed to be considerably less expensive than other routes for the production of PA. The catalyst tube filling system - metered amounts discharged from a rotating bin - enables 10,000 tubes to be filled in one 8-hr shift, compared to the three weeks that are normally required in other filling schemes. Although the catalyst used has been shown to have a lower yield than the best obtainable in other system (3-4% less) it operates well with cheaper feed-stocks, being able to handle a feed containing only 90% o-xylene contaminated with oil and water. It also works well with naphthalene without any modifications. Reactor is cooled by a salt bath circulating through external control equipment, thus providing more space inside the reactor for catalyst tubes. This is a fairly conventional arrangement, but in the Rheinstahl reactor the salt flows cross-flow to the tubes instead of the usual bottom-to-top countercurrent flow. Directed by baffles, the salt moves at high velocity, thus providing better heat transfer. Conventional processes also vary the temp of the salt bath to control the reaction temp. The Rheinstahl reactor uses a computerized system that regulates reaction temperature by changing the feedstock to air ratio, a technique which is more direct, simple and efficient. The desired feedstock/air ratio is maintained by means of a semi-conductor that senses the oxygen content of hte air stream and accordingly increases or decreases the amount of feedstock injected into the air. Reactors of this type can be built with as many as 16,000 tubes, equivalent to a single stream capacity of 25,000 metric tons of PA per annum
Throughput:	Feed contains 90% o-xylene with oil and water

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Data likely comes straight from manufacturer, but source is just a process description of a new method of producing PA.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Company that devised method is French or German, both OECD countries.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains process information and specific data about unit operations but not other meta-data.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

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:	Annual capacity of BASF Canada Cornwall Ont: 40,000 tonnes
Throughput:	Feedstock type/source, maximum throughput: purchased, 1.38 MMm^3/d
Comments:	Process used for production of PA is Von Heyden Chemiebau

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Not frequently used sources but report uses high quality data of Canada's petrochemical census.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Canada, an OECD country.
	Metric 3:	Applicability	High	Data is for production of PA, an in-scope use.
	Metric 4:	Temporal Representativeness	Low	Data is from 1979, over 20 years old
	Metric 5:	Sample Size	Low	Data not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Documents results but underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination **Low**

Study Citation:	APR, (2020). U.S. post-consumer plastic recycling data.
HERO ID:	11360400
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	"In 2020, a minimum of 4,803.8 million pounds of post-consumer plastic material sources in the U.S. was recovered for recycling in the categories of Bottles (by resin), Non-bottle Rigids, Film, and Other Plastics (excluding foam)."
Life cycle description:	% of total recovered for recycling: All bottles: 57.1%PET Bottles: 36.8%HDPE Bottles: 19.6% PP & Other Bottles: 0.7%Non-bottle Rigids: 22.0%Film: 20.5%Other Plastics: 0.3%

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 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	Medium	Variability addressed by describing amounts of recycled products for several categories but uncertainty is not addressed.

Overall Quality Determination **High**

Study Citation:	Aremco, (2023). Safety Data Sheet (SDS): Crystalbond 509-1, 509-2, 509-3.
HERO ID:	6301593
Conditions of Use:	Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	60 - 90%
Physical form:	Solid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation:	Bader,, Scott (2018). Safety Data Sheet (SDS): Crystic Roof Resin.
HERO ID:	6301578
Conditions of Use:	Paints/coatings (epoxy resin)

EXTRACTION

Parameter	**Data**
Chemical concentration:	Less than or equal to 0.3%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation:	Bhat, G. R., Gupta, S. K. (2008). MO optimization of phthalic anhydride industrial catalytic reactors using guided GA with the adapted jumping gene operator. Chemical Engineering Research and Design 86(9):959-976.
HERO ID:	5160515
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	Phthalic anhydride (PA) is used widely in industry for the production of a large variety of products. It is used as chemical intermediates in the production of plastics from vinyl chloride, and for the production of polyester resins, plasticizers, dyes, insect repellants, etc.
Process description:	PA is produced by the gas-phase catalytic oxidation of o-xylene or naphthalene, or a mixture of both. Mixed oxide catalysts, mainly consisting of V2O5 and TiO2 and packed in several zones in a multi-tubular reactor, are used for oxidation. The gas leaving the reactor is cooled in one set of 'switch' condensers. The PA solidifies on the finned tubes. The solidified PA is melted and collected from these during the heating cycle, during which the exit gas from the reactor is sent to the other set of cooled switch condensers. The treated gas is then either scrubbed with water, or catalytically or thermally incinerated (Ullmaan, 1992).

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	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	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	N/A	Information is all 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	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation:	BMI, (2010). Japan petrochemicals report 2010.
HERO ID:	5585660
Conditions of Use:	Manufacturing - importing/exporting

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Japans petrochemical exports from 2004-2008 in tonnes: 73,482; 66,048; 30,224; 24,527; 28,742. Japan's petrochemical imports by product, 2004-2008 in tonnes: 2; 1,188; 31.99; 2,073; 2,185

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report is Japan's petrochemical report. Not a frequently used source but would contain high quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for Japan, an OECD country
	Metric 3:	Applicability	High	Data is for production volume of PA.
	Metric 4:	Temporal Representativeness	Medium	Data is greater than 10 years old
	Metric 5:	Sample Size	Medium	Characterized by a range.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Does not state what industries are using the chemicals, how they are produced or any information beside the production volume.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Address variability by showing data from 2004 - 2008. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	BMI, (2011). Malaysia petrochemicals report 2011.
HERO ID:	5703347
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	BASF: Produced alongside multiple other chemicals: acrylic acid and esters, syngas, butyl acrylate, oxo-alcohols, phthalic anhydride and plasticizers, butanediol, etrahydrofurane, gamma-butyrolactone - 550,000 tonnes per annum; Petronas: 40,000 tonnes per annum

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Data is not from frequently used sources but is high quality.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is for Malaysia, a non-OECD country.
	Metric 3:	Applicability	High	Condition of use is for production and manufacturing
	Metric 4:	Temporal Representativeness	High	Data is just under 10 years old.
	Metric 5:	Sample Size	Low	Data not characterized by statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Report documents results and generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability.

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:	Paints and coatings

EXTRACTION

Parameter	**Data**
Process description:	In the industrial setting, paints can be applied to parts by brush, roller, dip, flow, curtain, tumbling, spray, and powder coating. Spray painting by air atomization is the most common application method encountered in industry and presents the principal hazards. Here, paint is conveyed from a paint reservoir by either siphon pickup created by airflow or a pressurized system. Compressed air atomizes the paint at the nozzle to form droplets or mist, releases the droplet cloud from the gun and conveys it to the workpiece. During powder coating, the fluidized powder is conveyed through a corona discharge where the powder particles pick up a negative charge. They are then directed by the electrostatic field to the grounded workpiece and deposit a uniform coating.
Throughput:	A 6-in wide brush may use 7 gallons of paint per day. A 9-in roller may use 14 gal/day, and air spray use varies from 10-70 gal/day.
Chemical concentration:	Powder paints contain 50-60% resin and hardener, 50-40% pigments and fillers, and 1-2% additives.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Assessment uses high quality methods 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	Data are for the use of paints and coatings, but are a general model, and not for one specific 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	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	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 paint application techniques. Uncertainty isn't addressed.

Overall Quality Determination — High

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:	Processing

EXTRACTION

Parameter	**Data**
Life cycle description:	The primary use of phthalic anhydride (PA) is as a chemical intermediate in the production of plastics from vinyl chloride. Phthalate esters, which function as plasticizers, are derived from phthalic anhydride. Phthalic anhydride has another major use in the production of polyester resins and other minor uses in the production of alkyd resins used in paints and lacquers, certain dyes (anthraquinone, phthalein, rhodamine, phthalocyanine, fluorescein, and xanthene dyes), insect repellents, and urethane polyester polyols. It has also been used as a rubber scorch inhibitor and retarder (HSDB, 1995; National Cancer Institute (NCI), 1979).

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Information does not indicate flaws or quality issues.
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	More than 20 years old.
	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	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:	Cardno ChemRisk, (2020). Phthalic anhydride risk management limit project [redacted].
HERO ID:	12980189
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Phthalic anhydride exists as part of a group of other anhydrides typically referred to as cyclic acid anhydrides. PA is a manufactured as a commercial product that is produced from xylene. At a facility, o-xylene arrives at the production facility via barges where the chemical flows through a series of blowers, evaporators, convertors, coolers, combustors, and condensers. Crude PA then flows from the condensers through a heater, pretreaters, distillation columns, coolers, and finally to storage tanks. Pure PA (>99.95%) is loaded onto either railcars or tractor-trailer tanks. At different steps along the process of PA production, PA exists in either a solid or a liquid state. Upon contact with atmosphere, PA condenses and forms a fluffy white crystalline solid.
Comments:	Source is redacted/edited it appears to hide identifiable information. Relevant information is available though and not redacted/edited.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Sampling method is not stated.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from the US.
	Metric 3:	Applicability	High	Data is applicable to in-scope use.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	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	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: 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:	Paints and coatings, Ink, toner, and colorant products

EXTRACTION

Parameter	**Data**
Throughput:	Typical maximum daily usage, based on sector knowledge,100 kg product/day at any one locationPigment/extender/filler - 10 kg/dayBinder - 10 kg/dayOrganic solvent/coalescent - 45 kg/dayAdditives - 0.50 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 specific to the chemical.
	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:	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:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Phthalic anhydride is produced through conversion of o-xylene or naphthalene in a tubular reactor with an air/HC (mass) ratio of 10/1 to 22/1.

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.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to 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	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	Information is qualitative
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:	CPSC, (2010). Toxicity review of di(isodecyl) phthalate.
HERO ID:	2841367
Conditions of Use:	Processing: Plastic material and resin manufacturing

EXTRACTION

Parameter	**Data**
Process description:	DIDP is created from a reaction of phthalic anhydride and isodecyl alcohol with an acid catalyst.

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 (Consumer Product Safety Commission document).
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 source is discussing an occupational scenario within the scope of the evaluation.
	Metric 4:	Temporal Representativeness	Medium	Greater than 10 years old, but not over 20.
	Metric 5:	Sample Size	N/A	No sample data (process description).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Memo clearly documents sources, but does not indicate which source provided the extracted information.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Process description.

Overall Quality Determination High

Study Citation: Curran, M. A., Turner, R. J. (1988). Incineration of three RCRA wastes at the U.S. EPA's combustion research facility (CRF).
HERO ID: 5177408
Conditions of Use: Disposal - incineration

EXTRACTION

Parameter	Data
Process description:	During the production process, K024 is poured directly into 55-gall on drums (at 250 deg C) where it cools and solidifies. The head space which is created upon contraction of the cooled material is filled with "flaked" K024. Flaking is achieved by slowly pouring the hot K024 stream onto a water-cooled stainless steel conveyor belt and using hand-held hammers to break the solidified K024 into small pieces. (K024 stands for PA production waste).Table 2 presents the design characteristics of the CRF's rotary kiln system. Figure 1 shows the system's general configuration. A ram feeder was used to inject 1.5-gallon cylindrical fiber packs containing the feed material into the kiln chamber. The kiln's design temperature is 1,000 deg C (1832 deg F). The feed rate was controlled by the ram feed operator and was occasionally adjusted as temperature and carbon monoxide (CO) levels were monitored. The hot combustion gases from the kiln pass through an afterburner for further incineration. The afterburner design temperature is 1200 deg C (2200 deg F) with an approximate 2-second residence time. Both the kiln and afterburner use propane for start up fuel, and as supplementary fuel when required, during a waste burn. The gases leaving the afterburner enter a venturi scrubber, followed by a packed tower, a carbon bed, and a high-efficiency particulate air (HEPA) filter in series (Figure 1). The carbon and HEPA filter are required by Arkansas since the CRF is an experimental facility and may not always be operated at optimum conditions. Sodium hydroxide is added to the scrubbing system (venturi and packed tower) to maintain a pH greater than 7. Makeup water is added at a rate of 5 to 10 gallons per minute, and the water system is blown down continuously at a rate of 2.0 to 2.5 gallons per minute.
Throughput:	3 tests were conducted with waste feed rates of 53 lb/h and the other two tests were 108 lb/hr.
Chemical concentration:	Major constituents in the sampled K024 (waste of PA production) is: 5% PA, 10% ash, <1% water, <1% other constituents, and 83% polymeric materials

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by EPA so likely accurate.
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	Controlled study for PA release from incinerator but can likely be applied to other sites that use a similar method.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics, lots of data is qualitative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides release media, waste treatment method and activity causing it.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Dempsey, C. R., Thurnau, R. C. (1991). Pilot-scale evaluation of incinerating listed wastes from specific sources. Water Science and Technology 24(12):255-265.
HERO ID:	5177794
Conditions of Use:	PA manufacturing - disposal of waste

EXTRACTION

Parameter	**Data**
Life cycle description:	The production of PA via the vapor-phase oxidation of naphthalene generates a distillation bottom waste which is contaminated with PA and defined as K024. This material was a greyish-black solid with a relatively high specific gravity (1.71). Here four 55-gallon drums of this waste were shipped to EPA incineration testing site and used as the feed material for three individual incineration tests.
Process description:	All tests were conducted in the Incineration Research Facility (IRF) rotary kiln system (RKS) and a simplified schematic is given in Figure 1. The system consisted of a primary combustion chamber, a transition section, fired afterburner chamber, primary air pollution control system, a redundant air pollution control system, and discharge to the atmosphere through an ID fan and stack. Kiln temp: 981 C (974 C - 1037 C); Afterburner temp: 1110 C (1099 - 1124 C); feed rate 39.6 kg/hr (23.5 - 47.7 kg/hr); afterburner exit oxygen conc.: 5.0 %
Throughput:	Characteristics of Kiln Main Chamber: Solids retention time: 1 hr (at 0.2 rpm). Characteristics of afterburner chamber: Gas residence time - 1.2 to 2.5 sec depending on temp and excess air. Characteristics of the air pollution control system - inlet gas flow: 1.07 m^/min at 1200 C and 101 kPa. Liquid flow - venturi scrubber: 77.2 L/min (20.4 gpm) at 69 kPa; Packed column - 116 l/min (30.6 gmp) at 68 kPa. PA had an average feed concentration of 141,000 mg/kg or 14.1%.
Chemical concentration:	Distillation bottom waste had a low ash (7.4%) and moisture (0.5%) content and fuel value with a higher heating value of 22.2 MJ/kg
Comments:	Phthalic anhydride assigned hazardous waste number K024. Various EPA methods are stated to be used. Semivolatiles analyzed by EPA Method 8270. Volatiles by Method 8000. Samples of packed tower scrubber exit gas volatiles collected by Method 0030 and analyzed by Method 8000. Samples for the semivolatile collected using modified Method 5, Method 0010, and analyzed Method 3540 and Method 8270. Method 5 used for particulate conc.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by EPA so methodology likely to be accurate.
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 is applicable to disposal methods that would exist or be used for PA manufacturing.
	Metric 4:	Temporal Representativeness	Low	The report 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	Low	The report does not address variability or uncertainty.

