

Summary of Continuous Emissions Data from Seven Source Categories Producing or Using Hazardous Organic Compounds

Emission Standards and Engineering Division

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TABLE OF CONTENTS

<u>Chapter</u>		<u>Page</u>
1.0	INTRODUCTION.	1-1
1.1	Objective.	1-1
1.2	Data Sources	1-1
	1.2.1 Recent Source Category Concurrence Investigations	1-1
	1.2.2 Other NESHAP and Source Assessment Activities	1-2
	1.2.3 Air Oxidation NSPS.	1-4
	1.2.4 <u>Organic Chemical Manufacturing</u> , Volumes 6-10.	1-4
1.3	Approach	1-4
2.0	PRODUCTION PROCESSES.	2-1
2.1	Description of Data Sources.	2-1
	2.1.1 Source Category Concurrence Investigations.	2-1
	2.1.1.1 Chlorinated Hydrocarbon Production	2-1
	2.1.1.2 Butadiene Production	2-3
	2.1.1.3 Ethylene Dichloride.	2-3
	2.1.1.4 Ethylene Oxide Production.	2-4
	2.1.2 Section 114 Responses and Trip reports from other NESHAP or Source Assessment Activities.	2-4
	2.1.2.1 Benzene Production	2-4
	2.1.2.2 Ethylbenzene/Styrene Production.	2-4
	2.1.2.3 Acrylonitrile Production	2-5
	2.1.3 Air Oxidation Production Processes.	2-5
	2.1.4 <u>Organic Chemical Manufacturing</u> , Volumes 6-10.	2-6
2.2	Emissions Summary.	2-6
2.3	Other Emission Parameters.	2-11
3.0	POLYMERIZATION PROCESSES.	3-1
3.1	Description of Data Sources.	3-1
3.2	Summary of Emissions from Polymerization Processes	3-2
3.3	Other Emission Parameters.	3-7
4.0	CHEMICAL PROCESS USE OF SOLVENTS.	4-1
4.1	Description of Data Sources.	4-1
	4.1.1 Chlorine Production	4-1
	4.1.2 Chlorinated Compound Users.	4-2
4.2	Summary of Emissions from Solvents Used in Chemical Processes.	4-2
4.3	Other Emission Parameters.	4-7
5.0	CHEMICAL PROCESS USE OF REACTANTS	5-1
5.1	Description of Data Sources.	5-1
	5.1.1 CFC Production.	5-1
	5.1.2 Miscellaneous Butadiene	5-2
	5.1.3 Chlorinated Compound Users.	5-2
	5.1.4 Miscellaneous Vinyl Chloride.	5-3
	5.1.5 <u>Organic Chemical Manufacturing</u> Data	5-3

TABLE OF CONTENTS
(continued)

<u>Chapter</u>	<u>Page</u>
5.0 CHEMICAL PROCESS USE OF REACTANTS (cont'd.)	
5.2 Summary of Emissions from Reactants Used in Chemical Processes.	5-4
5.3 Other Emission Parameters.	5-9
6.0 BLOWING AGENTS.	6-1
6.1 Description of Data Sources.	6-1
6.2 Summary of Emissions from Blowing Agents	6-1
6.3 Other Emission Parameters.	6-5
7.0 PESTICIDES PRODUCTION	7-1
7.1 Description of Data Sources.	7-1
7.2 Emissions Summary.	7-1
7.3 Other Emission Parameters.	7-6
8.0 PHARMACEUTICAL PRODUCTION	8-1
8.1 Summary of Emissions from Pharmaceutical Production.	8-1
8.2 Other Emission Parameters.	8-5
Appendix A: Production Processes	A-1
Appendix B: Polymerization Processes	B-1
Appendix C: Chemical Process Use of Solvents	C-1
Appendix D: Chemical Process Use of Reactants	D-1
Appendix E: Blowing Agents	E-1
Appendix F: Pesticides Production	F-1
Appendix G: Pharmaceutical Production	G-1

