December 1, 2021

Data Gathering and Analysis Division
Office of Pollution Prevention and Toxics
United States Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460-0001
ATTN: Mr. David Turk

RE: 40 CFR Part 716 Health and Safety Data Reporting Rule for High-Priority Substances

Dear Mr. Turk,

U.S. Environmental Protection Agency's (EPA) July 27, 2021 Health and Safety Data Reporting Rule[1] requires manufacturers (including importers) of 20 chemicals designated by EPA as high-priority substances for risk evaluation to report certain lists and copies of unpublished health and safety studies to EPA. The Vinyl Institute,[2] in accordance with 40 C.F.R. § 716.20(a)(10), is submitting potentially reportable health and safety studies developed as part of its work on the TSCA risk evaluations for 1,2-dichloroethane, 1,1-dichloroethane, 1,1,2-trichloroethane, and trans-1,2-dichloroethylene. These documents are explained below.

A. **Dry Resin Exposure Reverse Calculation** - In this document, a reverse calculation was performed to reach a residual ethylene dichloride concentration in dry resin that would not result in a risk greater than 10^{-4} to workers, assuming conservative inputs including EPA's out-of-date inhalation unit risk value. This calculation was prepared to assess what EPA might calculate if the Agency took a very conservative approach during risk evaluation, in order to identify and evaluate assumptions and inputs. Accordingly, the calculation used OSHA Particles Not Otherwise Regulated (PNOR) exposure levels and no respiratory protection, contrary to actual exposure levels and PPE. Because these calculations relate to the potential effects of a chemical substance and might be considered modeling, this document is being provided out of an abundance of caution; EPA guidance suggests that even were it modeling, it may not be reportable because of the "worst case" assumptions[3].

[1] 86 Fed. Reg. 34,147, June 29, 2021

[2] The Vinyl Institute (VI), established in 1982, represents the leading producers of vinyl resins and monomers, and ingredient and additive producers for vinyl compounds. The VI serves as the collective voice for the vinyl industry. More information can be found at www.vinylinfo.org.

[3] *See* U.S. EPA, "Questions and Answers: Applicability of TSCA Section 8(d) Model Health and Safety Data Reporting Rule (40 CFR Part 716) to Modeling Studies," *available at:* https://www.epa.gov/system/files/documents/2021-09/1989-reporting-guide-for-tsca-8d.pdf.

B. **EDC Byproduct-Impurity Air Monitoring Data Review** - This document compiled air concentration data (where available) for ethylene dichloride manufacturing impurities and/or byproducts (including 1,1-dichloroethane; 1,1,2-trichloroethane; and trans-1,2-dichloroethylene) from U.S. EPA or state agency monitoring sites. Air monitoring data for Kentucky and Louisiana were obtained from the EPA Ambient Monitoring Archive for hazardous air pollutants (HAPs) and monitoring data for Texas were obtained from the Texas Commission on Environmental Quality's (TCEQ) Texas Air Monitoring Information System (TAMIS). Because this report is not merely an aggregation of publicly available monitoring data, it is being submitted out of an abundance of caution.

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Please do not hesitate to contact me with any questions.

Sincerely,

Richard Krock

Richard P. Krock
Senior Vice President, Regulatory and Technical Affairs
e-mail: rkrock@vinylinfo.org

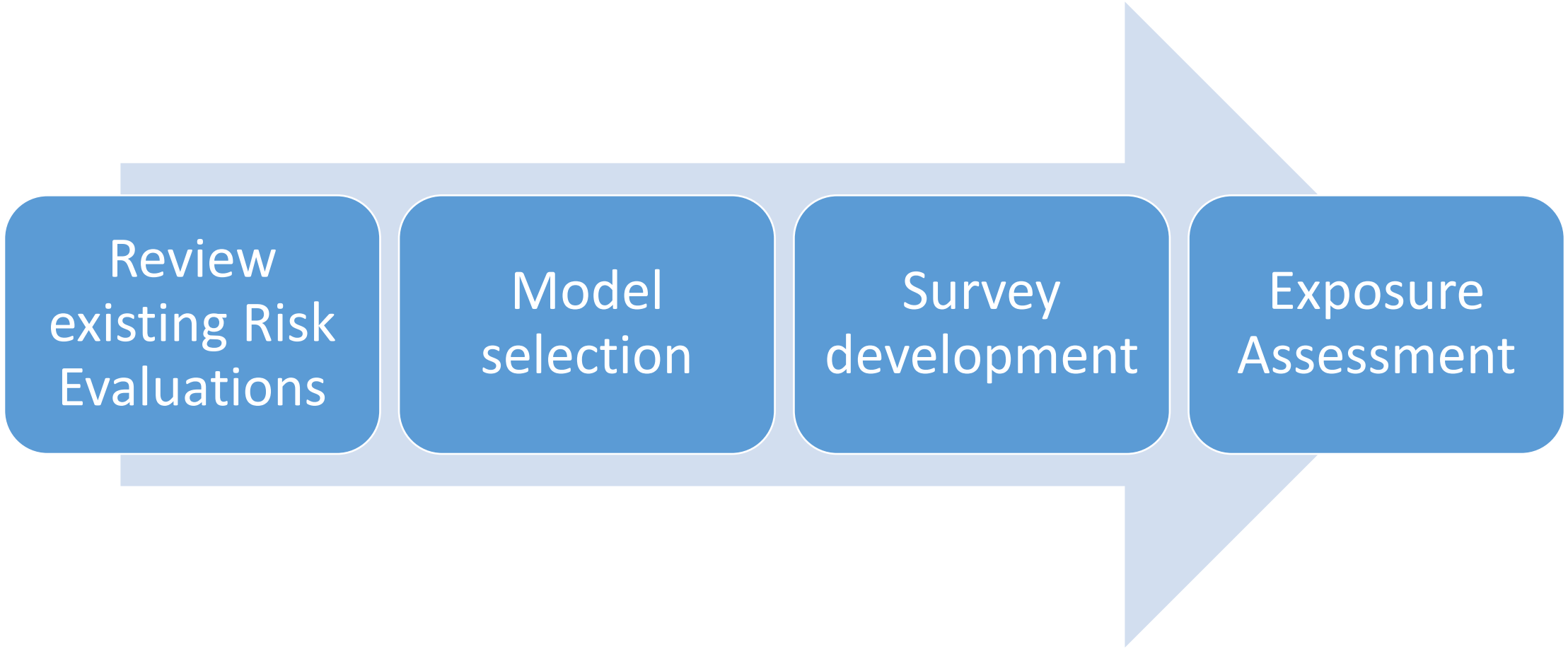
4854-2709-7604, v. 3

Task 1: Dry Resin Exposure Modeling

Task Description

- Purpose
  - Back-calculate a residual EDC concentration in dry resin that would not result in unreasonable riskCharacterize potential exposures across work tasks relevant to Vinyl Institute
- Worker scenario: particle exposures from handling dry plastic resins and finishing operations during manufacture of plastics or plastic articles
  - Primary (quantitative) pathway: inhalation
  - Secondary (qualitative) pathways: incidental ingestion, hand-to-mouth

Approach


Review existing Risk Evaluations
Model selection
Survey development
Exposure Assessment

Existing TSCA Worker Exposure Modeling

- Chlorinated solvents – no particle exposure modeling
- HBCD – 1 particle exposure scenario was modeled (v. measured data)
  - Inhalation exposure only (no hand-to-mouth, ingestion)
  - *Demolition and Disposal of XPS/EPS Foam Insulation Products in Residential, Public and Commercial Buildings, and Other Structures*
- Screening model in HBCD risk evaluation
  - No measured data
  - PNOR method (**P**articles **N**ot **O**therwise **R**egulated)
    - **OSHA PEL PNOR, Total Dust (15 mg/m^3) × HBCD% = Worker 8-HR TWA Exposure**
    - Assumed all of total dust was HBCD-containing foam generated from condition of use
  - Risk Characterization – non-cancer endpoints only; no exceedances with respiratory protection

Refined Exposure Modeling - Background

- Refined exposure modeling may be necessary because of cancer health endpoint for EDC and the IRIS IUR
- ChemSTEER – EPA/OPPT Small Volume Solids Handling Inhalation Model
  - Small volume = less than 54 kg/day
  - Activities for cleaning from transport container/vessels, loading/unloading solids into transport containers/vessels, equipment cleaning, miscellaneous activities related to solid processing
  - Defined emission factors built into model

Refined Exposure Modeling - Survey

- Model parameters served as the quantitative basis for the survey
  - Responses will be blinded and grouped to provide a range of exposure characterization for the model
- Primary information requested in the survey include
  - Qualitative: Industrial hygiene and safety measures
  - Quantitative: Mass handled continuously or in batches/containers, frequency of task, number of workers

Exposure Assessment: Worker Cancer Risk

$$LADC = \frac{C \times CF \times ED \times EF \times WY}{AT_C} \qquad Risk = LADC \times IUR$$