Overall Quality Determination — Medium

Study Citation:	DOE,, WA (2020). Priority consumer products report to the Legislature: Safer products for Washington implementation phase 2.
HERO ID:	10454465
Conditions of Use:	Plastic and rubber products

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Recent national estimates of the sales of resilient flooring, a category of flooring comprised largely of types of vinyl flooring, range from \$3.68 billion in 2016 (Floor Covering Weekly, 2017) to \$4.5 billion in 2019 (Resilient Floor Covering Institute, 2019), the lower amount corresponding to 4.27 billion square feet.
Life cycle description:	Phthalates are used in vinyl flooring, also known as polyvinyl chloride (PVC) flooring, to soften plastic and increase flexibility and durability.
Chemical concentration:	It was estimated that over half of vinyl flooring may contain phthalates at concentrations ranging from 9 to 32% by weight. In 2014, a study of 16 types of vinyl flooring found concentrations of phthalates ranging from 9 – 23% of the flooring by weight (Liang & Xu, 2014).

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	Medium	The report is for an occupational scenario within the scope of the risk evaluation but data is not chemical specific.
	Metric 4:	Temporal Representativeness	High	The report 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	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 concentrations from different literature sources but uncertainty is not addressed.

Overall Quality Determination **High**

Study Citation:	Dong, H., Jiang, L., Shen, J., Zhao, Z., Wang, Q., Shen, X. (2019). Identification and analysis of odor-active substances from PVC-overlaid MDF. Environmental Science and Pollution Research 26(20):20769-20779.
HERO ID:	5432879
Conditions of Use:	Lab study - can be applied to processing using PVC and adhesives.

EXTRACTION

Parameter	**Data**
Process description:	Table 1 has basic production parameters of PVC-overlaid MDF. Panel type: PVC-overlaid MDF; Density: 0.74 g/cm^3; Hot pressing temp (C): 190; Hot pressing time (s): 60-80; Adhesive: urea formaldehyde adhesive; Glue amount: surface layer: 11%, Core layer: 9%.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so sampling and analytical methodology is likely very accurate
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source published and conducted for European chemical society so likely OECD country conducted.
	Metric 3:	Applicability	Low	Data is not for an occupation scenario but has information that can be used to determine airborne exposure data of production of PVC-overlaid MDF
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2019)
	Metric 5:	Sample Size	Medium	Characterized by range of data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Lab study provides parameters of sampling time, sampling frequency, release source and emission factors.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling across multiple days, does not address uncertainty.

Overall Quality Determination	**Medium**

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**
Production, import, or use volume:	No production or use volume for PAD.
Number of sites:	Port Arthur: 2 sitesHouston: 13 sitesMossville: 1 siteCancer Alley: 6 sites

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Number of sites gathered from Toxics Release Inventory reporting.
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 is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Discrete release data provided.
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 evaluating the number of sites throughout different regions. However, uncertainty in not characterized.

Overall Quality Determination **High**

Study Citation:	ENF, (2024). Plastic recycling plants in the United States.
HERO ID:	11360395
Conditions of Use:	Recycling

EXTRACTION

Parameter	**Data**
Number of sites:	59 plants in the U.S. recycle plastics into various forms, including granules/pellets and flakes. The document lists all plants along with hyperlinks to their address and other metadata.

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 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	N/A	N/A - number of sites.
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 - number of sites.

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: Plastic Product Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Solid and foamed plastic products are manufactured by a variety of methods. The choice of manufacturing techniques used to process a plastic product depends largely on whether the resin is a thermoplastic or thermoset, and the dimensions, shape, or physical qualities of the desired product. Extrusion is the most widely used processing technique, followed by injection molding, blow molding, and foam processing. These four manufacturing techniques, in addition to lamination, coating, and finishing operations, are described in detail in the paper. (11/72)

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	Medium	The release data are for an occupational scenario within the scope of the risk evaluation, but data is general and not chemical-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	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	Process description.

Overall Quality Determination High

Study Citation: Fawcett, R. L. (1970). Air pollution potential of phthalic anhydride manufacture. Journal of the Air Pollution Control Association 20(7):461-465.
HERO ID: 28937
Conditions of Use: Manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	Combined capacity which was estimated at 650 million lbs per year for 1961 can reasonably be expected to be near one billion two hundred million pounds by 1970 when planned new facilities come on line. Individual plant capacities will likely range from 30 to 130 million pounds per year. More than 90% of the phthalic anhydride being produced is used for alkyds and polyesters, and phthalate plasticizers.
Process description:	Phthalic anhydride is produced by the vapor phase oxidation of naphthalene or, more recently, o-xylene, catalytically with excess air in fixed or fluid bed converters. Stoichiometric conversion of the reactants with the oxygen from the air would be: C10H8 (naphthalene) + 4.5 O2 (oxygen) –> C6H4<<CO>2>O (phthalic anhydride) + 2CO2 (carbon dioxide) + 2 H2O (water); C6H4(CH3)2 (o-xylene) + 3 O2 (oxygen) –> C6H4<<CO>2>O (phthalic anhydride) + 3 H2O (water); Block diagram in figure 1 illustrates the basic manufacturing process. Naphthalene or o-xylene is pumped from storage to an evaporator where it is vaporized and mixed with preheated air. The carefully controlled gas-vapor mixture is fed into the catalytic converters (reactors) where the desired partial oxidation to phthalic anhydride takes place. In the case of fluid bed processing, the feed stock and air are mixed in the converter itself. Under rather specific conditions of temperature and contact time, optimum yields are achieved with minimum production of unwanted by-products. The catalyst will be some form of vanadium pentoxide with proprietary modifiers, supported on various types of inert bases suitable for use in either the fixed or fluid bed systems. The oxidation is accompanied with a substantial heat release which is used for the production of process steam at the reactors. Additional steam is also generated in the subsequent gas coolers. The process vapors then pass from the coolers to a condensing system where crude anhydride product is separated from the process air stream. It is this process air leaving these condensers that, by far, offers the greatest potential for an air pollution problem. A few "fixed bed" plants recover the crude product by direct water scrubbing to produce a crude phthalic acid slurry. No new plants during recent years have been built using this recovery approach because of the favorable economics associated with the new dry recovery (condensation) processes being marketed. Crude molten product from dry recovery is collected in storage tanks from which it is fed after a heat-aging treatment to refining stills for purification. Refined product is stored molten for tank car or tank truck shipment, or for flaking for sale in bags. Residue is dropped batchwise from the stills for solid waste disposal. Aside from the noted large volume process off-gas, smaller sources of emission include the raw material and product storage tank vents, crude product treater vents, jet exhausts on the vacuum refining stills, residue dumping, flaking and bagging exhausts, and material transfer to and from tank cars and trucks.
Number of sites:	Table 1 provides all manufacturing sites of PA. 17 locations, some may be out of date due to how old the source is.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Reported data appears to be of high quality and do not indicate errors. Source is peer reviewed.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for the US.
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use for manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (from 1970)
	Metric 5:	Sample Size	Low	Qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides process description, use volume, and number of sites.
Domain 4: Variability and Uncertainty				

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Study Citation: Fawcett, R. L. (1970). Air pollution potential of phthalic anhydride manufacture. Journal of the Air Pollution Control Association 20(7):461-465.
HERO ID: 28937
Conditions of Use: Manufacturing

EVALUATION

Domain	Metric		Rating	Comments
	Metric 7:	Metadata Completeness	Medium	Addresses variability by production capacity over the course of a few years. Does not address uncertainty.

Overall Quality Determination Medium

Study Citation:	Gimenez, E. R., Rodriguez, C. A., Capone, L. (1990). Potential human exposure resulting from the chemical industry in Argentina. :75-78.
HERO ID:	4222410
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Information in thousands of tons for Argentina. 1983 - 20.4; 1984 - 18.9; 1985 - 17.0; 1986 - 25.0; 1987 - 30.2; Nominal annual capacity: 24.4. In the paint, varnish, and lacquer industries, 157 establishments employ 5600 workers. About 3.2% of the companies produce 54% of the total production and the remainder is generated by small and medium-sized businesses.
Number of sites:	Estimated that 144,604 people work in 6600 chemical businesses.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data that is from Argentina but does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from Argentina, a non-OECD country
	Metric 3:	Applicability	High	Report is directly applicable to a condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	Medium	Characterized by individual total production volumes for each year.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Report provides results, but underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by showing data over the course of a few years. Does not address uncertainty.

Overall Quality Determination — Low

Study Citation:	Graham, J. J. (1970). Fluidized bed phthalic anhydride process. Chemical Engineering Progress 66(9):54-58.
HERO ID:	5178930
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Phthalic anhydride is produced by the partial oxidation of either naphthalene or orth-oxylene in the presence of a vanadium catalyst. In the U. S., the majority of plants running naphthalene as feed utilize a fluidized catalyst bed for the reaction. The fluid bed reactor has many distinct advantages over a fixed bed reactor; liquid feed can be directly injected into the reactor, and the system can be operated within the flammability limits. The process sequence is illustrated in Figure 1. Liq uid naphthalene is pumped from tankage directly into the reactor at the bottom of the catalyst bed. Provision is made for adequate dispersion of the liquid as it enters the catalyst bed, and then the rapid movement of the catalyst particles causes further dispersion as the naphthalene is vaporized and oxidized to phthalic anhydride. The fact that the naphthalene tars can be burned in the reactor eliminates the need for a vaporizer with its attendant accumulation of pyrophores. Reaction air is introduced below the reactor distribution grid and aerates the fluidized catalyst. Because of the high degree of agitation and mixing within the fluid bed, a uniform temp is assured throughout the reaction zone. The range of bed temperatures is 340-380 C; however, the actual operating temperature is controlled within narrow limits. Reactor pressure is set by the back pressure of equipment downstream. In the dilute phase of the reactor, a low concentration of catalyst is entrained by the reaction gases and carries from the reactor. The entrainment of catalyst is actually beneficial for it acts as an inert suppressant which permits the reaction system to operate just within the flammability limits. PA product is condensed as both a liquid and a solid from the effluent gases. Non-condensible gases are water-scrubbed or incinerated before venting to the atmosphere. The condensed crude PA is heat-treated, whereby certain by-products are polymerized to a non-volatile pitch. The mixture is then distilled under vacuum to reject volatile impurities and the non-volatile pitch, and to produce a finished product. Moderate pressure steam in the range of 100 to 400 lb/sq in gauge is generated in the reactor to remove the exothermic heat of reaction. Low pressure steam is produced by the recovery of waste heat from the reactor effluent condenser. Throughout the process, pressure relieving devices are used to protect the vessels in accordance with standard phthalic anhydride plant practice. High temp alarms or shutdowns are provided in the reactor and condensers to preclude the possibility of an unnoticed runaway reaction. The safe operation of these plants over many years illustrates the fundamental safety of the fluid bed process.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data and sound methods but is not from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from US.
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by any statistics, just a process description.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Report documents results, and assumptions. Sources are provided and likely come directly from manufacturer. Provides process description, unit operations, process diagram.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

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Study Citation:	Graham, J. J. (1970). Fluidized bed phthalic anhydride process. Chemical Engineering Progress 66(9):54-58.
HERO ID:	5178930
Conditions of Use:	Manufacturing

EVALUATION

Domain	Metric	Rating	Comments
Overall Quality Determination		**Medium**	

Study Citation:	Heitbrink, W. (1993). In-depth survey report: Control technology for autobody repair and painting shops at Team Chevrolet, Colorado Springs, Colorado.
HERO ID:	6558535
Conditions of Use:	Commercial use - spray painting.

EXTRACTION

Parameter	**Data**
Process description:	Autobody shop is located in a two-story building. Before the cars are painted, structural damage to the cars is repaired on the upper level of the shop which is illustrated in the article. This involves the repair and replacement of damaged parts. Workers may be exposed to aerosols from sanding, grinding, and welding. Shop does some restoration of automobiles. After structural damage repair, they are prepared for painting. This involves sanding, washing, and covering parts of hte vehicle that are not being painted with either paper or plastic. After the car has been painted, defects in the paint job are removed by buffing. In the upper level of the shop, vehicle preparation is done next to the spray painting booth. Lower level is illustrated in the article. Spray painting booths in the upper level were Trimatic cross draft spray painting booths. Air is supplied and exhausted through filters that are mounted in plenums (described in article). Filters are changed every four to five weeks. Before some painting jobs, the filters are wetted down with water which likely reduces air flow until the filters dry off.

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	Medium	The report is for an occupational scenario within the scope of the risk evaluation, but does not specifically mention phthalates.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative 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	Process description of spray painting, no need to address uncertainty or variability.