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
2-1	Cumulative Percent of Emission Factors for Production Processes .	2-9
3-1	Cumulative Percent of Emission Factors for Polymerization Process Vents.	3-6
4-1	Cumulative Percent of Emission Factors for Chemical Process Use of Solvents.	4-5
5-1	Cumulative Percent of Emission Factors for Chemical Process Use of Reactants	5-6
6-1	Cumulative Percent of Emission Factors for Blowing Agent Process Vents.	6-4
7-1	Cumulative Percent of Emission Factors for Pesticide Production .	7-4
8-1	Cumulative Percent of Emission Factors for Pharmaceutical Process Vents.	8-4

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1-1 Recent Source Category Concurrence Investigations For Potentially Hazardous Air Pollutants (PHAPs)	1-3
1-2 Source Categories Included in This Data Summary	1-5
2-1 Data Sources for Emissions From Production Processes.	2-2
2-2 Emissions Summary for Production Processes.	2-7
2-3 Summary of Emission Parameters for Production Processes	2-12
3-1 Summary of Emission Data Sources for Polymerization	3-3
3-2 Summary of Emissions for Polymerization Processes	3-4
3-3 Summary of Emission Parameters for Polymerization Processes	3-8
4-1 Summary of Emissions Data for Chemical Process Use of Solvents.	4-3
4-2 Summary of Emission Parameters for Chemical Process Use of Solvents.	4-8
5-1 Summary of Emissions Data for Chemical Process Use of Reactants	5-5
5-2 Summary of Emission Parameters for Chemical Process Use of Reactants.	5-10
6-1 Summary of Emissions for Blowing Agents	6-2
6-2 Summary of Emission Parameters for Blowing Agents	6-6
7-1 Emissions Summary for Pesticide Production.	7-2
7-2 Summary of Emission Parameters for Pesticide Production	7-7
8-1 Summary of Emissions Data for Pharmaceutical Production	8-2
8-2 Summary of Emission Data Parameters for Pharmaceutical Production	8-6

1.0 INTRODUCTION

1.1 OBJECTIVE

The objective of this report is to present a summary of the emissions data that the Environmental Protection Agency (EPA) has obtained for recent source assessments and other regulatory efforts. These data provide a profile of emissions and emission parameters for seven major source category groupings. This information will assist in performing preliminary source assessments (screening studies) for potentially hazardous air pollutants (PHAPs) for which no actual emissions data are available. The sources of emissions data that were used to prepare this report are discussed in the following section.

1.2 DATA SOURCES

Four general sources of emissions data were used for this report. The first type is emissions data from Section 114 questionnaire responses and trip reports supporting recent EPA source category concurrence investigations for PHAPs. The second is data gathered from Section 114 questionnaires in support of the National Emissions Standard for Hazardous Air Pollutants (NESHAP) for benzene storage tanks and other source assessment work. The third source of data is Section 114 responses received in support of the New Source Performance Standard (NSPS) for air oxidation processes. The fourth data source is a series of Section 114 questionnaires and trip reports used in the compilation of Organic Chemical Manufacturing, Volumes 6-10. A description of each of these four data sources follows.

1.2.1 Recent Source Category Concurrence Investigations

EPA has gathered a substantial quantity of information in support of recent source category concurrence investigations for eight PHAPs. The eight pollutants of interest are: (1) butadiene, (2) ethylene dichloride, (3) ethylene oxide, (4) chloroform, (5) carbon tetrachloride, (6) methylene chloride, (7) perchloroethylene, and (8) trichloroethylene. Emissions data for these eight pollutants were gathered during the period 1984 through 1986. Investigations for these pollutants were divided into several source

categories covering production and use of the eight PHAPs. Table 1-1 shows a list of the source categories included in these investigations.

In general, there are nine types of emission sources for which data are available from these investigations. These are: (1) process vents, (2) equipment leaks, (3) storage, (4) handling operations, (5) equipment openings, (6) secondary sources, (7) relief device discharges, (8) liquid spills, and (9) accidental gaseous releases. However, data for every emission type are not available or necessarily applicable for every plant within a source category or for all source categories listed in Table 1-1.