- LADC = Lifetime average daily concentration (µg/m^3)
- **C = Airborne concentration (8-hr TWA; mg/m^3)**
  - **PNOR: C = 15 mg/m^3 × EDC%**
  - **ChemSTEER: C = refined algebraic model equation**
- CF = Conversion factor (1000 µg/mg)
- ED = Exposure duration (8 hr/day)
- EF = Exposure frequency (250 day/yr)
- WY = Worker exposure years (50th%ile = 31 yr; 95th%ile = 40 yr)
- AT_c = Cancer averaging time (78 yr × 250 day/yr × 8 hr/day)

- Risk = 10^{-4} (1 in 10,000 acceptable risk)
- IUR = 2.6×10^{-5} per µg/m^3

PNOR Back-Calculation (assuming no respiratory protection)

$$EDC\% = \frac{Risk \times AT_C}{PNOR\ PEL \times CF \times ED \times EF \times WY \times IUR}$$

$$EDC_{50th\%ile\ WY} = \frac{10^{-4} \times 156{,}000\ hr}{15\ \frac{mg}{m^3} \times 1000 \frac{\mu g}{mg} \times 8 \frac{hr}{d} \times 250 \frac{d}{yr} \times 31\ yr \times 2.6 \times 10^{-5} \frac{m^3}{\mu g}} = 0.065\%$$

$$EDC_{95th\%ile\ WY} = \frac{10^{-4} \times 156{,}000\ hr}{15\ \frac{mg}{m^3} \times 1000 \frac{\mu g}{mg} \times 8 \frac{hr}{d} \times 250 \frac{d}{yr} \times 40\ yr \times 2.6 \times 10^{-5} \frac{m^3}{\mu g}} = 0.050\%$$

SUMMARY OF ETHYLENE DICHLORIDE (EDC) IMPURITY/BYPRODUCT AIR CONCENTRATIONS IN PROXIMITY TO EDC PRODUCTION FACILITIES IN KENTUCKY, LOUISIANA, AND TEXAS

Prepared by: Cardno ChemRisk

Prepared for: Vinyl Institute

February 26, 2021

Overview of Air Monitoring Databases

Air concentration data were compiled (where available) for ethylene dichloride (EDC) impurities and/or byproducts from U.S. EPA or state agency monitoring sites. The following EDC impurities/byproducts were evaluated: 1,1-dichloroethane (75-34-3); 1,1,2-trichloroethane (79-00-5); trans-1,2-dichloroethylene (156-60-5); trichloroethylene (79-01-6); perchloroethylene (127-18-4); methylene chloride (75-09-2); and carbon tetrachloride (56-23-5).

Air monitoring data for Kentucky and Louisiana were obtained from the EPA Ambient Monitoring Archive for hazardous air pollutants (HAPs) and monitoring data for Texas were obtained from the Texas Commission on Environmental Quality's (TCEQ) Texas Air Monitoring Information System (TAMIS). Concentration data selected for analysis were collected at monitoring stations located within approximately five miles of 11 EDC producer facilities in Kentucky (one facility), Louisiana (six facilities), and Texas (four facilities). The five-mile radius was selected based on the modeling of EDC emissions from chemical facilities (as conducted by Cardno ChemRisk in 2019/2020); beyond the five-mile cut-off, ambient EDC concentrations were found to be negligible, suggesting that EDC concentrations sampled beyond this distance may arise from other sources. A summary of the monitoring site locations is provided in Table 1. The air concentrations were collected via canister and analyzed via gas chromatography, gas chromatography/mass spectrometry, and/or flame ionization detection.

Air Monitoring Data Analysis

Of the EDC byproducts/impurities evaluated, air concentration data were reported in the HAPs and TCEQ databases for all chemicals except trans-1,2-dichloroethylene (156-60-5); no other federal or state data sources for air monitoring data were found for this chemical. For the other six impurities/byproducts, 24-hour air sample data were compiled and analyzed from the federal and state databases.

Summary statistics (mean, median, minimum, and maximum) were determined for the overall data set across all study years and monitoring sites. In addition, average minimum and maximum air concentrations were calculated across monitoring sites and study years. A summary of the years of monitoring and overall and weighted average summary statistics are reported in Tables 2 to 7 for each EDC byproduct/impurity by state. Data quality and potential limitations on data for each site were also reviewed.

Table 1. Selected EPA and TCEQ Monitoring Sites

State	Agency	Region	County	TCEQ Region	AQS/AMA Site Code	Site Name	Latitude	Longitude	EDC Facility No.	Distance between EDC Facility and Monitoring Station (mi)
KY	USEPA (HAP Reporting)	-	-	-	211570016	KY Monitor 10	37.04176	-88.35407	17	1.43
KY	USEPA (HAP Reporting)	-	-	-	211570018	KY Monitor 11	37.02702	-88.34387	17	1.63
KY	USEPA (HAP Reporting)	-	-	-	211570019	KY Monitor 12	37.03718	-88.33411	17	0.77
KY	USEPA (HAP Reporting)	-	-	-	211390004	KY Monitor 8	37.07151	-88.33389	17	1.66
KY	USEPA (HAP Reporting)	-	-	-	211570014	KY Monitor 9	37.0452	-88.33087	17	0.19
LA	USEPA (HAP Reporting)	-	-	-	220050004	LA Monitor 1	30.229653	-90.965628	10	3.01
LA	USEPA (HAP Reporting)	-	-	-	220190008	LA Monitor 3	30.262604	-93.285084	7	0.92
LA	USEPA (HAP Reporting)	-	-	-	220330004	LA Monitor 4	30.461023	-91.187886	3	2.3
LA	USEPA (HAP Reporting)	-	-	-	220330009	LA Monitor 6	30.461981	-91.179219	3	2.14
TX	TCEQ	Houston	Harris	12	482010058	Baytown	29.7706975	-95.0312316	13	4.02

State	Agency	Region	County	TCEQ Region	AQS/AMA Site Code	Site Name	Latitude	Longitude	EDC Facility No.	Distance between EDC Facility and Monitoring Station (mi)
TX	TCEQ	Houston	Brazoria	12	480391003	Clute	29.0108409	-95.397744	2	4.11
TX	TCEQ	Houston	Harris	12	482011039	Houston Deer Park #2	29.670025	-95.1285077	13	5.06
TX	TCEQ	Houston	Harris	12	482010803	HRM #3 Haden Rd	29.7647877	-95.1785379	12	4.77
TX	TCEQ	Houston	Harris	12	482010036	Jacinto Port	29.7761	-95.1051	13	3.74
TX	TCEQ	Houston	Harris	12	482011015	Lynchburg Ferry	29.758889	-95.079444	13	2.15
TX	TCEQ	Houston	Harris	12	482011049	Pasadena North	29.716606	-95.222603	12	5.73
TX	TCEQ	Houston	Harris	12	482011041	San Jacinto Monument	29.751944	-95.083333	13	1.71

Table 2. 24-Hour 1,1,2-TCA Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m^3)	Median Concen. (µg/m^3)	Min. Concen. (µg/m^3)	Ave. Min. Concen. (µg/m^3)	Max. Concen. (µg/m^3)	Ave. Max. Concen. (µg/m^3)
KY	EPA AMA (for HAPs)[a]	2012-2017	1309	0.0655	0.0518	0.0327	0.0425	0.485	0.304
LA	EPA AMA (for HAPs)[b]	1990-2003	889	0.108	0.0546	0.0136	0.051	5.56	1.03
TX	TCEQ TAMIS[c]	1995-2020	8409	0.0296	0.0273	0.0273	0.0273	0.927	0.268

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m^3) to 0.022 ppb (0.012 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m^3) to 0.05 ppb (0.31 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m^3) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

The Kentucky HAP dataset contained 1,309 1,1,2-trichloroethane (1,1,2-TCA) air samples measured at five monitoring stations within five miles of VI facilities from 2012 to 2017. Across all monitoring sites and report years, the average and median 1,1,2-TCA air concentrations are 0.0655 µg/m^3 and 0.0518 µg/m^3, respectively. Absolute minimum and maximum concentrations range from 0.0327 to 0.485 µg/m^3 with an average minimum of 0.0425 µg/m^3 and an average maximum of 0.304 µg/m^3. The Louisiana HAP database contains 889 1,1,2-TCA samples collected at four monitoring stations over the report timeframe 1990 to 2003. The mean and median concentrations for the chemical of interest are 0.108 µg/m^3 and 0.0546 µg/m^3 (0.0136-5.56 µg/m^3). Across eight monitors in the state of Texas from 1995 to 2020, the average and median 1,1,2-TCA concentrations are 0.0296 µg/m^3 and 0.0273 µg/m^3 (0.0273-0.927 µg/m^3).