Overall Quality Determination **High**

Study Citation:	Heitbrink, W., Cooper, T., Edmonds, M., Bryant, C., Ruch, W. (1993). In-depth survey report: control technology for autobody repair and painting shops at Valley Paint and Body Shop, Amelia, Ohio.
HERO ID:	6558536
Conditions of Use:	commercial use - spray painting

EXTRACTION

Parameter	**Data**
Process description:	Autobody shop. Before the cars are painted, structural damage to the cars is repaired elsewhere in the shop. This involves the repair and replacement of damaged parts. During these activities, the workers may be exposed to aerosols from sanding, grinding, and welding. For some jobs, abrasive blasting with sand that contains crystalline silica is used for paint removal. This abrasive blasting was conducted in the open. After the cars have been repaired, they are brought to the paint shop that is shown in the article. There is some sanding of areas to be painted. Parts of the car which are not to be painted are protected with masking. The car and autobody parts are painted in either the spray painting booth or in the vehicle preparation station. Generally, the vehicle preparation station is used only for small paint jobs or for primer painting. Both the vehicle preparation station and the spray painting booth were manufactured by Garmat Inc. Vehicle prep station shown in article how two pays. Bays are separated by moveable cloth curtains that were suspended from rods in the ceiling. Each bay exhausts air through 3 filters in the back of the vehicle preparation station. Spray painting booths have 2 painting cycles. During the painting cycle, outside air is passed through a series of filters. The final set of filters cover the entire ceiling of the spray painting booth. A nominal 12,000 cfm of air flows out of the ceiling around the car or object being painted and out of the booth through exhaust grates located in the floor of the booth. Booth is 23 ft long, 13 ft wide and 9 ft high. Air is exhausted through a 2 ft wide, rectangular slot in the floor that is 17 ft by 6 ft. After the car or body part has been painted, the worker leaves the booth and the paint is cured at a temp between 120 and 140 F. during this period, the airflow in the booth is reduced and about 80 percent of the air flow in the booth is recycled.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study conducted by NIOSH.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	Data is likely for an in-scope of use which is paints and coatings, however the study does not mention PA or phthalates in this source.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	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	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: Henkel, (2023). Safety Data Sheet (SDS): LOCTITE 426 BLACK INSTANT ADHESIVE known as 426 Prism® Black Max® Gel Inst.
HERO ID: 6301570
Conditions of Use: Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1-1%
Physical form:	Gel

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation: Henkel, (2023). Safety Data Sheet (SDS): Loctite 4105.
HERO ID: 6301581
Conditions of Use: Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - < 1%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation: Henkel, (2018). Safety Data Sheet (SDS): Loctite 435 Rubber Tough. Inst ADH known as Loctite 435 Instant Adhesive.
HERO ID: 6301583
Conditions of Use: Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - 1%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation:	Hernon, (2020). Safety Data Sheet: Instantbond 120.
HERO ID:	6301618
Conditions of Use:	Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - 1 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination	**High**

Study Citation:	Hernon, (2016). Safety Data Sheet (SDS): Hernon Instantbond 122.
HERO ID:	6301650
Conditions of Use:	Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - 1 wt%
Physical form:	Liquid - gel

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation:	Hines, C. J., Hopf, Nilsen, N. B., Deddens, J. A., Calafat, A. M., Silva, M. J., Grote, A. A., Sammons, D. L. (2009). Urinary phthalate metabolite concentrations among workers in selected industries: A pilot biomonitoring study. Annals of Occupational Hygiene 53(1):1-17.
HERO ID:	1005742
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	In phthalate manufacturing, DMP, DEP, DBP and DEHP were manufactured in batch or continuous processes by the addition of alcohols to phthalic anhydride in the presence of a catalyst. Operators could be exposed while taking or analyzing in-process samples or while performing maintenance.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely does not contain errors in analytical techniques.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is from USA.
	Metric 3:	Applicability	High	Data in source is directly applicable to conditions of use.
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old.
	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	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:	Hughes, T. W., Jefcoat, I. A. (1979). Phthalic anhydride plant air pollution control. :394-404.
HERO ID:	5177569
Conditions of Use:	Domestic manufacturing

EXTRACTION

Parameter	**Data**
Process description:	PA is manufactured by the catalytic vapor-phase oxidation of either o-xylene or naphthalene. A schematic flow diagram for phthalic anhydride production is shown in Figure 1. Feedstock (o-xylene or naphthalene) and air are fed to reactors which use vanadium pentoxide catalyst. Plants using o-xylene as feed stock utilize fixed bed reactors while naphthalene-based plants use fluidized bed reactors. Reactor product gases are cooled. In naphthalene-based plants this cooling partially condenses the PA. PA is recovered from the reactor product gases in switch condensers. The off-gas from the switch condensers represents a potential air pollution problem. Table 1 shows the composition of the switch condenser off-gas for both o-xylene-based and naphthalene-based PA plants. On a mass basis, the o-xylene process emits 150% more organic material than does the naphthalene-based process; it also emits 200% more carbon monoxide than does the naphthalene-based process. Total losses of PA and maleic anhydride are 480 kg/hr and 200 kg/hr for the o-xylene and naphthalene-based processes, respectively.
Chemical concentration:	Current industry practice in study had 96.5% PA removal, new control methods need to achieve 99%.

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	The report 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	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	Addresses variability by looking at multiple pollution control methods to achieve 99% efficiency. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	International Paint Ltd, (2016). Safety Data Sheet (SDS): Interlac 665 Vermelho Seg 5F4/14.
HERO ID:	6301649
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	1 - 10 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation:	Kozlowski, R. R., Storzum, U. (2005). Di(2-propylheptyl) phthalate: A new plasticizer choice for PVC compounders. Journal of Vinyl and Additive Technology 11(4):155-159.
HERO ID:	6825436
Conditions of Use:	Processing - Production of Plasticizers

EXTRACTION

Parameter	**Data**
Life cycle description:	A major consumption of C10 alcohol is for esterification with phthalic anhydride to produce a phthalate ester used in the production of flexible PVC compounds. Trimethylheptanol, commonly known as isodecanol, is esterified to diisodecyl phthalate, whose acronym is DIDP. The 2-propyl heptanol ester has been assigned the acronym DPHP.

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 report is 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 more than 10 years old but no more than 20 years old.
	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	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	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Lee, S., Park, S., Kong, M., Kim, Y. S. (2020). A new compact AMS facility at the Dongguk University. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 465:15-18.
HERO ID:	6825139
Conditions of Use:	Use - Laboratory Chemical

EXTRACTION

Parameter	**Data**
Process description:	"Phthalic acid is used as a blank sample in accelerator mass spectrometry. This is a way to analyze solid 14C samples with a graphitization process that converts the original sample material into graphite. The system includes an element analyzer (EA) and a reduction system. The EA burns standard samples with O2 at 1800 °C. The EA produces CO2 from the samples, which include water vapor. The water vapor is eliminated using Mg(ClO4)2. Because of the combustion, CO2 is trapped with liquid nitrogen (LN2) in each line in the reduction system. Using H2 and Fe powder, the trapped CO2 is reduced to graphite at pressures as low as 10−5 mbar (1 mPa) and a temperature of 650 °C. The Fe powder requires a preheating process to remove the carbon absorbed during storage prior to the graphitization process. This pre-heating process involves oxidation with O2 to remove carbon from the Fe and reduction with H2 to remove O2 from Fe at 560 °C. The H2 is generated by an H2 generator. As the reduction system contains five lines to reduce CO2, the graphitization system can reduce five samples simultaneously. Completing the reactions for five samples requires approximately 5 h."

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 Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for use as a laboratory chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	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	High	All data sources, methods, results, and assumptions are clearly documented.
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 **High**

Study Citation:	Li, X. (2018). Chemical emissions from plastic manufactured in water infrastructure.
HERO ID:	5489083
Conditions of Use:	Maintenance and repair - resin manufacturing

EXTRACTION

Parameter	**Data**
Process description:	In the U.S., cured-in-place-pipe (CIPP) is a popular trenchless technology used for sanitary sewer pipe and storm water culvert repair. This technology involves the creation of a new plastic pipe inside an existing damaged host pipe, which is often buried underground. The in-situ process can require minimal excavation thereby avoiding roadway shutdowns, and the new plastic pipe can sometimes be placed into service shortly after manufacture. CIPPs are manufactured onsite using either thermal curing (hot water or steam) or photo curing (UV light) methods.
Chemical concentration:	Resin tube layer composition (mg/g): 1st layer - none; 2nd - 0.274 +/- 0.036; 3rd - 0.175 +/- 0.021; 4th - 0.176 +/- 0.017; 5th: 0.402 +/- 0.000; 6th - none.
Comments:	Says 6th layer is coated with PA but chemical composition does not list any data for PA conc. at 6th layer. Marked for process description but only states small differences between the process of CIPP systems.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Study is not peer reviewed but appears to contain high quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	Data is close to an occupational scenario such as resin manufacturing but appears to be a somewhat unorthodox method of this type of manufacturing since it is maintenance and repair.
	Metric 4:	Temporal Representativeness	High	Less 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	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:	Liss, G. M., Albro, P. W., Hartle, R. W., Stringer, W. T. (1985). Urine phthalate determinations as an index of occupational exposure to phthalic anhydride and di(2-ethylhexyl)phthalate. Scandinavian Journal of Work, Environment and Health 11(5):381-387.
HERO ID:	63766
Conditions of Use:	Manufacturing, Processing

EXTRACTION

Parameter	**Data**
Process description:	The PA and DEHP production areas in the study plant are located out-of-doors and are monitored from a common, enclosed control room. PA is produced from a reaction of o-xylene with air. DEHP is produced in an adjacent area by a continuous-flow operation involving the esterification of 2-ethylhexanol with PA in the presence of a catalyst (figure 2). Approximately 30 11/0 of the PA produced at the plant is used on-site in the production of DEHP, while the remainder is pumped to tank cars and trucks and sold for use elsewhere. In 1981 , a batch ester plant (BEP) came on-line at this site. The plant has the capacity to produce DEHP and other phthalates. Processes for the production of DEHP in this plant are essentially identical to those used in the PA/DEHP plant, except that they are batch in nature rather than continuous. In addition to the shift supervisor, four operators work each shift in the PA/DEHP plant, two on the DEHP side and two on the PA side. Due to the close proximity of the PA and DEHP production areas, both PA and DEHP chemical operators and maintenance workers may be exposed to DEHP and PA. The greatest potential for the exposure of operators to phthalates appeared to exist during sample acquisition, especially in the PA/DEHP plant, where sample ports are opened and flushed and sample containers are filled by hand. For the PA operators duties with the highest potential for exposure would include sample acquisition and occasional involvement in the dumping of the PA sublimator boxes. Tank farm operators are concerned primarily with loading tank trucks with DEHP and PA (resulting in multiple opportunities for exposures to both compounds). The use of respiratory protection is required, and local exhaust ventilation is utilized at the loading ports.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed and uses NIOSH analytical method(S-179)
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data 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	More than 20 years old.
	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	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:	Liss, G. M., Hartel, R. W. (1983). Health Hazard Evaluation Report No. HETA-82-032-1384, Badische Corporation, Kearny, New Jersey. NIOSH(HETA-82-032-1384):82-032.
HERO ID:	1334319
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Produces 100 million lbs/yr, approximately 10%-15% of the US production of PA (in 1981)
Process description:	Phthalic anhydride and DEHP production areas are located out of doors, with a common, enclosed control room. The PA production process reacts ortho-xylene with air in four reactors at 400 to 500 C in the presence of a catalyst. The PA is purified by passing through desublimators and two distillation columns. The light contaminants are distilled off in the first distillation column and include maleic anhydride and benzoic acid, which are incinerated. The second column removes the heavy, or crude contaminants, which are also incinerated. The plant is capable of production 100 million lbs/yr which is approximately 10%-15% of the current US production of PA. Tank Farm operators are primarily concerned with loading tank -trucks with DEHP and PA. This operation covers all shifts, with three Operators on the first shift, two on the second, and one on the third. The use of respiratory protection is required, and the loading ports are locally exhausted.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	NIOSH Report.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data 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	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	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:	LLC,, Finoric (2019). Material Safety Data Sheet (MSDS): Phthalic Anhydride.
HERO ID:	6301571
Conditions of Use:	Processing as a reactant (industrial manufacturing of hydraulic fracturing fluids)

EXTRACTION

Parameter	**Data**
Chemical concentration:	98 - 100%
Physical form:	Phthalic Anhydride is white to off-white flakes, granules, crystals, powder.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Manufacturer SDS expected to be accurate and without 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	High	SDS is from 2019, so less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Lord Corporation, (2020). Safety Data Sheet (SDS): Parker CoolTherm EP-6029 Epoxy Hardener.
HERO ID:	12974719
Conditions of Use:	Paints/coatings (epoxy resin)

EXTRACTION

Parameter	**Data**
Chemical concentration:	1 - 5%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination	**High**

Study Citation:	Lord Corporation, (2023). Safety Data Sheet (SDS): Parker VERSILOK 253S.
HERO ID:	12974720
Conditions of Use:	Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - 0.9%
Physical form:	Paste

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation: Lord Corporation, (2017). Safety Data Sheet (SDS): Lord EP-809 Hardener.
HERO ID: 6301654
Conditions of Use: Adhesives/sealants

EXTRACTION

Parameter	**Data**
Chemical concentration:	5 - 10%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Loveless, R. W., Atkins, J. R. (1961). Waste disposal planning using consultant's services at American Cyanamid's Bridgeville Pennsylvania plant. Engineering Extension Series, no. 106 :183-194.
HERO ID:	5177555
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Process description:	Principal products from this plant are phthalic anhydride made from naphthalene. End uses of the anhydride products and coating resins are in the paint industry.
Throughput:	Waste flow from the plant comes in at 2,300 gpm. The two waste treatment equalization tanks had a capacity of 54,000 gallons and turnover about every 2 minutes. The chemical mixing chamber had a capacity of 17,000 gpm.