Only emissions data supplied by facilities through questionnaire responses or trip reports were used in this report. In the case of equipment leak emissions, the Synthetic Organic Chemical Manufacturing Industry (SOCMI) emission factors were used to estimate emissions for each process based on equipment counts supplied by the facility. Similarly, storage emissions were calculated using AP-42 estimation methods and information on storage tanks provided by the facilities.

1.2.2 Other NESHAP and Source Assessments Activities

In support of other NESHAP and source assessment activities, EPA has gathered emissions data through Section 114 responses and trip reports. These data come from three general sources. The first source is data gathered from facilities storing benzene. These data were gathered in 1978 in support of the Benzene storage tank NESHAP effort. Only emissions data for storage and handling operations are available in this data source. The second source is data from producers of ethylbenzene/styrene which was gathered in 1977 through 1979. This information was also compiled in support of the benzene NESHAP. Emission sources include process vents and storage facilities.

The third data source is the Section 114 responses and trip reports collected in 1978 through 1981 during work on a source assessment for production of acrylonitrile. These data include information on emissions from process vents, storage, equipment leaks, secondary sources, handling operations, and relief device discharges.

TABLE 1-1. RECENT SOURCE CATEGORY CONCURRENCE INVESTIGATIONS
FOR POTENTIALLY HAZARDOUS AIR POLLUTANTS (PHAPs)

Potentially Hazardous Air Pollutant	Producer/ User	Source Category
1. Butadiene	Prod	Butadiene Production Use Styrene Butadiene Rubber Production Use Polybutadiene Production Use Neoprene (chloroprene) Production Use Miscellaneous Butadiene Users
2. Ethylene Dichloride	Prod	Ethylene Dichloride Production Use Pesticide Production
3. Ethylene Oxide	Prod	Ethylene Oxide Production Use Sterilization
4. Chloroform	Prod	Chlorinated Hydrocarbon Producers Use Chlorinated Hydrocarbon Users Use Chlorofluorocarbon Production
5. Carbon Tetrachloride	Prod	Chlorinated Hydrocarbon Producers Use Chlorinated Hydrocarbon Users Use Chlorofluorocarbon Production Use Chlorine Production Use Pesticides Production
6. Methylene Chloride	Prod	Chlorinated Hydrocarbon Producers Use Chlorinated Hydrocarbon Users Use Pesticides Production Use Pharmaceuticals Production Use Blowing Agents
7. Perchloroethylene	Prod	Chlorinated Hydrocarbon Producers Use Chlorinated Hydrocarbon User Use Chlorofluorocarbon Production
8. Trichloroethylene	Prod	Chlorinated Hydrocarbon Producers Use Chlorinated Hydrocarbon Users

1.2.3 Air Oxidation NSPS

In support of development of an NSPS for air oxidation processes, EPA gathered emissions data through Section 114 responses and trip reports. These data were gathered in 1975 through 1978 and cover over fifty air oxidation processes. The emissions data contain pollutant-specific data for process vents (from air oxidation reactors only) located at these facilities. In 1978, during the industry comment period, for the proposed NSPS, facilities submitted revised average volatile organic compound (VOC) emission rates. These data were presented in the Background Information Document (BID) published in October 1983. For the purposes of this study, the original responses were analyzed to obtain the vent stream compositions which were applied to the updated overall emission rate to obtain an estimate of the specific pollutant emission rate.

1.2.4 Organic Chemical Manufacturing, Volumes 6-10

The Organic Chemical Manufacturing series is a set of documents prepared for EPA by IT Enviroscience to characterize emissions from 39 separate chemical processes. In compiling these documents, IT Enviroscience gathered emissions data through questionnaires and trip reports for 192 chemical facilities. These data were collected in 1978 and cover emissions from process vents and storage tanks.

1.3 APPROACH

For the purpose of this data summary, the data from the sources described above were classified into seven source category groupings according to similarities in processes. These include the following categories:

- (1) Chemical Production
- (2) Polymerization Processes
- (3) Chemical Process Use of Solvents
- (4) Chemical Process Use of Reactants
- (5) Blowing Agents
- (6) Pesticide Production
- (7) Pharmaceutical Production

Table 1-2 lists the individual source categories that are contained in each of these source category groupings.