Table 3. 24-Hour 1,1-DCA Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m^3)	Median Concen. (µg/m^3)	Min. Concen. (µg/m^3)	Ave. Min. Concen. (µg/m^3)	Max. Concen. (µg/m^3)	Ave. Max. Concen. (µg/m^3)
KY	EPA AMA (for HAPs)[a]	2012-2017	1277	0.0409	0.0304	0.0202	0.0272	0.287	0.198
LA	EPA AMA (for HAPs)[b]	1990-2003	821	0.121	0.0405	0.0101	0.0365	10.6	1.80
TX	TCEQ TAMIS[c]	1994-2002, 2004-2020	7997	0.0211	0.0202	0.0202	0.0202	0.566	0.133

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m^3) to 0.022 ppb (0.012 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m^3) to 0.05 ppb (0.31 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m^3) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

A total of 1,277 1,1-dichloroethane (1,1-DCA) air samples were collected at the five Kentucky monitoring stations between 2012 and 2017. Mean and median concentrations are 0.0409 µg/m^3 and 0.0304 µg/m^3 with an absolute range of 0.0202 to 0.287 µg/m^3. From 1990 to 2003, 821 total samples were collected at four Louisiana monitoring sites; the mean and median concentrations are 0.121 µg/m^3 and 0.0405 µg/m^3 (0.0101-10.6 µg/m^3). For the 7,997 1,1-DCA samples collected across the eight Texas monitors, the mean and median concentrations are 0.0211 and 0.0202 µg/m^3 (0.0202-0.566 µg/m^3).

Table 4. 24-Hour DCM Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m^3)	Median Concen. (µg/m^3)	Min. Concen. (µg/m^3)	Ave. Min. Concen. (µg/m^3)	Max. Concen. (µg/m^3)	Ave. Max. Concen. (µg/m^3)
KY	EPA AMA (for HAPs)[a]	2012, 2015-2017	95	0.213	0.215	0.118	0.137	0.406	0.332
LA	EPA AMA (for HAPs)[b]	1990-2003	846	0.855	0.382	0.0174	0.142	170	8.05
TX	TCEQ TAMIS[c]	1992-2020	8634	0.567	0.278	0.0174	0.0174	296	20.5

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m^3) to 0.022 ppb (0.012 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m^3) to 0.05 ppb (0.31 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m^3) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

Due to a high number of quality control issues in the Kentucky dataset, only 95 total methylene chloride (DCM) samples were analyzed corresponding to report years 2012, 2015, 2016, and 2017. The mean and median concentrations for this data set are 0.213 µg/m^3 and 0.215 µg/m^3 with an absolute range of 0.118 µg/m^3 to 0.406 µg/m^3. For the Louisiana monitoring data, the 846 samples collected between 1990 and 2003 have a mean DCM concentration of 0.855 µg/m^3 and a median concentration of 0.382 µg/m^3 (0.0174-170 µg/m^3). For the 8,634 DCM samples collected across the Texas monitoring sites from 1992 to 2020, the mean and median concentrations are 0.567 and 0.278 µg/m^3 (0.0174-296 µg/m^3).

Table 5. 24-Hour CCl_4 Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m³)	Median Concen. (µg/m³)	Min. Concen. (µg/m³)	Ave. Min. Concen. (µg/m³)	Max. Concen. (µg/m³)	Ave. Max. Concen. (µg/m³)
KY	EPA AMA (for HAPs)[a]	2012, 2014, 2016-2017	5	0.435	0.327	0.157	0.409	0.931	0.461
LA	EPA AMA (for HAPs)[b]	1990-2003	903	0.831	0.629	0.0315	0.308	33.0	5.79
TX	TCEQ TAMIS[c]	1992-2020	8526	0.711	0.629	0.0314	0.0821	42.9	6.53

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m³) to 0.022 ppb (0.012 µg/m³), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m³) to 0.05 ppb (0.31 µg/m³), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m³) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

The Kentucky monitoring data for carbon tetrachloride was also significantly reduced due to the number of reported quality control issues; only five samples collected in 2012, 2014, 2016, and 2017 remained in the dataset once all samples impacted by data quality or near-interference were excluded. 903 carbon tetrachloride samples collected across Louisiana monitoring sites between 1990 and 2003. The mean and median concentrations for this dataset are 0.831 µg/m³ and 0.629 µg/m³ (0.0315-33 µg/m³). Across the state of Texas, 8,526 samples were collected for carbon tetrachloride from 1992 to 2020; the mean concentration is 0.711 µg/m³ and the median concentration is 0.629 µg/m³ (0.0314-42.9 µg/m³).

Table 6. 24-Hour PERC Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m^3)	Median Concen. (µg/m^3)	Min. Concen. (µg/m^3)	Ave. Min. Concen. (µg/m^3)	Max. Concen. (µg/m^3)	Ave. Max. Concen. (µg/m^3)
KY	EPA AMA (for HAPs)[a]	2012-2017	1321	0.0725	0.0610	0.0271	0.0317	0.617	0.317
LA	EPA AMA (for HAPs)[b]	1990-2003	897	0.886	0.214	0.0214	0.0948	60.5	9.50
TX	TCEQ TAMIS[c]	1992-2020	8663	0.148	0.0678	0.0339	0.0339	9.08	2.43

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m^3) to 0.022 ppb (0.012 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m^3) to 0.05 ppb (0.31 µg/m^3), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m^3) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

A total of 1,321 tetrachloroethylene (PERC) air samples were collected at the five Kentucky monitoring stations between 2012 and 2017. Mean and median concentrations are 0.0.0725 µg/m^3 and 0.0610 µg/m^3 with an absolute range of 0.0271 µg/m^3 to 0.617 µg/m^3. From 1990 to 2003, 8,287 total samples were collected at the four Louisiana monitoring sites; the mean and median concentrations are 0.886 µg/m^3 and 0.214 µg/m^3 (0.0214-60.5 µg/m^3). For the 8,663 PERC samples collected across the eight Texas monitors from 1992 to 2020, the mean and median concentrations are 0.148 and 0.0678 µg/m^3 (0.0339-9.08 µg/m^3).

Table 7. 24-Hour TCE Air Monitoring Data at Sites within 5 Miles of EDC Production Facilities

State	Data Source	Years of Monitoring	No. of Samples	Mean Concen. (µg/m³)	Median Concen. (µg/m³)	Min. Concen. (µg/m³)	Ave. Min. Concen. (µg/m³)	Max. Concen. (µg/m³)	Ave. Max. Concen. (µg/m³)
KY	EPA AMA (for HAPs)[a]	2012-2017	1325	0.0559	0.0457	0.0269	0.0314	0.263	0.230
LA	EPA AMA (for HAPs)[b]	1990-2003	890	0.853	0.0537	0.0107	0.0115	133	11.4
TX	TCEQ TAMIS[c]	1992-2020	8668	0.126	0.0269	0.0269	0.0269	274	5.89

[a]For KY EDC HAP data, all air concentrations that were invalidated by the KYDEP and that contained the above-mentioned qualifiers were removed. Non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.005 ppb (0.02 µg/m³) to 0.022 ppb (0.012 µg/m³), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[b]For LA EDC HAP data, non-detects reported as 0 were changed to ½ the reported MDLs for the purposes of calculating summary statistics, which ranged from 0.002 ppb (0.012 µg/m³) to 0.05 ppb (0.31 µg/m³), depending on the chemical and analytical method. EPA AMA dataset for HAPs accessible at: https://www3.epa.gov/ttn/amtic/toxdat.html#data.

[c]For TCEQ TAMIS EDC data, JMP dataset containing validated and valid concentration data was used. LabF qualifiers were removed from the dataset. Non-detects reported as 0 were changed to ½ the assumed MRL of 0.01 ppb (0.005 ppb or 0.0202 µg/m³) for the purposes of calculating summary statistics. TCEQ TAMIS dataset accessible at: https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome

The Kentucky dataset contained 1,325 trichloroethylene (TCE) air samples measured at five monitoring stations from 2012 to 2017. The overall average and median TCE air concentrations are 0.0559 µg/m³ and 0.0457 µg/m³, respectively. Absolute minimum and maximum concentrations range from 0.0269 µg/m³ to 0.263 µg/m³. The Louisiana HAP database contains 890 TCE samples collected at four monitoring stations over the 1990 to 2003 report timeframe. The mean and median concentrations for the chemical of interest are 0.853 µg/m³ and 0.0537 µg/m³ (0.0107-133 µg/m³). Across the eight Texas monitors that collected 8,668 TCE samples from 1992 to 2020, the average and median concentrations are 0.126 µg/m³ and 0.0269 µg/m³ (0.0269-274 µg/m³).

- Data Quality and Limitations

The Louisiana HAP dataset contained air concentration data for the EDC impurities and byproducts up until 2003; no monitoring data were available for these chemicals at the monitoring sites of interest in subsequent years. Thus, this data may not represent current air concentrations of these impurities. None of the impurity/byproduct samples were invalidated by the state for quality control issues. In addition, none of the samples were flagged as having been influenced by near-source interference, e.g. chemical spills, fireworks, or wildfires.