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 the disposal of phthalic anhydride 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	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	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:	Malten, K. E., Zielhaus, R. L. (1964). Food and cosmetics toxicology. :59-70.
HERO ID:	5353572
Conditions of Use:	Processing - resin manufacturing

EXTRACTION

Parameter	**Data**
Life cycle description:	PA is used to create alkyd resins. They are polycondensates from dicarboxylic acids and polyalcohols; they are a particular type of polyesters, the saturated ones. They are chiefly applied as paint vehicles, they are mostly modified with fatty acids (drying or non-drying oils). As dicarboxylic acid, chiefly PA (o-benzene dicarboxylic acid anydride) is used; in some cases the unsaturated maleic acid anhydride is added in small quantities. As polyalcohols, mainly glycerol and in some cases pentaerythritol, dipentaerythritol or sorbitol are applied. Non-modified alkyd resins may be usesd as plastifiers; in this case adipic acid, sebacic acid, hexanetriol and butanetriol may also be used as modifying the alcohol components. Of the above mentioned compounds only the dicarboxylic acids involve industrial health hazards.
Process description:	PA is formed by catalytic (V2O5) oxidation of naphthalene. The resulting PA must be gathered from condensation chambers; the exposure to the compounds presents a real hazard. Several impurities may complicate the industrial pathology. Non-purified naphthalene may contain phenols, pyridine, anthracene, carbazol, phenanthrene, pyrocatechin; purification (up to 98%) takes place by melting and distillation. During the oxidation into PA several by-products may be formed: maleic anhydride, CO, naphthoquinone. Non-purified PA still contains 0.5% MA and 0.1-0.5% naphthoquinone; it is purified by refining and distilling at 200 C; purified PA contains less than 0.1% MA and 0.001% naphthoquinone. In some factories, mercury is used as heat transferring material. Moreover cracking of naphthalene may yield benzene and -CN compounds.
Chemical concentration:	Non-purified PA has 0.5% MA and 0.1-0.5% naphthoquinone. Purified PA contains less than 0.1% MA and 0.001% naphthoquinone.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so the sampled data used is likely accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Sampling data was conducted by non-OECD country.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	Low	Sample size uncertain.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains process information, exposure route, area data, but lacks other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination **Low**

Study Citation:	Manufacturing Chemists Association, (1956). Chemical Safety Data Sheet: Properties and essential information for safe handling and use of phthalic anhydride (commercial).
HERO ID:	5353592
Conditions of Use:	Manufacturing, processing - any type of handling of PA.

EXTRACTION

Parameter	**Data**
Chemical concentration:	Minimum conc. of PA dust which can form an explosive mixture with air is 0.015 oz per cu ft

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report uses high quality data from not frequently used sources but is an industry trade group for the Manufacturing Chemists Association.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to condition of use for manufacturing, processing, storage, or just generic handling of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1956)
	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	High	Addresses variability by providing handling methods for multiple stages of use for PA. Addresses uncertainty.

Overall Quality Determination	**High**

Study Citation: Mark, V.D., M. R., Sandefur, K. D., Durham, K. A. (2005). Paint. :1-24.
HERO ID: 9493552
Conditions of Use: Processing - Intermediate in paint and coating manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The manufacturing process [for Alkyds] involves the condensation polymerization of the oil with a branching polyol such as pentaritheritol and a carboxylate such as phthalic anhydride or dimethyl phthalate. The oligomerized material is usually dissolved in mineral spirits or an aromatic solvent. The alkyd resin-based coating dries first by evaporation, then it crosslinks by an oxidation, and is then catalyzed by chemical driers such as cobalt naphthenate.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The source uses high quality data from frequently used sources (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 source is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The source 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	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source clearly documents its data sources and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - Process Description

Overall Quality Determination High

Study Citation:	Mersiowsky, N. (2002). Long-term fate of PVC products and their additives in landfills. Progress in Polymer Science 27(10):2227-2277.
HERO ID:	6826007
Conditions of Use:	Disposal

EXTRACTION

Parameter	**Data**
Chemical concentration:	Phthalates make up 30% of generic PVC cable and 35% of generic PVC flooring.

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	The report is generally more than 10 years 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	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: Midwest Research Institute, (1984). Performance evaluation of full-scale hazardous waste incinerators - Volume I (excutive summary) contract no. 68-02-3177 (43).
HERO ID: 1269556
Conditions of Use: disposal - air/water releases.

EXTRACTION

Parameter	**Data**
Process description:	The incinerator is a commercial facility located in Ohio. It consists of a large, nearly rectangular combustion chamber and a rotary kiln as shown schematically in Figure C-1. There are four waste feed streams to the incinerator. Aqueous waste is fed continuously into the combustion chamber above the rotary kiln exit into the chamber. Liquid organic waste is fed continuously at the opposite end, below the gas exhaust duct that is near the top of that end of the chamber. The other two waste feeds are both drummed waste. Depending on the waste characteristics, some drums are sliced into sections and conveyed into the kiln. Other drums are placed in groups of four on metal ”sleds” and are conveyed through the combustion chamber, remaining in the chamber for about 4 hr. Normally, these latter drums are recycled back through the kiln after they have passed through the combustion chamber. This was not done during the tests because the test period was not long enough to encompass travel of drums through the combustion chamber and recycling them back through the kiln. The number of drums per hour fed to the chamber and kiln were four and an average of seven, respectively. No auxiliary fuel is used at this plant. Gases exiting the combustion chamber pass through a water quench section and two packed scrubbers with caustic addition to adjust pH. The gases then pass through a two-stage ionizing wet scrubber (IWS) and into the 200 hp induced draft fan that discharges into the stainless steel stack. All liquid effluents are recycled to the two ponds, with makeup provided by nearby lake water. Thus, the only effluent from the incinerator, other than the stack, is the ash discharged from the rotary kiln. Data showed that the combustion chamber temperature ranged from 1117 to 1154 C and the calculated residence time was 6.2 to 6.7 sec. Average heat input rate to the incinerator from all wastes was 74 x 10^6 BTU/hr. Waste feed rates monitored during the tests are summarized in Table C-4.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is a TSCA submission, conducted by 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	More than 20 years.
	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	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:	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

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Total Plastic Waste Managed in U.S. in 2019:PET: 5,986 ktHDPE: 7,910 ktPP: 8,189 ktLDPE/LLDPE: 15,139 ktPVC: 699 ktPS/EPS: 3,094 ktOther: 3,115 kt
Life cycle description:	Percentage of total plastic waste managed by category:PET: 14%HDPE: 18%PP: 19%LDPE/LLDPE: 34%PVC: 2%PS/EPS: 7%Other: 7%

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 disposal, an in-scope occupational scenario; however, the data are not chemical specific.
	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 discussing multiple types of plastic products but uncertainty is not addressed.

Overall Quality Determination **High**

Study Citation: Mohsenpour, M., Pazuki, M. M., Salimi, M., Amidpour, M. (2024). Optimized heat exchanger network design for a phthalic anhydride plant using pinch technology: A Maximum Energy Recovery approach with economic analysis. Results in Engineering 24:103438.
HERO ID: 12193389
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The production of PA involves controlling the oxidation of either naphthalene or o-xylene. The process employs a catalyst composed of titanium dioxide and vanadium pentoxide. To achieve optimal PA, the temperature of the reaction should be precisely controlled within a narrow range. The phase of reaction is the vapor phase, in which the reactor temperature is maintained between 380 and 400°C. due to being a highly exothermic reaction, multi-tubular reactors are utilized, and cooling is achieved using various heat transfer media. Among these, the heat transfer of themolten salt is commonly preferred.In the process, the mixture reaction enters the reactor—tubularcatalytic. To manage the heat of the reaction effectively, recirculation of molten salt is employed for heat removal from the reactor. Maintaining precise temperature control within the reactor is challenging using methods other than molten salt. Specifically, heat is transferred from the molten salt stream, which transitions from 377 to 375°C. This is achieved by integrating one or more single-level steam generators (such as VHP, HP, MP, and LP) or a combination of them. Therefore, a heat recovery steam generator (HRSG) that generates high-pressure steam can be utilized.Figure 1 is a process flowsheet of a phthalic anhydride unit.All located on PDF Page 3.
Comments:	Source is primarily about an energy efficiency study for heat exchanger(s) at a phthalic anhydride manufacturing plant.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Source appears to use high quality data and information that does not appear to indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Source is from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Source is for an in-scope use.
	Metric 4:	Temporal Representativeness	Medium	Source is from within the last 10 years however, the cited data is from between 10 and 20 years ago.
	Metric 5:	Sample Size	N/A	Source is only about a process description
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source clearly documents its data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Source addresses variability by citing multiple sources when it comes to information regarding the process. Does not address uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Morris, L., G.D. (1996). Phthalic anhydride - Koppers and Stepan-Reichhold join Aristech in expansion race. Chemical Week 158(39):13-13.
HERO ID:	5179457
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Table contains capacities of PA at certain sites and their expected growth in capacity. 4 sites have no growth with capacities at 250, 215, 80 and 80 million lbs/yr. 3 sites have expected growth with 220, 180, and 175 million lbs/yr with expected growth of 90, 60 and 65 million lbs/yr respectively.
Number of sites:	7

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	Data sources / techniques are not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is directly applicable to production of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	N/A	Data has no statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Does not clearly document sources but provides results.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address uncertainty.

Overall Quality Determination **Low**

Study Citation:	(1998). Phthalic anhydride - Neste licenses new PA technology to Lonza. European Chemical News 69(1802):27-27.
HERO ID:	5178624
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	New PA ”post-reactor” technology increases plant capacity by 20% and extend catalyst life by 30%. Current capacity at the sites are 110,000 tonne/yr.
Process description:	The post-reactor technology, using an adiabatic reactor after the conventional fixed bed reactor, was developed in Sweden, where the process has been under development for 8 yrs on its 35,000 tonne/yr unit. Described as a post-reactor, it may be more appropriately described as a ”polishing reactor”, as it takes ”raw” PA from the main reactor as its feedstock. ”By having the post-reactor they are able to increase the load of the main reactor”.
Number of sites:	This technology is being implemented at 3 plants in Italy.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Data is not peer reviewed and comes from what appears to be a newspaper article ”European Chemical News”. Data likely comes from manufacturer so likely accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for Italy and Poland, both OECD countries.
	Metric 3:	Applicability	High	Data is directly applicable to manufacturing of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Contains some metadata such as some of the unit operations and processes but does not contain other important metadata around unit operations, exposures, or releases.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination — Low

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**
Throughput:	50,000 tonne/year at Italian plant; 85,000 tonne/yr in Belgium;

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	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to 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	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	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 **Low**

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:	Asian capacity for phthalic anhydride production is expected to increase by 300,000 tonne/yr by mid-1997. Increase of 40,000 tonne in China, 60,000 tonne in Taiwan, 50,000 tonne in Korea, 40,000 tonne in Indonesia, 30,000 tonne in Singapore, and 85,000 tonne in India

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	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	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. The report captures operations, equipment, and worker activities 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	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 **Low**

Study Citation:	NCBI, (2020). PubChem Compound Summary for CID 6811 Phthalic anhydride.
HERO ID:	10171484
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	(1978) 4.44X10+11 G - SRI(1982) 3.14X10+11 G - SRI(1988) 9.99X10+8 LBProduction volumes for non-confidential chemicals reported under the Inventory Update Rule.Year Production Range (pounds)1986 >500 million-1 billion1990 >500 million-1 billion1994 >500 million-1 billion1998 >1 billion2002 >500 million-1 billion (P. 43/50)Import (1978) 1.83X10+10 G - SRI(1982) 8.63X10+8 G - SRIExport(1978) 4.18X10+8 G - SRI(1982) 5.05X10+9 G - SRI
Life cycle description:	Phthalic anhydride is an important intermediate in the chemical industry. The major subsequent product groups are plasticizers(56%), unsaturated polyester resins (17%), and alkyd resins (17%). Phthalic anhydride is also used as an intermediate in theproduction of pigments and dyes, agricultural, pharmaceutical, and several other chemical products. Phthalic anhydridecontaining materials are used in coatings applications for home appliances, automobiles, medical devices and furniture
Number of sites:	16 manufacturers of PA in 2012, listed in Table 12.2

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The assessment or report uses high quality data and techniques 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	Medium	Data is generally more than 10 years, but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Total U.S. production volumes provided, but data from individual facilities was not provided.
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 production volumes not assessed.
Overall Quality Determination			**High**	

Study Citation:	NCBI, (2020). PubChem Database: Compound Summary: Phthalic acid.
HERO ID:	7274473
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Produced in or imported into the U.S. in >1 million pounds in 1990 and/or 1994.
Life cycle description:	Phthalic acid is used in the production of dyes, phenolphthalein, phthalimide, anthranilic acid, synthetic perfumes and laboratory reagents
Process description:	Phthalic acid is produced by vapor-phase oxidation of naphthalene, catalyzed by vanadium and molybdenum oxides, followed by hydrolysis. It is also manufactured by catalytic oxidation of o-toluic acid and oxidation of xylene. It is also Formed as a byproduct in the manufacture of phthalic anhydride. Phthalic acid appears as white crystals or fine white powder. Phthalic anhydride is the principal commercial form of phthalic acid and it is presently manufactured by catalytic air oxidation of o-xylene or naphthalene.
Chemical concentration:	Typically 99.5% from bulk 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 (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 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. The report captures operations, equipment, and worker activities that are expected to be outdated.
	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	Low	The report does not address variability or uncertainty.

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 of paints and coatings / of adhesives..