TABLE 1-2. SOURCE CATEGORIES INCLUDED IN THIS DATA SUMMARY

1. CHEMICAL PRODUCTION
 - Chlorinated Hydrocarbon Production
 - Butadiene Production
 - Ethylene Oxide Production
 - Ethylene Dichloride Production
 - Benzene Production
 - Ethylbenzene/Styrene Production
 - Acrylonitrile Production
 - Epichlorohydrin Production
 - Air Oxidation Production Processes
 - Organic Chemical Manufacturing Data
2. POLYMERIZATION PROCESSES
 - Neoprene (chloroprene) Production
 - Polybutadiene Production
 - Styrene-Butadiene Rubber Production
 - ABS Resin and Nitrile-Butyl Production
 - Miscellaneous Butadiene Users
3. CHEMICAL PROCESS USE OF SOLVENTS
 - Chlorine Production
 - Chemical Plants - Chlorinated Compound Users
4. CHEMICAL PROCESSES USE OF REACTANTS
 - CFC Production
 - Chemical Plants - Chlorinated Compound Users
 - Miscellaneous Butadiene
 - Miscellaneous Vinyl Chloride
 - Organic Chemical Manufacturing Data
5. BLOWING AGENTS
 - Polyurethane Foam Production
6. PESTICIDE PRODUCTION
7. PHARMACEUTICAL PRODUCTION

The analysis of Section 114 data for a source category began with retrieval of emission parameters from various EPA memoranda and, in some cases, the actual Section 114 responses. The emission parameters of interest are those required for Human Exposure Modeling (HEM). These include emission rate, vent height, vent diameter, temperature, and velocity. These emission parameters were assimilated separately for each type of emission source (i.e., process vents, equipment leaks, etc.) within a source category .

For the purpose of this study, it was assumed that emissions from process vents, storage, handling, secondary waste streams, and equipment openings are a function of consumption or production of the pollutant. An emission factor was developed for each of these emission sources. The emission factor was expressed as the ratio of emissions of a specific pollutant to consumption or production of the pollutant (kg/Mg). A separate emission factor was calculated for each emission source. Consumption or production data were extracted from the Section 114 responses when available. If this information was not available in the response, it was obtained from literature, such as the Directory of Chemical Producers and Mannsville's Chemical Product Synopsis. Equipment leaks, relief valve discharges, accidental gaseous releases, and liquid spills were assumed to be independent of consumption or production. For these emission sources, an emission rate (kg/yr) was used instead of an emission factor.

Sections 2.0 through 8.0 discuss the results from the data analysis for the seven source category groupings. Each section contains a table showing average values of the emissions data available. These averages are calculated using only non-zero emission values. When plants did not report a particular type of emission, or reported zero emissions, these data were not included in calculating the average values or determining 95th-percentiles. Another table in each section presents averages and ranges for other emission parameters that are important to risk modeling. The data on an individual plant or process basis appear in an appendix to this report for each source category grouping.

2.0 PRODUCTION PROCESSES

This section presents a summary of available data concerning emissions of a pollutant from processes where the pollutant is an end product. All processes in this source category grouping generate emissions from production of the pollutant. Table 2-1 presents a summary of the sources of data used in this section. A brief description of each source of data is presented in Section 2.1, and the data are summarized in Sections 2.2 and 2.3.

2.1 DESCRIPTION OF DATA SOURCES

2.1.1 Source Category Concurrence Investigations

Data for these four source categories were gathered from responses to Section 114 questionnaires and trip reports for the four EPA source category concurrence investigations listed in Table 2-1.

2.1.1.1 Chlorinated Hydrocarbon Production

This source category covers production of five chlorinated hydrocarbons; (1) carbon tetrachloride, (2) chloroform, (3) methylene chloride, (4) perchloroethylene, and (5) trichloroethylene. These chlorinated hydrocarbons are currently produced as a product or co-product in at least eight different production processes. Section 114 responses reviewed during this source category concurrence investigation cover six of these processes.