Comparatively, the Kentucky HAP database contained a significant number of samples that were invalidated by the state due to quality control (QC) issues or that were influenced by near-source contamination. The samples contained upwards of three tiers of AQS qualifiers denoting QC or near-source influence. All samples with the following Tier 1 qualifiers were removed from the data set: 3, 4, 6, IC, IH, IL, IT, NS, QX, and Y (defined in Table 8 below). However, the number of remaining samples that contained either Tier 2 or 3 qualifiers indicative of quality control problems or source interference was

significant. For example, the proportion of remaining samples that contained the Tier 2 '6' QC qualifier ranged from approximately 67% to 100%, depending on the EDC byproduct/impurity (Table 9). To evaluate a more complete data set, the Kentucky data were analyzed containing both Tier 2 and 3 qualifiers with the exception of the 'NS' near-source qualifier, which was also removed from Tier 2. Note that even with the inclusion of data impacted by QC or source interference, the total number of samples for two EDC byproducts/impurities were drastically lowered: methylene chloride (95 samples) and carbon tetrachloride (5 samples).

Quality control samples reported in the Texas database (flagged as LabF) were removed from the dataset. However, even after the removal of these samples, the Texas TCEQ dataset was the most extensive compared to the other states' – with the largest total sample size reported from 1992 or 1995 to 2020 for each chemical.

Of the three datasets, Cardno ChemRisk recommends that the Vinyl Institute use the TCEQ data to estimate plant contributions of EDC byproducts/impurities to the ambient air. The Louisiana HAP database does not contain monitoring data from the last 18 years, and the monitoring data in the Kentucky HAP database is likely inaccurate due to influence from near-sources and QC issues. Graphs of the overall mean and median concentrations of each byproduct/impurity at Texas sites over time are presented in Figures 1-6.

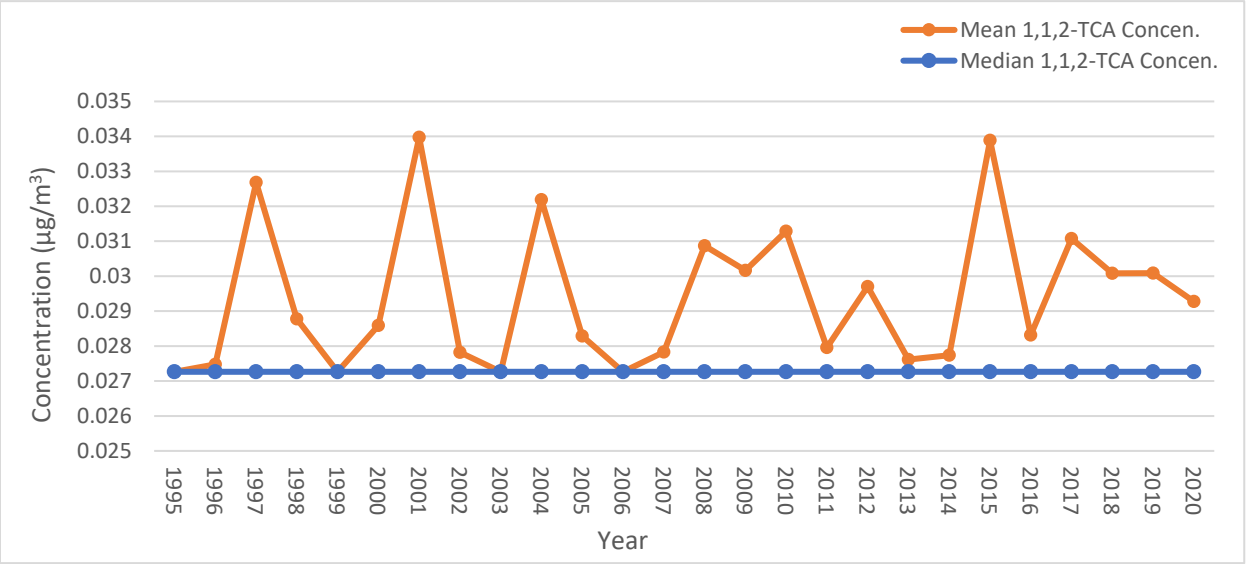
Table 8. Data Qualifiers Reported and Removed from HAP and TCEQ Databases

Database	Data Qualifier Code	Data Qualifier Definition	Reported in Tier No.	Removed from Tier No.
KY EPA HAP	3	Quality assurance - Field issue	1, 2	1
	4	Quality assurance - Lab issue	1, 2	1
	6	Quality assurance – QAPP Issue	1, 2, 3	1
	IC	Chemical spills and industrial accidents	1, 2	1
	IH	Fireworks	1, 2	1
	IL	Other	1	1
	IT	Wildfire	1	1
	NS	Influenced by nearby source	1, 2	1, 2
	QX	Quality assurance – Does not meet QC criteria	1	1
	Y	Quality assurance – Elapsed sample time out of spec.	1	1
LA EPA HAP	None	N/A	N/A	N/A
TX TCEQ TAMIS	LabF	QC failure	Removed from dataset	Removed from dataset

Table 9. Percent of Kentucky EDC Byproducts/Impurities with Select Tier 2 QC Flags

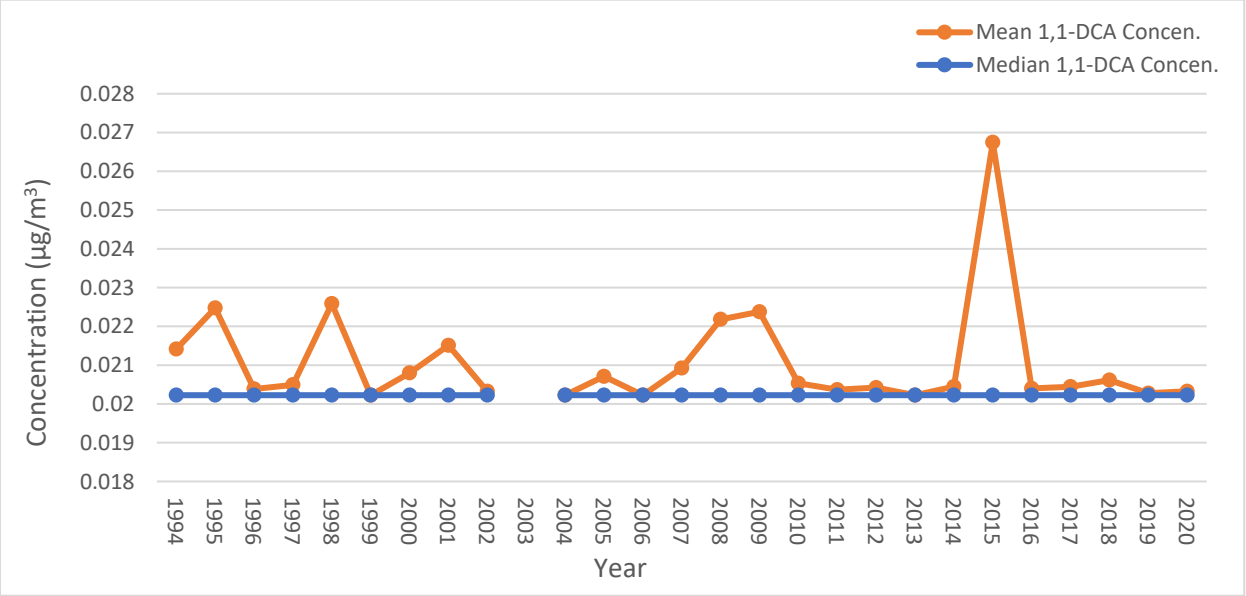
Chemical	Monitoring Years	Qualifier Code	**Percent of Samples with Tier 2 QC Qualifiers** (Samples with Qualifiers/Total Samples)
1,1,2-TCA	2012-2017	6 (QAPP Issue)	90.9% (279/307) – 97.8% (137/140)
1,1-DCA			83.7% (257/307) – 99.4% (166/167)
DCM			95.2% (60/63) – 100% (3/3 and 20/20)
CCl_4			66.7% (2/3) – 100% (3/3)
PERC			92.1% (130/140) – 99.0% (208/210)
TCE			91.6% (304/332) – 99% (204/206)

Figure 1. Mean and Median 1,1,2-TCA Air Concentrations at TX Monitoring Sites (by year)