EXTRACTION

Parameter	**Data**
Life cycle description:	The largest categories of products made by coated and laminated substrate manufacturers are tapes and labels. Classes of tape, identified by construction, include woven and nonwoven fabric tape, paper tape, film tape, foil tape, and foam tapes. Some of the web materials mentioned previously are used in combination with glass, rayon, nylon, polyester, or acetate fibers to produce reinforced substrates. Films such as polyethylene, polyester, or polypropylene are often combined with these fibers to produce tapes used in heavy-duty packing and bundling applications. The type and number of reinforcing strands per area, the thickness of the coating applied, and the type of film used differentiate the grades and types of film tape. Twofaced tapes are substrates with an adhesive coating applied on both sides of the substrate (usually foam or film). Two-faced tapes have both heavy-duty uses in carpet tapes and light-duty uses in business forms and nametag applications. Label manufacturing is similar to pressure-sensitive tape manufacturing, with priority properties being printability, flatness, ease of die cutting, and release paper components. A label manufacturer may sell the product either in rolls or sheets as a final product, or as a raw product for a printing and die-cutting operation. Other adhesive-coated and laminated product lines include adhesive-coated floor tiles, wall coverings, automotive and furniture woodgrain films, and decorative sheets for packaging.
Process description:	Both batch processing and dedicated-line facilities employ basically the same process flow. 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. Only a small percentage of the coatings used by a batch processor is mixed from scratch. After the coatings have been mixed, they are pumped via a manifold system to the appropriate coating application system. Both industry segments use the same types of application equipment, including direct and reverse roll coaters and gravure cylinders. 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. UV and EB process differentials: EB-curing occurs when a specially formulated coating is exposed to electrons. The proper curing of an EB adhesive is dependent on the mixture of raw materials and the level of energy used to power the electrons. One advantage that EB has over UV is that the electrons can cure the layers of 100% solid adhesives. This ability allows EB-curing to be used on a variety of substrates [l I]. However, if the ratio of energy to raw materials is not properly determined, a substrate can be damaged (e.g., paper can become brittle) [12]. EB-curing is similar to UV-curing with one notable exception: the UV-curing requires a photoinitiator to generate the free radicals. Both systems cure the coating in approximately 1 s [l 11. The use of radiation-curable adhesives has allowed the coating of substrates which have previously been unusable. Substrates such as plastics can now be coated with EB- and UV-curable adhesives which provide high bond strengths at low adhesive weights. Although no EB-curable adhesive lines are in commercial operation in the United States, tests have been conducted to evaluate and compare the performance of EB-laminating adhesives with those of solvent and standard hot-melt adhesives. Laboratory tests were conducted comparing peel and shear properties of radiationcurable, solvent-based, hot-melt, and silicone-based adhesives.
Comments:	Does not contain any information regarding PA, but is an applicable use.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed and information used in report was conducted by EPA.
Domain 2: Representativeness				

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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 of paints and coatings / of adhesives..

EVALUATION

Domain	Metric		Rating	Comments
	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Medium	Data is for a condition of use but source never mentions the chemical of interest
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1994)
	Metric 5:	Sample Size	Low	Information is qualitative
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides various process description information as well as some life cycle description for substrates and adhesives
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability through various different production methods, does not address uncertainty.

Overall Quality Determination	**Medium**

Study Citation:	OECD, (2024). Emission Scenario Document on chemicals used in hydraulic fracturing.
HERO ID:	12974717
Conditions of Use:	Lubricants and functional fluids

EXTRACTION

Parameter	**Data**
Chemical concentration:	If the type of chemical (e.g., biocide, surfactant) is unknown, the assessor should select the value that is most appropriate for the assessment from the following statistics calculated from Table 1.1: Minimum: 0.00001; 25th percentile: 0.00023; 50th percentile: 0.0004 (default); 75th percentile: 0.004; 95th percentile: 0.005.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The emission scenario document uses high quality data 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	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	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	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination **High**

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

EXTRACTION

Parameter	**Data**
Throughput:	Use Rates (kg/site-yr):Computer/electronic and electrical product manufacturing - 1,500Motor and non-motor vehicle, vehicle parts, and tire manufacturing - 13,500General assembly - 141,198

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, 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	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	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 report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination	**High**

Study Citation:	Paints,, Harris (2025). Safety Data Sheet (SDS): T.O.V. Varnish.
HERO ID:	12905622
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	10 - 25 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from a territory of 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Paints,, Harris (2025). Safety Data Sheet (SDS): T.O.V. Marine Clear Spar Varnish.
HERO ID:	12905651
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	10 - 25 wt%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from a territory of 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 is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation:	Paints,, Harris (2025). Safety Data Sheet (SDS): Harris Red Oxide Primer.			
HERO ID:	6301590			
Conditions of Use:	Paints/coatings			
		EXTRACTION		
Parameter		**Data**		
Chemical concentration:		1 - 10 wt%		
Physical form:		Liquid		
		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from territory of 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.
Overall Quality Determination			**High**	

Study Citation: Park, C., Sheehan, R. J. (2000). Phthalic acids and other benzenepolycarboxylic acids. :1-45.
HERO ID: 679796
Conditions of Use: Manufacture

EXTRACTION

Parameter	Data
Production, import, or use volume:	455,000 T in 1993
Process description:	Well in excess of 90% of the phthalic anhydride produced is obtained by oxidizing o-xylene in the vapor phase over a fixed bed of catalyst. The other 10% include fixed-bed vapor-phase oxidation of naphthalene, fluidized-bed vapor-phase oxidation, and liquid-phase oxidation of o-xylene.
Number of sites:	5 producers
Chemical concentration:	99.5%

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is high-quality document. Data are well-sourced.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	U.S. Source
	Metric 3:	Applicability	High	Source discusses manufacturing, which is in scope.
	Metric 4:	Temporal Representativeness	Low	Source appears to be from 2000.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source clearly documents the source of the data contained.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.

Overall Quality Determination High

Study Citation: Pfaffli, P., Hameila, M., Keskinen, H., Wirmoila, R. (2002). Exposure to cyclic anhydrides in welding: A new allergen-chlorendic anhydride. Applied Occupational and Environmental Hygiene 17(11):765-767.
HERO ID: 5175072
Conditions of Use: Commercial/industrial - welding

EXTRACTION

Parameter	**Data**
Process description:	The electric arc welding method used was MIG-welding (metal inert gas) with argon as Mison Ultra shield gas. The temperature of the metal over a large area around the welding point was high enough for the degradation of the paint resin. Most paint films are electrical insulators, and the voltages in arc welding are so low that an intact paint film cannot be penetrated. Therefore, before welding some paint is removed from the metal surface mechanically with an abrasive wheel or by burning with a "gas fuel torch" (oxygen-acetylene flame at<3000 C).
Chemical concentration:	According to the manufacturer, the two-component paint (1 part of hardener and 2 parts of resin) contained unsaturated chlorinated polyester resin (65%of the hardener), and necessary ingredients, such as alkyd resin (0.6%), epoxydized natural oils, inorganic fillers, pigments, and corrosion-inhibiting agents. The thickness of the paint film on the steel was 40 um.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely does not contain errors in sampling methodology.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Source is from Finland, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to a commercial or industrial use.
	Metric 4:	Temporal Representativeness	Medium	Source is over 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain 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: Phenova, (2015). Safety Data Sheet (SDS): Phthalic Anhydride Standard.
HERO ID: 12974718
Conditions of Use: Laboratory chemicals

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.2%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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 is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination **High**

Study Citation:	Phenova, (2017). Safety Data Sheet: Custom 8270 Misc Mix.
HERO ID:	6301640
Conditions of Use:	Laboratory chemicals

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination High

Study Citation:	Piirilä, P., Keskinen, H., Anttila, S., Hyvönen, M., Pfäffli, P., Tuomi, T., Tupasela, O., Tuppurainen, M., Nordman, H. (1997). Allergic alveolitis following exposure to epoxy polyester powder paint containing low amounts ($< 1\%$) of acid anhydrides. European Respiratory Journal 10(4):948-951.
HERO ID:	5176255
Conditions of Use:	Industrial or commercial use - paints and coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	PA is incorporated into paints. Polyester powder paint contains <1% amounts of PA. Paint found to contain free acid anhydrides (0.02% of PA).

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so likely does not contain any errors.
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	More than 20 years old.
	Metric 5:	Sample Size	Low	Sample size for data is uncertain.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route and one sampling point but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation: Polynt, (2016). Safety Data Sheet (SDS): NORSODYNE H 23100 TA.
HERO ID: 6301626
Conditions of Use: Paints/coatings (epoxy resin)

EXTRACTION

Parameter	Data
Chemical concentration:	< 1 wt%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Polynt, (2024). Safety Data Sheet (SDS): EASYLAM LSE.
HERO ID:	6301636
Conditions of Use:	Paints/coatings (epoxy resin)

EXTRACTION

Parameter	**Data**
Chemical concentration:	0.1 - < 1 wt%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Prime-Line, (2015). Serrated PVC Spline.
HERO ID:	6984601
Conditions of Use:	Plastic and Rubber Products

EXTRACTION

Parameter	**Data**
Chemical concentration:	14% by weight Phthalic Acid

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	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:	programs, E.O. (1974). Air pollution control engineering and cost study of the paint and varnish industry.
HERO ID:	6580284
Conditions of Use:	Formulation of paint and varnish

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Trade sale finishes and industrial finishes are produced in almost equal volume with the production for 1972 estimated at 465 million gallons for trade sales and 485 million gallons for industrial finishes. // Per table 6, 104.55 million pounds of PA was used to produce paints and varnishes.
Process description:	Mixing or dispersing pigment and vehicle to give the final product. The paint vehicle is defined as the liquid portion of the paint and consists of volatile solvent or dispersing medium and non-volatile binder such as oils and resins. The non-volatile portion is also called the vehicle solid or film former. The incorporation of the pigment in the paint vehicle is accomplished by a combination of grinding and dispersion or dispersion alone. When it is necessary to further grind the raw pigment, pebble or steel ball mills are normally used. With the advent of fine particle grades of pigment and extenders, as well as the wide spread use of wetting agents, the trend is toward milling methods that are based on dispersion without grinding. Dispersion consists of breaking up of the pigment clusters and agglomerates, followed by wetting of the individual particles with the binder or vehicle. Some of the more popular methods currently being used are high-speed disc impellers, high speed impingement mills and the sand mill. // There are two basic types of varnishes, spirit varnishes and oleoresinous varnishes.2 Spirit varnishes are formed by dissolving a resin in a solvent and they dry by evaporation of the solvent. The dry film formed undergoes no substantial change in the process of drying and is classified as non-convertible. Varnish is cooked in both portable kettles and large reactors. Kettles are used only to a limited extent and primarily by the smaller manufacturers. The very old, coke fired, 30 gallon capacity copper kettles are no longer used. The varnish kettles which are used, have capacities of 150 to 375 gallons. These are fabricated of stainless steel, have straight sides and are equipped with three or four-wheel trucks. Heating is done with natural gas or fuel oil for better temperature control. The kettles are fitted with retractable hoods and exhaust pipes, some of which may incorporate solvent condensers. Cooling and thinning is normally done in special rooms. // Source contains more information on raw materials, specific processes, and equipment. // For many years, phthalic anhydride (ortho) was the only polybasic acid used in substantial proportions in alkyds. It still remains the predominant dibasic acid. PA is produced from the catalytic oxidation of naphthalene or ortho-xylene. Some resin manufacturers produce their own PA.
Number of sites:	The industry is made up of about 1,500 companies operating about 1,700 plants

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The data methodology is known or expected to be accurate and is known to cover all 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.
	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, andassumptions.

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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: Formulation of paint and varnish

EVALUATION

Domain	Metric		Rating	Comments
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:	ResinLab, (2023). Safety Data Sheet (SDS): SEC1244 B.		
HERO ID:	6301627		
Conditions of Use:	Paints/coatings (epoxy resin)		

EXTRACTION

Parameter	**Data**
Chemical concentration:	0. 1 - 0.5%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Ridgway, P., Morris, L., Ogunbiyi, A. O., Brown, R. H., Cocker, J. (1996). Acid anhydrides: Criteria document for an occupational exposure limit.
HERO ID:	830957
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	At present there are two manufacturing sites in the United Kingdom (UK) with a total production capacity of about 85,000 tonnes per annum.
Process description:	The commercial route to phthalic anhydride production is the catalytic air oxidation of a-xylene or naphthalene. The recovered product is purified and stored on site in molten form before it is dispatched or converted to solid, flake form. At present there are two manufacturing sites in the United Kingdom (UK) with a total production capacity of about 85,000 tonnes per annum. The UK market for phthalic anhydride is estimated to be about 40,000 tonnes. Phthalic anhydride is available in three forms: a. molten- delivered in road tankers, b. flake - in standard 25 kg bags, c. flake - in one tonne semi-bulk bags, The customer chooses the form which best suits the company's process requirements and handling facilities. Molten phthalic anhydride is mainly used by the companies which regularly handle large amounts of the material, (more than 2000 tonnes per annum). Heated storage and transfer facilities are required. The 25 kg bags are mainly handled by customers using less than 2000 tonnes per annum. The bags are generally of multi-wall paper construction, delivered to the customer on pallets (40 bags per pallet) enclosed in shrink-wrapped plastic film. Some imported phthalic anhydride may be packaged in single wall polypropylene bags. The semi-bulk bags are single wall heavy duty bags capable of being opened at the bottom to facilitate emptying. Unlike the semi bulk bags used for trimellitic anhydride, they are not designed to give a closed, dust-free system during emptying.
Number of sites:	2 manufacturing sites in UK

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Source is a technical report from the UK. Does not use US sources but does not indicate flaws or 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	Data is directly applicable to conditions of use.
	Metric 4:	Temporal Representativeness	Low	The report 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	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 **Low**

Study Citation:	Rodgers, B., Tallury, S. S., Klingensmith, W. (2016). Rubber compounding. :1-60.
HERO ID:	7324725
Conditions of Use:	Synthetic rubber manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Compounding methods for various types of rubber are described in detail. Also, the article explains how PA is used as an acid retarded in rubber compounding. "Examples of organic acid retarders include phthalic anhydride, benzoic acid, and salicylic acids. These materials will react with more basic accelerator fragments, with other basic compounding ingredients, and with impurities. These basic moieties, which would normally serve to accelerate vulcanization and produce a higher state of cure, are thus neutralized by the acid retarders."