Emissions of chlorinated hydrocarbons occur from the following sources: process vents, equipment leaks, storage tanks, handling operations, equipment openings, relief device discharges, secondary sources, and liquid spills. The data presented here were originally summarized in three memoranda documenting the source category concurrence investigation:

- (1) Estimates of Carbon Tetrachloride, Methylene Chloride, Chloroform, Trichloroethylene, and Perchloroethylene Emissions from Chlorinated Hydrocarbon Production Facilities and Emissions Reductions Achievable with Additional Control, dated August 29, 1986.
- (2) Documentation of Emission Parameters for Carbon Tetrachloride, Methylene Chloride, Chloroform, Trichloroethylene, and Perchloroethylene Emissions from Chlorinated Hydrocarbon Production Plants, dated August 25, 1986.
- (3) Documentation of Short-term Emissions from Chlorinated Hydrocarbon Production, dated November 7, 1986.

TABLE 2-1. DATA SOURCES FOR EMISSIONS FROM PRODUCTION PROCESSES

1. Source Category Concurrence investigations for:
 - Chlorinated Hydrocarbon Production
 - Butadiene Production
 - Ethylene Oxide Production
 - Ethylene Dichloride Production

 2. Section 114 responses and Trip Reports from other NESHAP or Source Assessment Activities for facilities producing:
 - Benzene
 - Ethylbenzene/Styrene
 - Acrylonitrile

 3. Section 114 responses and the Background Information Document (BID) for Air Oxidation Production Processes.

 4. Section 114 responses and trip reports that were used to prepare the Organic Chemical Manufacturing Volumes 6-10, (EPA-450/3-80-028, a-e).
-

Further information concerning this source category and the specific data sources used can be found in these three memoranda.

2.1.1.2 Butadiene Production

This source category covers production of 1,3-butadiene, a high-volume intermediate organic chemical used to produce various types of rubber, resins, and plastics. Emissions of butadiene from production processes occur from the following sources: process vents, equipment leaks, secondary sources, equipment openings, relief device discharges, and accidental gaseous releases. Data summarized in this report were originally presented in two memoranda supporting the source category concurrence investigation:

- (1) Estimates of 1,3-Butadiene Emissions from Production Facilities and Emissions Reductions Achievable with Additional Controls, dated March 25, 1986.
- (2) Documentation of Emission Parameters at Baseline and After Candidate NESHAP Controls for 1,3-Butadiene Production Facilities, dated March 24, 1986.

These memoranda document estimated emissions from process vents, equipment leaks, and secondary sources. Additional information concerning this source category can be found in the documents listed above. In addition, Section 114 responses concerning short-term emissions from seven production facilities were analyzed to obtain emission parameters for emissions from equipment openings, relief device discharges, and accidental gaseous releases.

2.1.1.3 Ethylene Dichloride Production

Ethylene dichloride (EDC) is a chlorinated hydrocarbon used mainly as an intermediate in the production of vinyl chloride monomer. Emissions of EDC may occur from the following sources: process vents, equipment leaks, secondary sources, storage tanks, handling operations, relief valve discharges, and accidental releases. Emissions data presented here were originally summarized in a memorandum titled "Estimates of Ethylene Dichloride Emissions from Production Facilities and HEM Inputs," and is dated April 23, 1986. This memorandum is based on 15 Section 114 responses and a trip report for one EDC production plant. Further information regarding the EDC Production source category may be found in this memorandum.

2.1.1.4 Ethylene Oxide Production

Ethylene Oxide (EO) is used mainly as an intermediate in the production of EO derivatives such as ethylene glycol. Reported sources of EO emissions are: process vents, equipment leaks, and secondary sources. The data summarized in this section are only from the nine nonconfidential Section 114 responses from EO production facilities. Information claimed confidential by any reporting facility was not available and was not included in this report. All information for three facilities and partial information for three others is claimed confidential. Additional information concerning the source category may be found in a memorandum titled "Technical Report: Ethylene Oxide Production," dated July 30, 1986.

2.1.2 Section 114 Responses and Trip Reports from other NESHAP or Source Assessment Activities

Section 114 responses and trip reports were analyzed for three source categories: (1) Benzene Production, (2) Ethylbenzene/Styrene production, and (3) Acrylonitrile Production. These data were gathered from either NESHAP efforts or Source Assessment projects concerning these source categories.