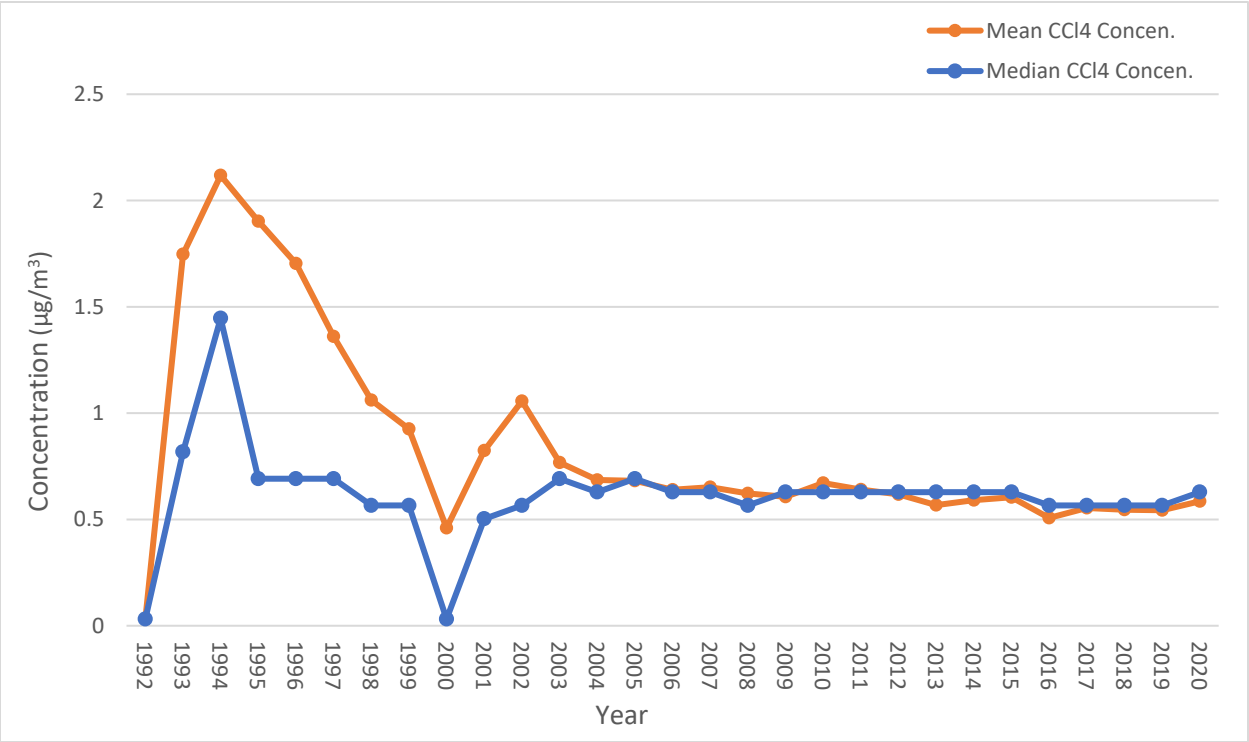
Mean 1,1,2-TCE concentrations have generally fluctuated between 0.027 µg/m^3 and 0.034 µg/m^3 since 1995. A decrease in mean concentrations has occurred since 2017 with levels ranging from approximately 0.0311 µg/m^3 in 2017 to 0.0293 µg/m^3 in 2020. The median concentrations have remained constant at one-half the detection limit of 0.0273 µg/m^3 since 1995.

Figure 2. Mean and Median 1,1-DCA Air Concentrations at TX Monitoring Sites (by year)



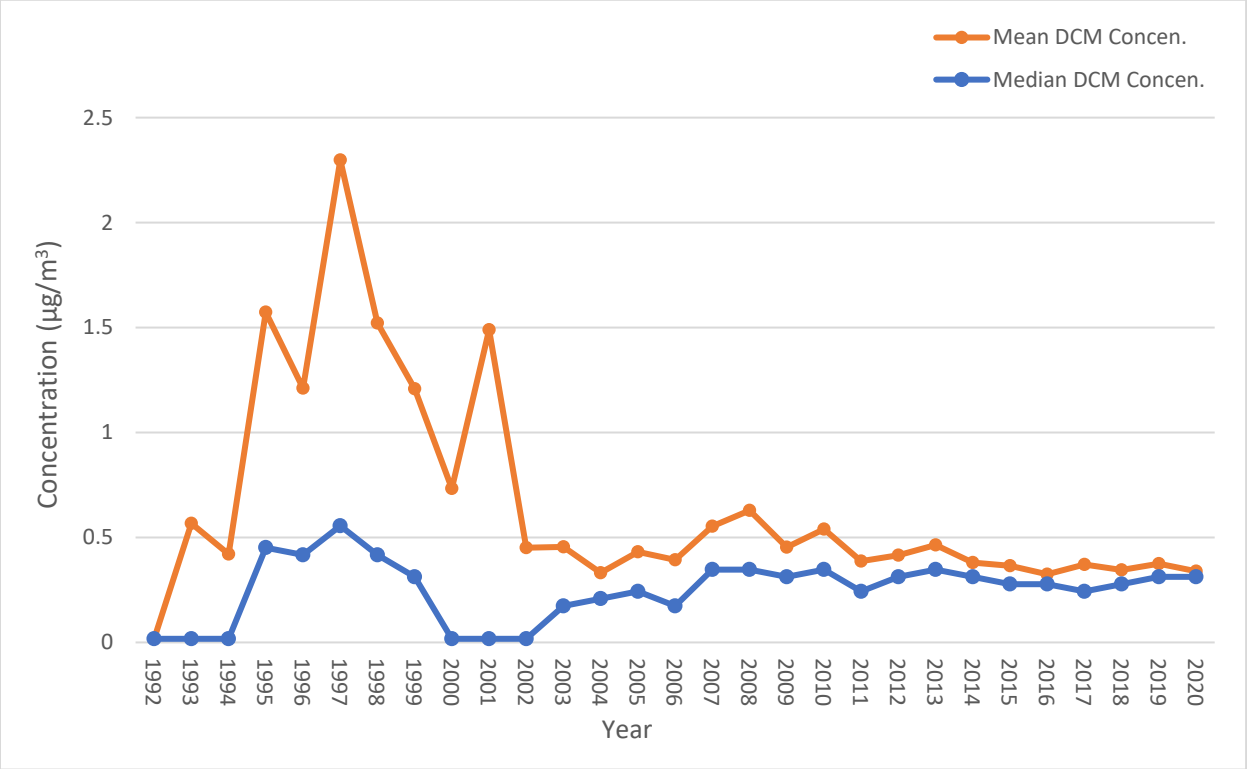
Mean 1,1-DCA concentrations have generally fluctuated between non-detects (assumed to be 0.02 µg/m^3, one-half of the detection limit) and 0.022 µg/m^3 from 1994 to 2002 as well as from 2004 to 2014. The mean concentration peaked in 2015 at approximately 0.0267 µg/m^3 and in subsequent years levels have decreased to be at or slightly above the detection limit. Median 1,1-DCA concentrations have remained at one-half the limit of detection since 1994.

Figure 3. Mean and Median CCl_4 Air Concentrations at TX Monitoring Sites (by year)



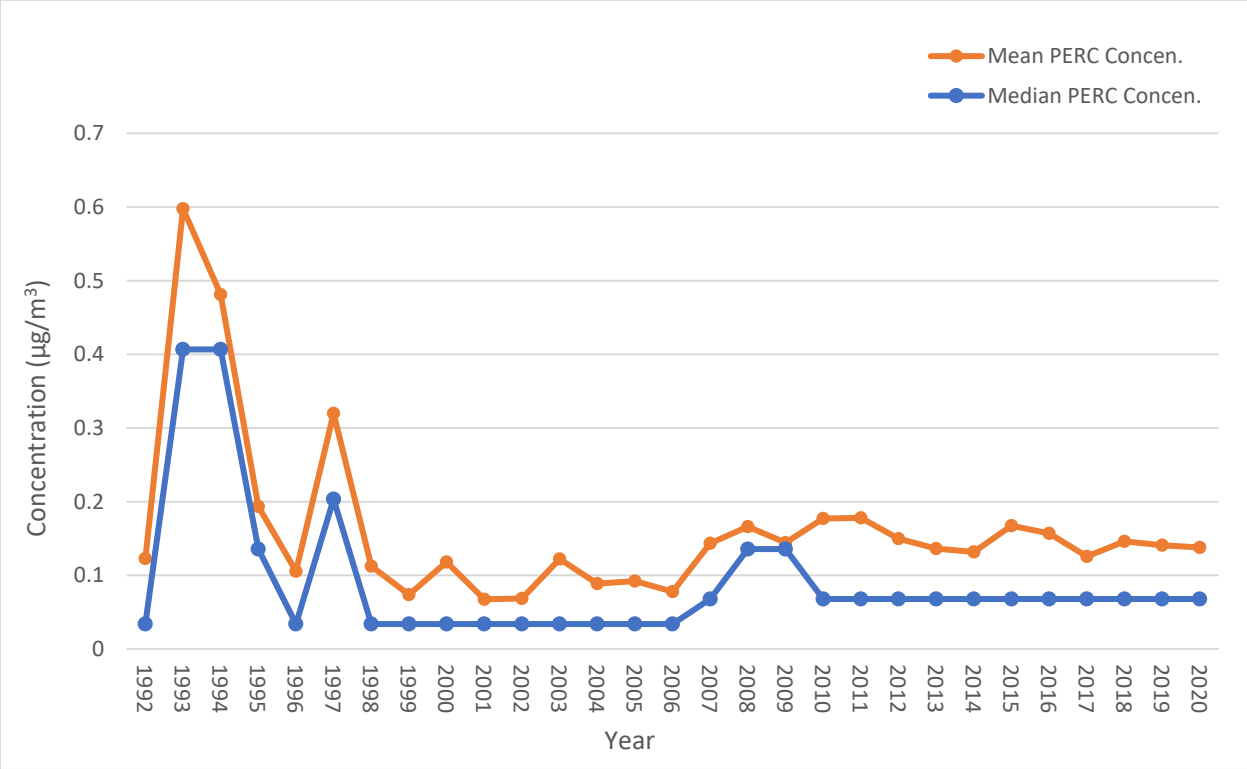
Mean and median CCl_4 concentrations follow a similar trend over time: they peak in 1994 (mean: 2.12 µg/m^3; median: 1.45 µg/m^3); decline throughout the 1990s until 2000 (mean: 0.460 µg/m^3; median: 0.0314 µg/m^3); increase throughout the early 2000s; and plateau as of 2003. Since 2003, mean and median concentrations have generally fluctuated between approximately 0.57 µg/m^3 and 0.63 µg/m^3.