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources (Kirk-Othmer).
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	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	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination High

Study Citation:	Rusyanov, N. D., Kogan, B. E., Evzelman, I. B., Kostromi, A. S., Malkin, R. A., Bednov, V. M., Alekseev, T. A., Krugliko, A. A., Dokuchae, V. F., Kasyanov, V. A., Nikonov, V. P., Khomutin, G. V., Sizov, M. N. (1972). Production of phthalic anhydride from distilled naphthalene and methylnaphthalenes. Koks i Khimiya (USSR) 1972(5):32-35.
HERO ID:	5178874
Conditions of Use:	Manufacturing.

EXTRACTION

Parameter	**Data**
Process description:	The oxidation process to phthalic anhydride is favorably influenced by increases the methyl-naphthalenes content of the feedstock to 10-15%; the load on the catalyst can be increased and the quality of the phthalic anhydride is raised because mixtures of naphthalene and methyl naphthalenes oxidize highly selectively to this compound. Stage 1 of the process consisted of the production at a coke-oven plant of 80 tons of the naphthalene oil and its oxidation in one of the reactor units in the phthalic anhydride plant. Stage 2, the same feedstock was produced continuously at the coke-oven plant and oxidized in all reactors in both phthalic anhydride plants. Ina ll, 2000 tonnes of feedstock were processed. Catalyst load was 144 kg/hr.
Throughput:	Feedstock is described in table 1. Stage 1 feedstock was 0.005% indole, 89.3% naphthalene, 6.1% alpha-methylnaphthalene, 1.9% beta-methylnaphthalene, and 0.8% diphenyl+dimethynaphthalene. Stage 2 feed stock was used on 3 different dates. Feed stock composition was 86.4, 87.0 and 87.8% naphthalene; 8.0, 7.6 and 7.7% alpha methylnaphthalene; 3.1, 2.7, and 2.1% beta methylnaphthalene; and 1.18, 1.09, and 0.46% diphenyl + dimethylnaphthalene. Conversion rates listed in table 3, conversion to PA ranged from 86.0 to 89.1% based on the feedstock conditions stated.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Report appears to use high quality data directly from manufacturer but it is not from frequently used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	No info about location in article, publisher was a British association however all references are from the USSR. Likely Russian which is a non-OECD country
	Metric 3:	Applicability	High	Data is directly applicable to manufacturing of PA.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old (1970)
	Metric 5:	Sample Size	Medium	Characterized by a range of values based on different testing days and conditions of manufacturing.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Report documents results, methods and assumptions. Sources are not described. Information about process, unit operations and throughput are provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing multiple times over different months with different feed stock conditions to determine best conversion to generate PA.

Overall Quality Determination **Medium**

Study Citation:	Schwab, R. F., Doyle, W. H. (1970). Hazards in phthalic anhydride plants. Chemical Engineering Progress 66(9):49.
HERO ID:	5180284
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Chemical reaction with structures is described on page 1. To get the fuel into the system, preheated liquid may be injected directly into a fluidized catalyst bed or into a heated air stream that feeds a fixed bed converter. In the case of injection into the fluid bed, it appears that the catalyst particles act as an excellent heat sink (1) . Theoretically, any flame that might occur in a flammable mixture generated in a bubble in the bed near an injection point would soon be quenched and would not propagate out of the bubble. Or, ignition may never occur. In any event, we have no knowledge of any accidents resulting from this practice. When liquid injection is into a hot air stream, the fuel nozzle and the air pipe should be electrically bonded to minimize the chance of ignition by an elec trostatic spark. Also, the distance between the injec tion point and the catalyst bed should be less than about 10 diameters of the pipe carrying the fuel-air mixture. This will insure that any pressure increase resulting from ignition of a combustible mixture can be vented by a rupture disc installed for that purpose in the inlet plenum of the reactor. At least ten pipe diameters (probably 18 to 20) are needed for transi tion of a fuel-air combustion process from a deflagra tion (sub-sonic pressure wave) which can be vented to a detonation (supersonic shock wave) which cannot. To minimize the formation of combustible mixtures, two things are required : a knowledge of the explosion limits of the mixture at the temperature involved and ; a management which frowns on operating in the com bustible range in order to obtain higher yields than otherwise possible. Tests to determine the explosive range of naphthalene-air mixtures have produced the data illustrated in Figure 1. The majority of the phthalic anhydride converters are of the fixed bed type. The charge composition is 25- 30 lb. of air ,1b. of napthalene or 20- 24 lb. of air/lb. of ortho-xylene. It is desirable to introduce the mixture into the converter at a fuel-air concentration below the L.F.L. Fluid bed units follow oil refinery practice in the matters of catalyst handling, fluidization, etc. How ever, the hazards are inherently different in that most refinery processes are endothermic, operate in the absence of air, and have external heat sources, Figure 3. In these phthalic reactors, the heat of reaction is removed by internal pipes containing either water or Dowtherm A which, in turn, is cooled by water in an external heat exchanger. Fluid bed reactors require some gaseous product filtering system to keep catalyst fines from getting into the condensing system where, besides constituting a product contaminant, they can cause ignition. Filters are of two general types. Sintered metal is one and the other is made up of glass cloth supported by glass wool on perforated pipes. The filters are approximately sub divided so that one, or one set, is always being back blown while the others are functioning normally. Fail ure of the back blown system, as by sticking of a valve, will reduce product flow through the portion of the system controlled by the valve. As the space velocity decreases and catalyst thickness builds up, a secondary oxidation takes place at the filters. Eventually, over heating causes filter failure. Glass filters fail at a lower temperature than sintered metal so, ordinarily, sintered metal is to be preferred. Modern plants use cyclic condensers cooled by either water or oil. The plant is designed with a series of these condensers; while one is in the condensing cycle, the others are in various stages of melt-down. After running one unit as a condenser for the re quired period, the gas flow is shifted to another unit and the melt-down cycle begins. The condensers should operate above the dew point of water so that the water of reaction does not condense out. If this is not done, the water and phthalic anhydride react to form phthalic acid with subsequent corrosion and plug-up troubles, plus the possibility of forming pyrophoric compounds.
Throughput:	The major amount of phthalic anhydride is produced by the oxidation of naphthalene with air, in accordance with reaction 1 (4). Theoretically, a yield of 116 lb. of phthalic anhydride is obtained per 100 lb. of naphthalene. However, side reactions, including the production of maleic anhydride and naphthaquinone limit this to 80- 102 lb. of phthalic anhydride lb. of naphthalene. Since a large excess of air is used to ensure that the feed mixture is outside or barely in the explosive range, on the lean side, side reaction prod ucts are mostly at a high state of oxidation. This increases heat evolved from a theoretical value of 6,300 B.t.u./lb. of naphthalene converted to a figure in the neighborhood of 7000-9000 B.t.u./lb. The necessity of dissipating this heat of reaction imposes severe re strictions on the reactor design (1, 5, 6). The other source of phthalic anhydride is o-xylene oxidized with air in accordance with reaction 2. In this case, the theoretical maximum yield is 140 lb. of phthalic anhydride/100 lb. of xylene. However, the actual yield per pound is approximately 0.1 lb. less than when naphthalene is used. Even if 1 lb. of pure ortho-xylene and 1 lb. of pure naphthalene each pro duced 0.83 lb. of phthalic anhydride, this is a yield for naphthalene of 71.5% of theoretical, but only 59.8% for ortho-xylene. A larger proportion of ortho-xylene is being oxidized to CCs, etc., which means relatively more heat is evolved.
Comments:	Source is essentially one giant process description for preventions against explosions in the production of PA.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report is peer reviewed so likely contains data up to standards.

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Study Citation:	Schwab, R. F., Doyle, W. H. (1970). Hazards in phthalic anhydride plants. Chemical Engineering Progress 66(9):49.
HERO ID:	5180284
Conditions of Use:	Manufacturing

EVALUATION

Domain		Metric	Rating	Comments
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Study conducted by US.
	Metric 3:	Applicability	High	Directly applicable to condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1960s and 1970s)
	Metric 5:	Sample Size	Low	Characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Provides sources, results, and assumptions as well as very detailed descriptions of the process and many of the unit operations associated with it.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at differences between different processes of making PA. Does not address uncertainty.

Overall Quality Determination	**Medium**

Study Citation:	Scientific,, ThermoFisher (2022). Safety Data Sheet (SDS): Phthalic anhydride.
HERO ID:	6301605
Conditions of Use:	Laboratory chemicals

EXTRACTION

Parameter	**Data**
Chemical concentration:	< 100%
Physical form:	Solid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation: Selskii, B. I., Lozhkin, V. A., Serebrennikov, B. N., Kabanov, I. V., Vyalshina, L. E., Kasyanov, V. A., Lobachev, V. M. (1975). Study of hydraulic operating-conditions in contact section of a phthalic anhydride plant. Koks i Khimiya (USSR) 1975(2):30-31.
HERO ID: 5178780
Conditions of Use: Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	The condensers receive the phthalic anhydride at a temperature of 170 degrees C. The phthalic anhydride is condensed on tubes cooled with oil at 30-40 degrees C. However, the phthalic anhydride is not completely frozen out; a proportion remains in the gases which flow on into the manifold and eventually into the anti-pollution fan. As they enter the latter, water is sprayed into the spent gases and the residual phthalic anhydride either dissolved in it or settles out in the centrifugal trap. The purified gases are released up the exhaust stack. After 4-5 hours freezing, each condenser is switched over to melting conditions, after closure of the cut-off valve at the inlet and the safety valve at the outlet. Hot oil at 180-200 degrees C is pumped through the tubes and the condensed phthalic anhydride on them is melted and drained off into a tank, from which it is transferred to the distillation section for further processing.
Chemical concentration:	The phthalic anhydride content of the mixture varies between 18 and 35 g/m3.

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 Russia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the production of phthalic anhydride, 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	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 varying operating temperatures and flow rates. Uncertainty is not addressed.

Overall Quality Determination — Low

Study Citation:	Sergeev, A. P. (1975). Problem of phthalic anhydride production. Koks i Khimiya (USSR) 6(6):35-37.
HERO ID:	5178792
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Most of the phthalic anhydride currently produced in the Soviet Union is made by oxidizing naphthalene with atmospheric oxygen on vanadium-containing catalysts. The majority of plants use a stationary catalyst of complex composition (vanadium-potassium sulphate), but a few use a fluidized catalyst bed. The latter plants can operate with technical naphthalene of low quality. The plants installed between 1960 and 1970 consisted of sets of six 4000-t/a reactors and were designed to make phthalic anhydride from unpurified technical naphthalene prepared by melting pressed naphthalene with a c.p. of not less than 78.8°C, thoroughly separating any residual tar and filtering through a special multi-layer paper filter. The naphthalene temperature should not rise above 90-100 °C during preparation, otherwise resinification occurs. The reactor in which naphthalene is oxidized to phthalic anhydride are multi-tube units with catalyst in the tubes; the inter-tube spaces are filled with a molten salt mixture. The molten salts provide a cooling action and the heat liberated in the reaction tubes is recovered in steam generators.
Throughput:	4000 t/a per reactor (sets of six reactors at a site).

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	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	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. The report captures operations, equipment, and worker activities 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	Low	Assessment or report does not document its datasources, assessment methods, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination Low

Study Citation: Sigma-Aldrich, (2025). Safety Data Sheet (SDS): Phthalic Anhydride.
HERO ID: 6301610
Conditions of Use: Laboratory chemicals

EXTRACTION

Parameter	**Data**
Chemical concentration:	90 - 100 wt%
Physical form:	Crystalline

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination **High**

Study Citation:	Silva, da, C. C., Coelho, R. R., Cirqueira, M. D., Melo, de, C., A.C., Rosa, L., I.M., Ellena, J., Martins, F. T. (2012). Salts of the anti-HIV drug lamivudine with phthalic and salicylic acids. CrystEngComm 14(14):4562-4566.
HERO ID:	6826378
Conditions of Use:	Laboratory Use of Phthalic Acid as Counterions

EXTRACTION

Parameter	**Data**
Process description:	Here, phthalic acid and salicylic acid were selected as salt formers. Their salts with lamivudine were prepared and structurally elucidated by single-crystal X-ray diffraction.

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	The data are from a non-OECD country.
	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 is no more than 10 years old.
	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	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	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination — High

Study Citation:	Südwest, (2019). Safety Data Sheet (SDS): SUDWEST Holz-Isolier-Grund.
HERO ID:	6301595
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	≥0.1 - <1% by weight
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	SDS 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	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation:	Technologies,, Broadview (2015). Safety Data Sheet (SDS): AC-59.
HERO ID:	6301580
Conditions of Use:	Paints/coatings (epoxy resin)

EXTRACTION

Parameter	**Data**
Chemical concentration:	1 - 10 wt%
Physical form:	Liquid resin

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination — High

Study Citation:	Tongeren, van, M. J., Barker, R. D., Gardiner, K., Harris, J. M., Venables, K. M., Taylor, A. J., Harrington, J. M. (1995). Exposure to acid anhydrides in three resin and one cushioned flooring manufacturing plants. Annals of Occupational Hygiene 39(5):559-571.
HERO ID:	831008
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	Three of the factories participating in the study produce resins used in the manufacture of paints. The main products are alkyd resins, polyester resins and acrylic resins. All acid anhydrides are used for the production of the alkyd resins; only maleic anhydride is used in the production of polyester resins. No acid anhydrides are used for the production of acrylic resins. The resins are manufactured in large reactors (Fig. 2) with the three factories having a total of 1,4 and 6 reactors in operation, respectively. The manufacture of resins involves the use of a natural oil or a fatty acid, a polyol such as pentaerythritol and a dicarboxylic acid or acid anhydride. In two factories (1 and 4), liquid PA is added automatically and manual loading of PA is only needed occasionally in the case of breakdown of the liquid phthalic anhydride (LPA) storage and supply system. In the other resin manufacturing factory solid PA is added manually from 25 kg bags or mechanically from big bags (500-1000 kg). TMA and MA are always used in the solid form, TMA as a fine powder and MA as briquettes. During the production of the resins, samples are taken at regular intervals to test the acid value and the viscosity of the resin. After a period ranging from 8 to 20 h, the resin is downloaded into a thinning vessel where more solvents are added and finally pressed through filters. The resins are either stored in drums or in large tanks.
Number of sites:	4

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Some literature data that is cited is from NIOSH, however sampling methodology is laid out in detail and is peer reviewed so likely does not contain errors.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the 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	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	Low	The report does not address variability or uncertainty.