Figure 4. Mean and Median DCM Air Concentrations at TX Monitoring Sites (by year)



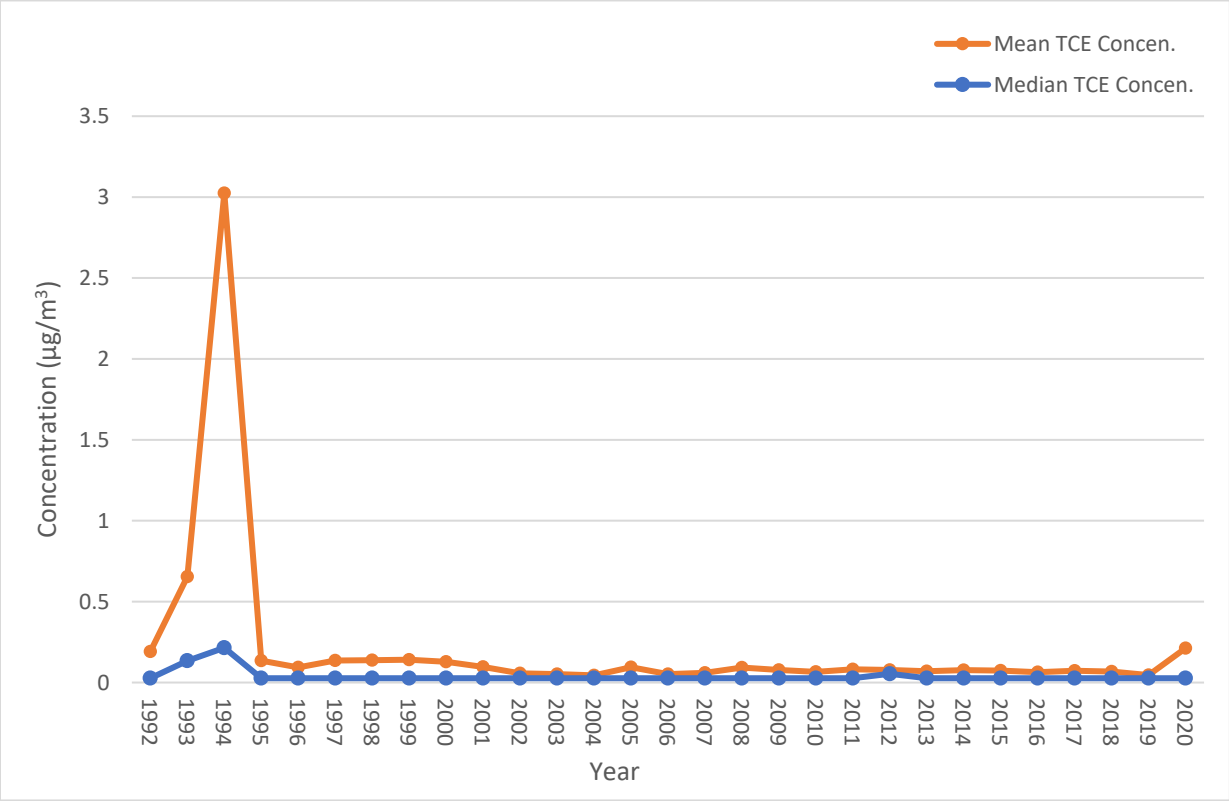
DCM mean concentrations underwent a series of fluctuations throughout the 1990s and early 2000s; of note, the mean concentration peaked at 2.30 µg/m^3 in 1997, fell to 0.733 µg/m^3 by 2000, and rose again to approximately 1.5 µg/m^{3}in 2001. As of 2002, the mean concentrations have remained consistently lower, ranging between approximately 0.33 µg/m^3 and 0.63 µg/m^3. In the last decade, the mean concentration peaked at 0.464 in 2013 and has subsequently decreased, ranging from approximately 0.32 µg/m^3 to 0.37 µg/m^3 from 2014 to 2020. The median DCM concentrations follow a similar trend, peaking in 1997 at 0.556 µg/m^3 and decreasing to 0.173 µg/m^3, one-half the detection limit, from 2000 to 2002. From 2003 to 2020, the median concentrations range from 0.173 µg/m^3 to 0.347 µg/m^3. Since 2011, the median concentrations have decreased, fluctuating between approximately 0.24 µg/m^3 and 0.34 µg/m^3.

Figure 5. Mean and Median PERC Air Concentrations at TX Monitoring Sites (by year)



Both the mean and median PERC air concentrations follow a similar trend from 1992 to 2020. The data have two peaks in the mid- and late-1990s: 1993 (mean: 0.6 µg/m^3; median: 0.41 µg/m^3);1994 (median: 0.41 µg/m^3); and 1997 (mean: 0.32 µg/m^3; median: 0.20 µg/m^3). Sizable reductions were observed during the 2000s, with mean concentrations ranging from approximately 0.068 µg/m^3 to 0.17 µg/m^3. Since 2010, mean concentrations have decreased slightly over time, peaking at 0.177 µg/m^3 in 2010 and decreasing to 0.138 µg/m^3 in 2020. Median concentrations have remained at 0.0677 µg/m^3 from 2010 to 2020.

Figure 6. Mean and Median TCE Air Concentrations at TX Monitoring Sites (by year)



With the exception of a drastically increased mean air concentration in 1994, the mean TCE concentrations have remained between approximately 0.044 µg/m^3 and 0.14 µg/m^3 between 1995 and 2019. 2020 saw an increase in mean air concentration to 0.212 µg/m^3 up from 0.0464 in 2019. It is unclear at this point time in what direction the mean TCE concentration is currently trending. Median TCE air concentrations also peaked in 1994 at 0.214 µg/m^3 but have since leveled off at or slightly above 0.0269 µg/m^3, one-half the detection limit.

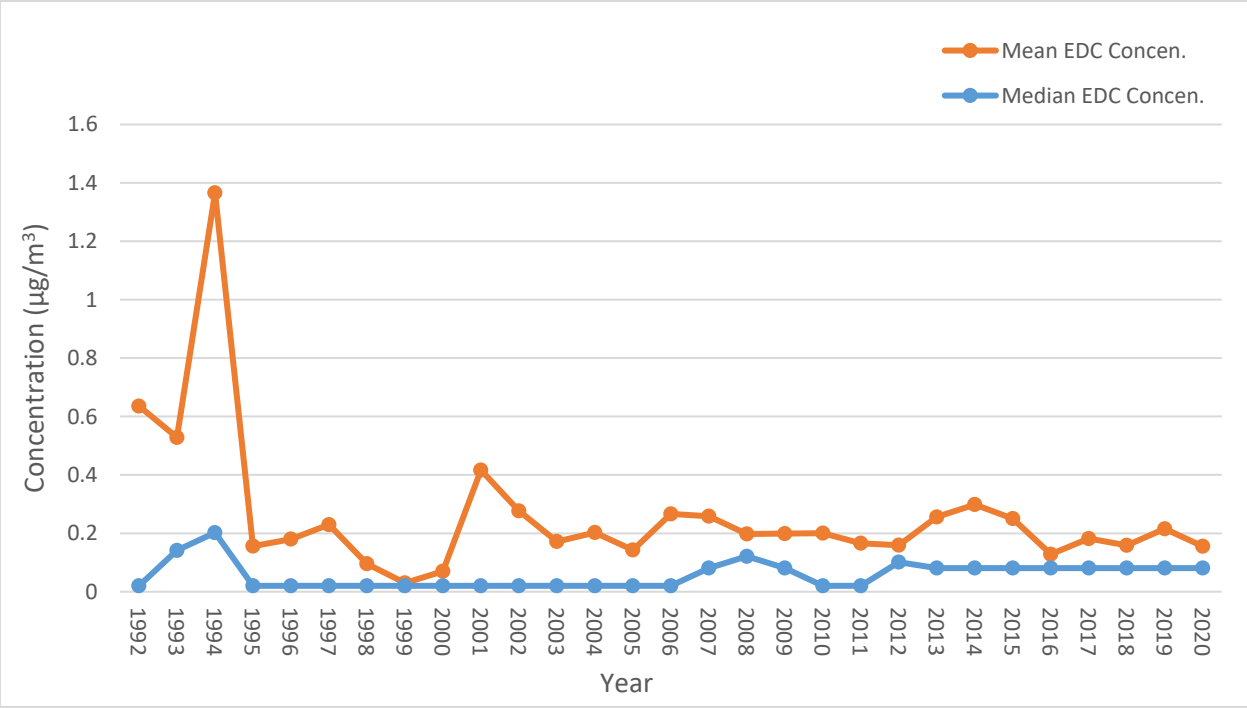
Summary of Data Trends

Since the mid-1990s, mean 1,1,2-TCA and 1,1-DCA concentrations in Texas have exhibited small-scale fluctuations while median concentrations have remained constant over time. Mean and median concentrations of CCl_4, DCM, PERC, and TCE all peak in the 1990s (1993, 1994, or 1997). The maximum mean concentrations for these byproducts are significantly higher than the plateaued concentrations in the 2010s. For example, the maximum mean concentrations for PERC and CCl_4 in 1993 and 1994, respectively, are approximately 4 times higher than the plateaued concentrations circa 2017 to 2020. The maximum mean concentration for TCE in 1994 is approximately 43 times higher than those in the 2010s. Similarly, the maximum median concentrations for carbon tetrachloride and PERC in the 1990s are also elevated compared to the leveled off concentrations in the 2010s.

For comparison, the mean and median Texas EDC concentrations are presented below in Figure 7. Of note, the mean EDC concentration peaks in 1994 at 1.37 $\mu g/m^3$ and drastically decreases in the following years; by the 2010s, mean concentrations range between approximately 0.13 $\mu g/m^3$ in 2016 to 0.30 $\mu g/m^3$ in 2014. The relationship between the concentrations of EDC and its byproducts over time is unclear. Although the surge in CCl_4 and TCE concentrations occurred during the same report year as the EDC peak (1994), the PERC maximum concentration occurred before the EDC peak in 1993 while DCM concentrations increased over subsequent years between 1995 and 1997. 1,1,2-TCA and 1,1-DCA fluctuations, although slight, appear to be cyclical in nature, rising and falling every two years throughout the 1990s, 2000s, and 2010s independent of EDC concentration. This finding suggests that measurement of these impurities may not be solely associated with EDC manufacturing.

A more detailed analysis on the impact of sampling size and distribution on mean and median EDC byproduct concentrations over time is provided in Appendix A.

Figure 7. Mean and Median EDC Air Concentrations at TX Monitoring Sites (by year)



Conclusions

Based on the review of EPA and TCEQ 24-hour ambient air monitoring data for EDC byproducts across the states of Kentucky, Louisiana, and Texas, the TCEQ data from 2010 to 2020 is best representative of current EDC plant emissions. As discussed, the Louisiana HAP database does not contain monitoring data from the last 18 years and data across other states indicates concentrations in these impurities have generally decreased over time such that much of this data may not be representative of current conditions. The Kentucky HAP dataset is likely inaccurate due to near-source interference and QC issues. Although mean and median EDC byproduct concentrations in the TCEQ dataset fluctuated throughout the 1990s, they have remained relatively stable since the early 2000s. Cardno ChemRisk recommends that the Vinyl Institute rely on the TCEQ monitoring data reported for the last 10 years to represent current conditions. Summary statistics for EDC byproduct air concentration data collected at Texas monitoring sites within five miles of EDC production facilities from 2010 to 2020 are presented in Table 10 below.

Table 10. 24-Hour EDC Byproduct Air Monitoring Data at TX Sites within 5 Miles of EDC Production Facilities (2010-2020)

Chemical	No. of Samples	Mean Concen. ($\mu g/m^3$)	Median Concen. ($\mu g/m^3$)	Min. Concen. ($\mu g/m^3$)	Ave. Min. Concen. ($\mu g/m^3$)	Max. Concen. ($\mu g/m^3$)	Ave. Max. Concen. ($\mu g/m^3$)
1,1,2-TCA	4474	0.0298	0.0273	0.0273	0.0273	0.654	0.272
1,1-DCA	4476	0.0211	0.0202	0.0202	0.0202	0.566	0.115
CCl_4	4448	0.585	0.629	0.0314	0.0314	4.09	2.12
DCM	4448	0.393	0.278	0.0174	0.0174	10.6	6.07
PERC	4475	0.151	0.0678	0.0339	0.0339	4.27	2.63
TCE	4476	0.0763	0.0269	0.0269	0.0269	14.8	2.11

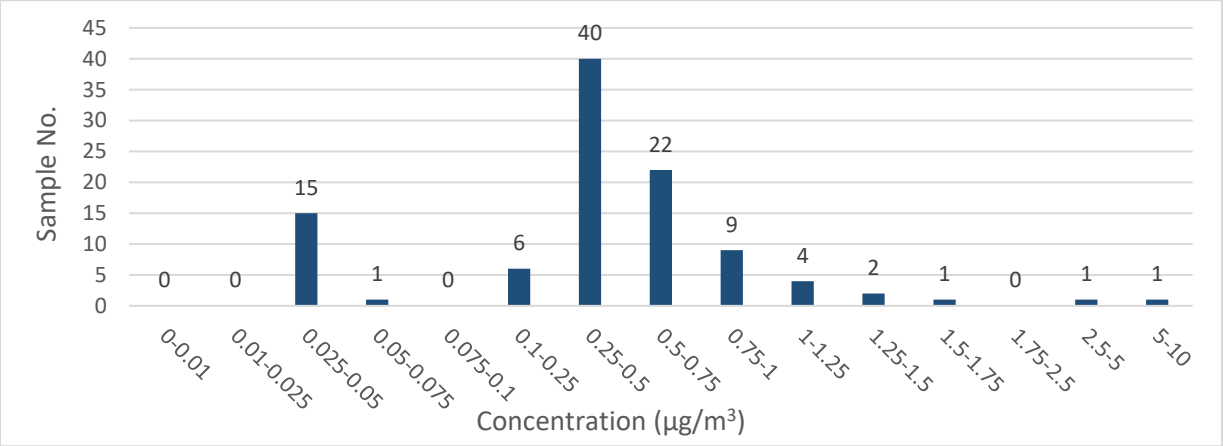
APPENDIX A: Temporal Trends in Sample Distribution and Sample Size

APPENDIX A: Temporal Trends in Sample Distribution and Sample Size

The increased mean and median concentrations for CCl_4, DCM, PERC, and TCE in the 1990s compared to the 2000s and 2010s appear to be influenced by both sample distribution and sample size. Histograms of PERC sample distributions over discrete concentration ranges in 1993, 1994, and 2008 are presented in Figures 8-10. The elevated mean concentration in 1993 is driven by two outliers (4.54 and 9.08 $\mu g/m^3$) in a sample size of 102. In subsequent years, the mean concentration decreases with the number and magnitude of outliers; further, the effect of outliers in 2008 is greatly reduced due to a larger sample size (N = 424).

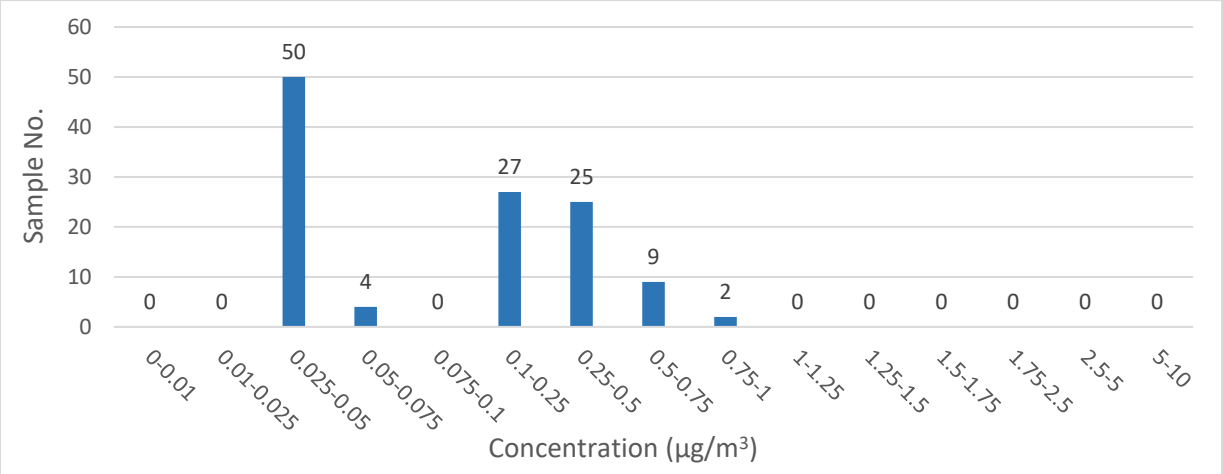
Sample distributions for CCl_4 for select years are shown in Figures 11-13. In 1994 (the year with the highest mean and median concentrations), the sample data fit a comparatively wide distribution, ranging from approximately 0.03 to 12.4 $\mu g/m^3$. The mean and median concentrations are influenced by a fairly even sample distribution across the 0.5-1 $\mu g/m^3$ (15 samples) 1-1.5 $\mu g/m^3$ (17 samples), 1.5-2 $\mu g/m^3$ (13 samples), and 2.5-5 $\mu g/m^3$ (13 samples) concentration ranges (N = 79). In 1998, despite the presence of an outlier of 42.9 $\mu g/m^3$, the mean and median concentrations skew lower due to a high proportion of samples that fall within the 0.01-1 $\mu g/m^3$ concentration range (153 of 180 samples). An even more pronounced decrease in mean and median concentrations is reported in 2008 due to the gross majority of samples falling in the 0.5-1 $\mu g/m^3$ concentration bin (407 of 416 samples) as well as the absence of outliers.