Overall Quality Determination **Medium**

Study Citation:	Truman, A. H. (1970). Batch distillation of phthalic anhydride. Chemical Engineering Progress 66(3):62-65.
HERO ID:	5179964
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	PA is purified by heat treating and vacuum distillation in 3 stages: 1) atmospheric pressure, high temperature heat treating under an inert gas blanket to remove partly volatile impurities such as water, maleic anhydride and benzoic acid, and also to resinify byproducts, such as quinones, to a non-volatile residue. 2) Vacum distillation in which the pure PA is vaporized, leaving behind tars and other high boilers. 3) Further vacuum distillation of the residues to recover the last traces of PA. In the case considered here, a distillation plant had already been designed for batch treatment using two distillation trains, each with a pre-treater kettle, a main vacuum still column and kettle, and a residues still column and kettle. The jacketed vessels were to be heated by circulating high temperature diphenyl/diphenyl-oxide liquid. The required distillation temperatures vary from 200 F to 560 F in the different vessels and at various points in the treating cycles. It was decided to alter the scheme to use a vapor phase heating medium as it would simplify the furnace and enable the vaporizer (or boiler) to be incorporated in a fume incinerator required for the PA plant waste gas. This allowed a cost saving on the kettle shell and jacket wall thicknesses because the heating circuit operating pressure is reduced from 650 F, 80 psig for the liquid medium to 650 F, 55 psig for the vapor phase heating medium. Scheme II in Figure 2 was selected for the design approach for production of PA. Nitrogen/atmosphere maintained in the condensate vapor collector and kettle jacket. The atmosphere in the collector would vary from 100% nitrogen when the system was cold to 80% vapor and 20% nitrogen when at its hottest temperature. The atmosphere in the kettle jackets would vary according to duty and throughout the cycle, ranging as high as 100% vapor when at its hottest in the pre-still and residues still. The jacket and collector would be connected by means of pressure balancing lines (vents) as well as the liquid lines to enable the displacement of nitrogen from the jackets to the collector during "heating up" and to be replenished during "cooling down". A nitrogen make up system and a venting system were designed to operate under split level pressure control, to maintain the overall system operating pressure. A vent condenser (air cooled) was designed to handle the mixed gases and return the condensate to the collector while venting the excess nitrogen. Scheme II was selected to be used and modified to use submerged pumps.
Comments:	Most of the source is modification of a system to work for production of PA. Scheme II was selected and is described in the diagram on page 3. The entire source is essentially a giant process description of how the correct scheme was selected.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report appears to use high quality data and is all in theory with some results of the study stated within the article. Most of the source is just how the engineer concluded which design to implement. Source is peer reviewed.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is for production of PA.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1970)
	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	High	Data documents its results very well and explains reasoning behind information.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by talking about multiple design schemes considered. Does not address uncertainty.

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Study Citation:	Truman, A. H. (1970). Batch distillation of phthalic anhydride. Chemical Engineering Progress 66(3):62-65.
HERO ID:	5179964
Conditions of Use:	Manufacturing

EVALUATION

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

Study Citation:	Tur, M. Y., Huang, J. C. (1997). Treatment of phthalic waste by anaerobic hybrid reactor. Journal of Environmental Engineering 123(11):1093-1099.
HERO ID:	6814457
Conditions of Use:	Disposal - Treatment of Phthalic waste

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	The phthalic anhydride production in 1994 was 2,700,000 tons, most of which had been used for manufacturing plasticizers, unsaturated polyester resins, and alkyd resins.
Process description:	The reactor was operated with continuous flow recirculation to maintain a proper upflow velocity for UASB. The recycled flow was mixed with the influent and then externally heated to 35°C in a water bath. The influent feed and the recirculation flow were each handled by a Masterflex pump. The reactor was insulated with a sponge-blanket to minimize heat loss.
Throughput:	The volumetric flow of the reactor started at 0.78 g-COD/L-d and was increased to 46.3 g-COD/L-d by the end of the experiment.
Chemical concentration:	The wastewater entered the reactor with a concentration of 4,000 mg/L phthalic acid.

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	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release media and waste treatment provided but missing release quantities and emission factors.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is addressed by varying waste loading levels. Uncertainty is not addressed.

Overall Quality Determination **Medium**

Study Citation: Tustin, T., Kundu-Orwa, S., Lodwick, J., Cannon, D. L., McCarthy, R. B. (2022). An outbreak of work-related asthma and silicosis at a US countertop manufacturing and fabrication facility. American Journal of Industrial Medicine 65(1):12-19.
HERO ID: 10113574
Conditions of Use: Use in Epoxy Resins

EXTRACTION

Parameter	Data
Process description:	Section 2.1 provides a process description for the manufacturing of the epoxy resin countertop."The company manufactures and fabricates chemical-resistantepoxy resin countertops. Briefly, the process is as follows.First, worker in the "casting" department mix and heat raw materials including silica sand (which comprises more than 70% ofeach countertop by weight), epoxy resin, PA, and pigments.Workers then pour the resulting viscous liquid into flat rectangular molds and place the molds in ovens for curing. To facilitaterelease of the countertops from the molds after curing, workerscoat the molds with a release coating composed of Stoddardsolvent, xylene, ethylbenzene, and cumene. After curing, workersin the nearby "fabrication" department clean the countertopsand use saws and routers to cut the product into the correctshapes. Other fabrication workers smooth the countertopswith mechanical sanders and join countertop pieces with gluebefore packing them for shipment to clients. (The fabricationdepartment also occasionally cuts and sizes phenol-formaldehyderesin boards that are manufactured offsite.)"
Comments:	Source is about the formulation of epoxy resin countertops. It is unclear what the function of the phthalic anhydride is though in the mix whether it is functioning as a reactant or just being incorporated into the mix.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Process description is expected to be accurately described in report.
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	N/A	Sample size is not applicable for 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	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

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

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, (1977). Phthalic anhydride plant air pollution control. :115.
HERO ID: 10182527
Conditions of Use: Manufacture

EXTRACTION

Parameter	**Data**
Process description:	phthalic anhydride is manufactured using either o-xyelene or naphthalene as the primary feedstock. in 1975, 67% phthalic anhydride was manufactured using o-xylene and the remaining 33% using naphthalene. o-xylene feedstock and a vanadium pentoxide catalyst creates phthalic anhydride and water (p.18). Page 20 includes a process flow diagram of the BASF process (o-xylene feedstock) and the equipment involved in the manufacture process and pages 22-24 describes the process streams in detail. Naphthalene, oxygen, and a vanadium-oxide catalyst produces phthalic anhydride, carbon dioxide, and water (p. 24). A process flow diagram for the Badger-Sherwin-Williams process is shown on page 25 process and pages 27-29 describes the process streams in detail.
Throughput:	production capacity of 59,000 metric tons/yr (p.33)
Number of sites:	There are currently 10 phthalic anhydride plants in US (1977)
Chemical concentration:	phthalic anhydride manufactured from o-xylene is 99.99% (p.24) and 99.7% minimum from naphthalene(p. 29)

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report 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 manufacture of phthalic anhydride, 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 (1975)
	Metric 5:	Sample Size	High	Statistical distribution of samples is 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 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**
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.

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, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.
HERO ID:	46492
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Phthalic anhydride (PAN) production in the United States in 1972 was 0.9 billion pounds per year; this total is estimated to increase to 2.2 billion pounds per year by 1985. Of the current production, 50 percent is used for plasticizers, 25 percent for alkyd resins, 20 percent for unsaturated polyester resins, and 5 percent for miscellaneous and exports.
Process description:	PAN is produced by catalytic oxidation of either ortho-xylene or naphthalene. Since naphthalene is a higher-priced feedstock and has a lower feed utilization (about 1.0 lb PAN/lb o-xylene versus 0.97 lb PAN/lb naphthalene), future production growth is predicted to utilize o-xylene. The processes for producing PAN by o-xylene or naphthalene are the same except for reactors, catalyst handling, and recovery facilities required for fluid bed reactors.In PAN production using o-xylene as the basic feedstock, filtered air is preheated, compressed, and mixed with vaporized o-xylene and fed into the fixed-bed tubular reactors. The reactors contain the catalyst, vanadium pentoxide, and are operated at 650 to 725°F (340 to 385°C). Small amounts of sulfur dioxide are added to the reactor feed to maintain catalyst activity. Exothermic heat is removed by a molten salt bath circulated around the reactor tubes and transferred to a steam generation system.Naphthalene-based feedstock is made up of vaporized naphthalene and compressed air. It is transferred to the fluidized bed reactor and oxidized in the presence of a catalyst, vanadium pentoxide, at 650 to 725°F (340 to 385°C). Cooling tubes located in the catalyst bed remove the exothermic heat, which is used to produce high-pressure steam. The reactor effluent consists of PAN vapors, entrained catalyst, and various byproducts and non-reactant gas. The catalyst is removed by filtering and returned to the reactor.The reactor effluent containing crude PAN plus products from side reactions and excess oxygen passes to a series of switch condensers where the crude PAN cools and crystallizes. The condensers are alternately cooled and then heated, allowing PAN crystals to form and then melt from the condenser tube fins.The crude liquid is transferred to a pretreatment section in which phthalic acid is dehydrated to anhydride. Water, maleic anhydride, and benzoic acid are partially evaporated. The liquid then goes to a vacuum distillation section where pure PAN (99.8 wt. percent pure) is recovered. The product can be stored and shipped either as a liquid or a solid (in which case it is dried, flaked, and packaged in multi-wall paper bags). Tanks for holding liquid PAN are kept at 300·F (150·C) and blanketed with dry nitrogen to prevent the entry of oxygen (fire) or water vapor (hydrolysis to phthalic acid).
Chemical concentration:	99.8 wt. percent pure

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the United States.
	Metric 3:	Applicability	High	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	Report clearly documents its data sources
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Process description and production volume.

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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:	Manufacturing

EVALUATION

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

Study Citation:	U.S. EPA, (2004). Use of additives in foamed plastics – generic scenario for estimating occupational exposures and environmental releases – Draft.
HERO ID:	6304171
Conditions of Use:	Flexible and Rigid Polyurethane Foam Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	2,365 million lbs polurethan foam/yr6,442 million lbs polysytrene/yr
Life cycle description:	Flexible and Rigid Polyurethane Foam Manufacture
Process description:	Converters mix plastic resins with additives, shaping/molding
Throughput:	no information available
Number of sites:	566 total polystyrene sites, 610 total polyurethane foam sites

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	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	Medium	Uncertainty not addressed. Variability addressed by considering multiple foam types.

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:	Manufacture

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Production in the United States in 1972 was 0.9 billion pounds peryear; this total is estimated to increase to 2.2 billion pounds per year by 1985.
Life cycle description:	Of the current production, 50 percent is used for plasticizers, 25 percent for alkyd resins, 20 percent for unsaturated polyester resins, and 5 percent for miscellaneous and exports.
Process description:	The processes for producing PAN by o-xylene or naphthalene are the same except for reactors, catalyst handling, and recovery facilities required for fluid bed reactors.In PAN production using o-xylene as the basic feedstock, filtered air is preheated, compressed, and mixed with vaporized o-xylene and fed into the fixed-bed tubular reactors. The reactors contain the catalyst, vanadium pentoxide, and are operated at 650 to 725°F (340 to 385°C).Small amounts of sulfur dioxide are added to the reactor feed to maintain catalyst activity. Exothermic heat is removed by a molten salt bath circulated around the reactor tubes and transferred to a steam generation system.Naphthalene-based feedstock is made up of vaporized naphthalene and compressed air. It is transferred to the fluidized bed reactor and oxidized in the presence of a catalyst, vanadium pentoxide, at 650 to 725°F (340 to 385°C). Cooling tubes located in the catalyst bed remove the exothermic heat, which is used to produce high-pressure steam. The reactor effluent consists of PAN vapors, entrained catalyst, and various byproducts and nonreactant gas. The catalyst is removed by filtering and returned to the reactor. The reactor effluent containing crude PAN plus products from side reactions and excess oxygen passes to a series of switch condensers where the crude PAN cools and crystallizes. The condensers are alternately cooled and then heated, allowing PAN crystals to form and then melt from the condenser tube fins.The crude liquid is transferred to a pretreatment section in which phthalic acid is dehydrated to anhydride. Water, maleic anhydride, and benzoic acid are partially evaporated. The liquid then goes to a vacuum distillation section where pure PAN (99.8 wt. percent pure) is recovered. The product can be stored and shipped either as a liquid or a solid (in which case it is dried, flaked, and packaged in multi-wall paper bags). Tanks for holding liquid PAN are kept at 300°F (I50°C) and blanketed with dry nitrogen to prevent the entry of oxygen (fire) or water vapor (hydrolysis to phthalic acid). (p. 31-32)

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 and are generally accepted by the scientific community, and associatedinformation 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	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	Data not based on sampling
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). 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:	Manufacture

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, (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 phthalic anhydride is not specifically mentioned, the group of articles provide information on various types of coating on metal and non-mental surfaces. As for example, process description for can coating includes description of sheet coating. Sheet coating includes base coating and printing or lithographing, followed by curing at temperatures of up to 220°C (425°F). When the sheets have been formed into cylinders, the seam is sprayed, usually with a lacquer, to protect the exposed metal. If they are to contain an edible product, the interiors are spray coated, and the cans baked at up to 220°C (425°F).