Figure 8. Distribution of PERC Air Concentrations at TX Monitoring Sites (1993)



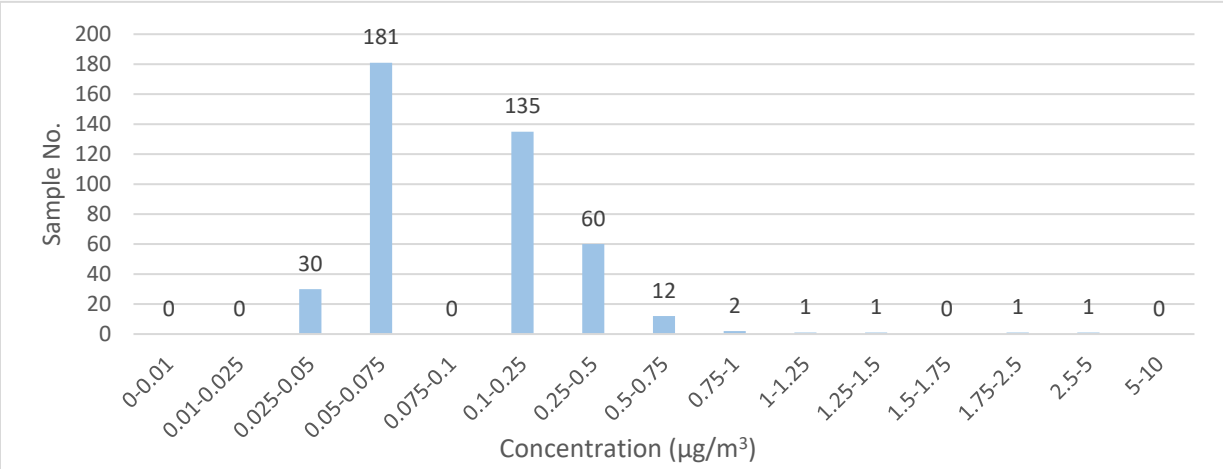
N = 102

Figure 9. Distribution of PERC Air Concentrations at TX Monitoring Sites (1995)



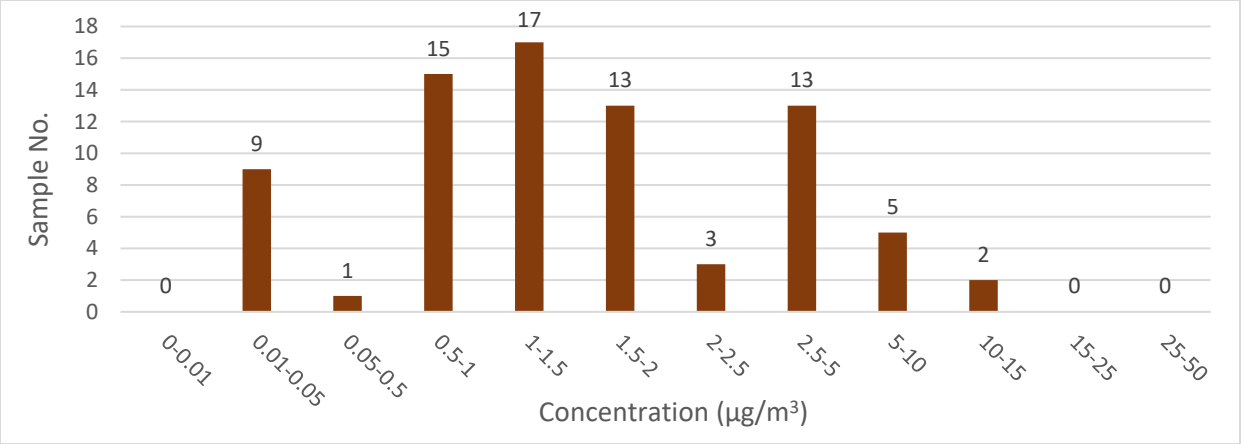
N = 117

Figure 10. Distribution of PERC Air Concentrations at TX Monitoring Sites (2008)



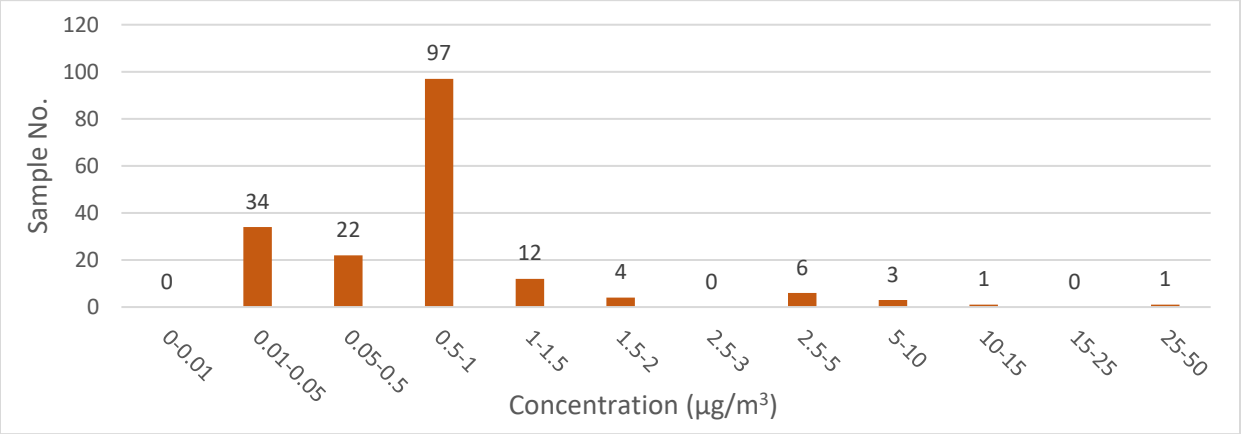
N = 424

Figure 11. Distribution of CCl_4 Air Concentrations at TX Monitoring Sites (1994)



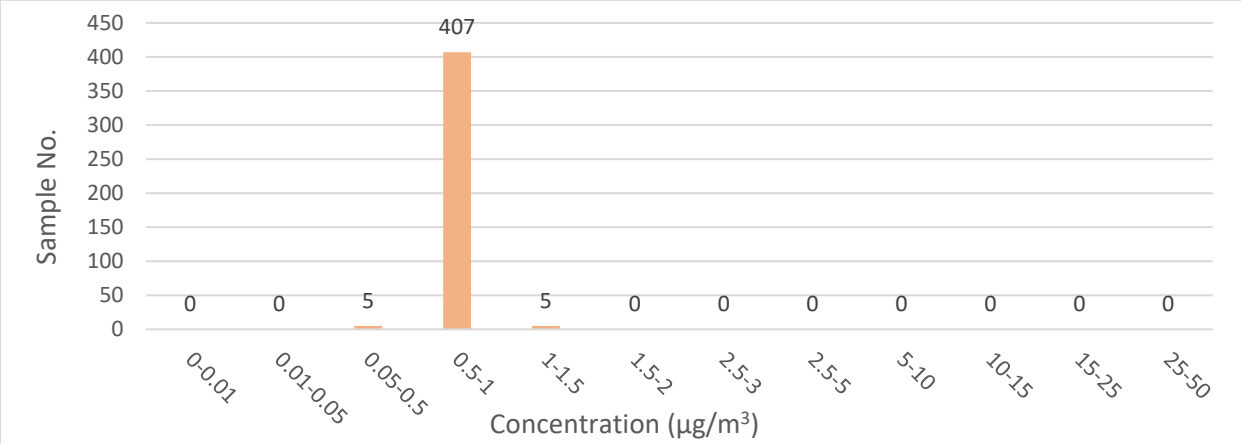
N = 79

Figure 12. Distribution of CCl_4 Air Concentrations at TX Monitoring Sites (1998)



N = 180

Figure 13. Distribution of CCl_4 Air Concentrations at TX Monitoring Sites (2008)



N = 417