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	report uses high quality data
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 - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	underlying methods, data sources, and assumptions are not fully transparent.
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: U.S. EPA, (1995). AP-42: Chapter 11.1 - Hot mix asphalt plants.
HERO ID: 7315971
Conditions of Use: Formulation of asphalt

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	In 1996, approximately 500 million tons of HMA were produced. The total 1996 HMA production from batch and drum mix plants is estimated at about 240 million tons and 260 million tons, respectively.
Process description:	Hot mix asphalt (HMA) paving materials are a mixture of size-graded, high quality aggregate (which can include reclaimed asphalt pavement [RAP]), and liquid asphalt cement, which is heated and mixed in measured quantities to produce HMA. Aggregate and RAP (if used) constitute over 92 percent by weight of the total mixture. Hot mix asphalt paving materials can be manufactured by: (1) batch mix plants, (2) continuous mix (mix outside dryer drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. This order of listing generally reflects the chronological order of development and use within the HMA industry. Source contains a process description of each type of process.
Number of sites:	In 1996, approximately 500 million tons of HMA were produced at the 3,600 (estimated) active asphalt plants in the United States. Of these 3,600 plants, approximately 2,300 are batch plants, 1,000 are parallel flow drum mix plants, and 300 are counterflow drum mix 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 (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	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to this chemical.
	Metric 4:	Temporal Representativeness	Low	Report is more than 10 years old but less than 20 years old. But, information in the report is generally from 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	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 report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — Medium

Study Citation:	Vainiotalo, S., Pfaffli, P. (1990). Air impurities in the PVC plastics processing industry. Annals of Occupational Hygiene 34(6):585-590.
HERO ID:	5175697
Conditions of Use:	Processing - plasticizer in PVC and reactant for DEHP

EXTRACTION

Parameter	**Data**
Process description:	POLYVINYLCHLORIDE (PVC) is one of the most common polymers and it is processed by several different methods. It accounts for about 25% of total production of the most widely used thermoplastics (polyethylene, polypropylene, plastics containing styrene and PVC). To modify and improve its technical properties, many additives are used, and among these plasticizers are common: the typical amounts of plasticizer are around 30%, but they may rise to 70% of the total weight of the material. Nevertheless, they may be volatilized at typical processing temperatures of 150-200°C. The basic reaction in the degradation of PVC is the elimination of hydrogen chloride, with subsequent fragmentation of the remaining polyene chain followed by combination of the fragments to form aromatic hydrocarbons (benzene). The formation of hydrogen chloride seems to be a good indicator of PVC polymer decomposition, since it is the major degradation product at processing temperatures. Di-2-ethylhexylphthalate (DEHP) is the plasticizer most commonly used in PVC plastics. DEHP may also decompose at the temperatures used in PVC processing and one of the products is phthalic anhydride, which is an irritant and a sensitizer.
Chemical concentration:	30% of PVC up to 70% by weight of the material may be made up of plasticizers.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so sampling methodology is likely error free.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data from Britain (UK), an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to conditions of use listed.
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain 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:	Vandervort, R., Brooks, S. M. (1977). Polyvinyl chloride film thermal decomposition products as an occupational illness: I. Environmental exposures and toxicology. Journal of Occupational and Environmental Medicine 19(3):188-191.
HERO ID:	59547
Conditions of Use:	Production of PVC film for meat wrapping

EXTRACTION

Parameter	**Data**
Process description:	Film ingredients are melted or dissolved, mixed, blown-bubble extruded or solvent cast, and the finished film is wound on rolls and cut to size for sale. Although these film making processes are Widely applied in industry, the operating parameters, techniques and accessory equipment are basically developed by each manufacturer and are considered proprietary. The finished film has a thickness of several ten-thousandths of an inch (typically 0.00075 inches.
Chemical concentration:	plasticizers in PVC wrappings can be up to 30% of the film

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 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 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	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	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination — High

Study Citation:	Vandervort, R., Brooks, S. M. (1977). Polyvinyl chloride film thermal decomposition products as an occupational illness: I. Environmental exposures and toxicology. Journal of Occupational and Environmental Medicine 19(3):188-191.
HERO ID:	59547
Conditions of Use:	Adhesive Formulation for Labels

EXTRACTION

Parameter	**Data**
Process description:	Adhesive ingredients are combined in a water emulsion/dispersion and applied to the paper stock by a knife coating process. Coated label stock is dried and wound into rolls. later the label stock is printed with the design/advertising requested by the customer.
Chemical concentration:	plasticizers in adhesives can be up to 60%

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 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 20 years old. The report captures operations, equipment, and worker activities 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	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:	VHG Labs, (2017). Safety Data Sheet (SDS): Semivolatile Mix, 1,000 mg.L in Methylene chloride (RM, ISO GUIDE 34).
HERO ID:	6301645
Conditions of Use:	Laboratory chemicals

EXTRACTION

Parameter	**Data**
Chemical concentration:	$< 0.1\%$
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination High

Study Citation:	Wainwright, M. S., Foster, N. R. (1979). Catalysts, kinetics, and reactor design in phthalic-anhydride synthesis. Catalysis Reviews: Science and Engineering 19(2):211-292.
HERO ID:	5178986
Conditions of Use:	Manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Phthalic anhydride is generally produced by the vapor-phase oxidation of o-xylene or naphthalene over vanadium pentoxide catalysts. In recent years o-xylene has become the preferred raw material due to its lower cost, availability, and ease of transportation. However, in certain countries where there are small-scale petrochemical industries and large-scale steel plants, naphthalene is still used. Most of the phthalic anhydride produced in the USSR is made from naphthalene [1]. As crude oil supplies dwindle, naphthalene from coal will doubtless become a more attractive feedstock [2]. Source provides more information on reaction equations, kinetics, rates of reaction, and catalysts.

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	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to 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	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	Information 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	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination High

Study Citation:	Waterlox Coatings Corporation, (2015). Safety Data Sheet (SDS): Marine Finish Satin Sheen.
HERO ID:	12907681
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	2.5 - 10%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination	**High**

Study Citation:	Waterlox Coatings Corporation, (2015). Safety Data Sheet (SDS): Original Marine Finish High Gloss.
HERO ID:	6584217
Conditions of Use:	Paints/coatings

EXTRACTION

Parameter	**Data**
Chemical concentration:	2.5 - 10%
Physical form:	Liquid

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Supplier SDS expected to be accurate and without 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	High	SDS is less than 10 years old.
	Metric 5:	Sample Size	N/A	Sample data not applicable to SDS.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	SDS provides metadata including composition and physical form.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability is characterized by the range of potential concentrations. However, uncertainty in the chemical concentration is not addressed.

Overall Quality Determination	**High**

Study Citation:	Wei, Z., Zhou, F., Chen, S., Zhao, H. (2022). Composition, properties, and utilization of fumaric acid sludge by-produced from industrial phthalic anhydride wastewater treatment. Polymers 14(23):5169.
HERO ID:	12191625
Conditions of Use:	Disposal - WWTP

EXTRACTION

Parameter	**Data**
Production, import, or use volume:	Source states that for about 150,000 tons of phthalic anhydride generated, there will be about 4,000 tons of fumaric acid sludge (which contains 0.2 to 0.3% phthalic anhydride).
Life cycle description:	Phthalic anhydride is manufactured which creates organic tail gas which ultimately makes its way through the wastewater treatment process to create fumaric acid sludge (which contains residual amounts of phthalic anhydride)
Process description:	The organic tail gas generated in the production of phthalic anhydride will turn into acidic organic wastewater after washing with water. Thiourea is added to acidic organic wastewater to make maleic acid isomerize into fumaric acid, and then after cooling, crystallization, and centrifugation, acidic organic wastewater becomes fumaric acid wastewater. The red and black fumaric acid wastewater was flocculated, precipitated, and dried to obtain powdery solid fumaric acid sludge (FAS). The generated process of fumaric acid sludge (FAS) is shown in Figure 1 (PDF page 2).
Chemical concentration:	Conclusions state 0.2 - 0.3% PAD by mass within fumaric acid sludge (FAS); Table 6 states it to be between 0.234 and 0.244 %.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The release data methodology is described well and expected to be accurate.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	Data is from China, a non-OECD country.
	Metric 3:	Applicability	High	Data is for an in-scope use, disposal through WWTPs.
	Metric 4:	Temporal Representativeness	High	Data is from within the last 10 years.
	Metric 5:	Sample Size	High	Data samples are characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Release data include the metadata such as media, and high level of detail of the source of the release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Source does not address variability or uncertainty.

Overall Quality Determination High

Study Citation:	Wernfors, M., Nielsen, J., Schütz, A., Skerfving, S. (1986). Phthalic anhydride-induced occupational asthma. International Archives of Allergy and Applied Immunology 79(1):77-82.
HERO ID:	5176303
Conditions of Use:	Processing - resin manufacturing

EXTRACTION

Parameter	**Data**
Chemical concentration:	Fraction of respirable PA dust used in bagging was 40 and 46%.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so sampling and analytical methodology likely error free.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is from Sweden, an OECD country
	Metric 3:	Applicability	High	Applicable to condition of use for processing into resins.
	Metric 4:	Temporal Representativeness	Low	Data is 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	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:	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:	US production: 985 million pounds in 1974, 709 million pounds in 1975, 902 million pounds in 1976

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	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	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	Medium	The report provides only limited discussion of the variability and uncertainty in the results.

Overall Quality Determination	**Medium**

Study Citation:	Wicks, Z. W., Jr, Jones, F. N. (2013). Coatings.
HERO ID:	6301611
Conditions of Use:	Processing: Intermediate in paint and coating manufacturing

EXTRACTION

Parameter	**Data**
Process description:	Polyester resins for coatings are produced by direct esterification of dialcohols or polyalcohols with a mixture of aliphatic and aromatic (or cycloaliphatic) diacids (or diesters) at elevated temperatures, often around 200 C. . The most common diacid is probably phthalic acid; it is expedient to make the resins from phthalic anhydride (PA) (1,3-isobenzofurandione) [85-44-0].

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	The source uses high quality data and/or techniques or sound methods that are from frequently used sources (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 source includes information for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The source 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	N/A	No sample data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, andassumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - Process Description

Overall Quality Determination **High**

Study Citation:	Yokota, K., Johyama, Y., Yamaguchi, K., Takeshita, T., Morimoto, K. (1999). Exposure-response relationships in rhinitis and conjunctivitis caused by methyltetrahydrophthalic anhydride. International Archives of Occupational and Environmental Health 72(1):14-8. [International archives of occupational and environmental health].
HERO ID:	5175237
Conditions of Use:	Industrial use - hardener for epoxy resin system

EXTRACTION

Parameter	**Data**
Process description:	The two plants (A and B) that were investigated were involved in the manufacture of condensers for electric appliances. MTHPA is used as a hardener in an epoxy resin system for electric insulation and protection. The manufacturing process in each plant consisted of assembly (zone 1), loading and hardening (zone 2), and inspection (zone 3). After the condensers have been assembled automatically, a small amount of epoxy resin mixture is poured into them. They pass through a curing oven at a temperature of 100 °C. After curing, they are tested electrically.
Comments:	This chemical evaluated is methyltetrahydrophthalic anhydride (MTHPA) which is similar to PA and its exposure levels are compared to what the exposure standards are for PA. It has a similar condition of use so extraction was conducted.

EVALUATION

Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	Source is peer reviewed so sampling and analytical methodology likely to contain no errors
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data appears to be from Japan, an OECD country.
	Metric 3:	Applicability	Low	Data is for a chemical similar to PA in an identical condition of use.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	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	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	Medium	Addresses variability by assessing data over a few years on different industrial plants. Does not address uncertainty.

Overall Quality Determination — Low

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HERO ID:	5178667
Conditions of Use:	Processing

EXTRACTION

Parameter	**Data**
Process description:	The diglycidyl ester of phthalic acid is used as a powerful thinner to improve the processing of the epoxy resin EPIDIAN 5 without destroying the elastic and optical properties and the degree of elasticity of the crosslinked resin. These esters can be produced in 4 ways: 1. Direct esterification of glycidol with acid chlorides, which is a multi-step process and requires quite expensive raw materials 2. Reaction of carboxylic acids with epichlorohydrin to produce a-carboxylic esters of a- chloropropyleneglycol, which further undergoes dehydrohalogenation by alcali to form the corresponding glycidyl ester. However the overall yield of this method is low 3. The glycidyl ester may be directly prepared by the reaction of a fatty acid with a large excess of epichlorohydrin, in the presence of an ammonium halide as a catalyst. An obvious drawback of this method is the use of large quantities of epichlorohydrin. Furthermore the reaction products can not be easily purified 4. Reaction of carboxylic acid salts with epichlorohydrin gives glycidyl esters with higher yields while there is no production of HCI during the reaction. The HCI would hydrolyze the epichlorohydrin. necessitating thus the use of large excess of the reactant. Consequently products of higher purity are obtained. However, traces of moisture may significantly lower the yield. Recently, another method for the preparation of glycidyl esters has been developed and has shown significant potential for an industrial scale application. The method consists of two discrete stages (chemical reactions). The first stage aims at the preparation of the sodium salt of the monoester of a dicarboxylic acid (reaction I), while the procedure is completed by the reaction of epichlorohydrin with the product of the first stage under the presence of a catalyst (reaction 11) (see Fig. 1). This method has been found to be superior to those reported in the literature, on the grounds of accessibility of raw materials, smooth reaction conditions and high yields and purity of products. Furthermore byproducts are easily separated. Figure 2 shows the experimentally measured yields for reactions I and I1 for ten discrete runs.

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 Greece, an OECD country.
	Metric 3:	Applicability	High	Data are for incorporation into plasticizers in epoxy curing agents, 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	Missing Comment
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	Missing Comment

Overall Quality Determination — NEED TO QC

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EVALUATION

Domain	Metric	Rating	Comments