2.1.2.1 Benzene Production

EPA has collected emissions data from facilities producing benzene in support of the Benzene NESHAP for the storage and handling of benzene. Section 114 responses were reviewed from 15 facilities producing benzene. These responses are based mainly on operation in 1976 and include emission data for storage and handling operations only.

2.1.2.2 Ethylbenzene/Styrene Production

To support a NESHAP effort for facilities producing ethylbenzene/styrene (EBS), EPA collected emissions data via Section 114 responses. Data from five EBS facilities are summarized in this section. These responses are from the years 1977-1979. Reported emissions sources include process vents and storage facilities.

2.1.2.3 Acrylonitrile Production

To support a Source Assessment published in 1981 for emissions of acrylonitrile, EPA sent out Section 114 questionnaires and visited facilities producing this chemical. The available emissions data from the Section 114 responses and trip reports are summarized in this section. Data were available for six facilities. Emission sources include: process vents, storage, equipment leaks, handling operations, secondary sources, and relief device discharges.

2.1.3 Air Oxidation Production Processes

In support of an NSPS for Air Oxidation Processes, EPA received Section 114 responses from facilities using air-ox processes for chemical production. These responses are concerned only with process vent emissions from air-ox reactors and primary recovery. Air oxidation reactors are defined as any process vessel in which one or more organic reactants are combined with air, or a combination of air and oxygen, to produce one or more organic compounds. The emission factors developed in this report are meant to reflect total emissions from a given process. Since emissions from air oxidation reactors may comprise only part of the total emissions from an air-ox process, these data points have been analyzed separately in this report. The specific emission factors developed from the air oxidation data represent emissions from air oxidation reactors.

Fifty-nine responses were analyzed for this section of the report. Data pertinent to the production source category were available for 22 plants producing seven different chemicals. The responses were analyzed to determine the compositions of individual vent streams at the facilities. During the industry comment period on the proposed regulations in 1978, facilities updated overall emission estimates, which were presented in a document titled "Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry - Background Information for Proposed Standards," dated October 1983. The compositions calculated for the individual streams were applied to the updated overall emission estimates in the above document in order to estimate the amount of pollutant emitted.

2.1.4 Organic Chemical Manufacturing Volumes 6 through 10

The Organic Chemical Manufacturing Volumes 6 through 10 contain emissions data for 39 different manufacturing processes. The Section 114 questionnaires and trip reports that were used to characterize the 39 different chemical processes are included in this analysis. Emissions resulting from production processes were extracted from 72 Section 114 responses and trip reports. The analysis of the Organic Chemical Manufacturing data is limited to emissions from process vents and storage tanks because this was the only data requested. Descriptions of the 39 different manufacturing processes and references to the 72 supporting Section 114 responses are available in the Organic Chemical Manufacturing Volumes 6 through 10.

2.2 EMISSIONS SUMMARY

The production source category grouping consists of data from 190 chemical processes. Table 2-2 presents a summary of the emissions data. The data on a per-process basis is presented in Table A-1 of Appendix A. The data in Appendix A are shown totalled for each process by emission type. For example, the total process vent emission rate for a process with three process vents is the sum of the emission rates for each process vent.

For this analysis, five of the emission types are assumed to be a function of production rate - process vents, storage, handling, secondary and equipment openings. For these emission types, the total emissions are expressed as a ratio of emissions of pollutant to amount of pollutant produced by the process. The units of the emission factor are kilograms of pollutant emitted per megagram of pollutant produced. The remaining emission types - equipment leaks, accidental gas releases, liquid spills, and relief device discharges are assumed to be independent of production, and are expressed as emission rates. The units of emission rate are kilograms of pollutant emitted per year.

Table 2-2 presents the average, standard deviation and the 95th-percentile emission factor (or rate) for each emission type. In order to develop conservative emission estimates, these values are based only on data supplied by facilities that reported non-zero emission occurrences. The 95th-percentile factor is the emission factor that corresponds to the value for which 95 percent of the other processes reported lower emission factors (or rates). The 95th-percentile emission factor provides a conservative

TABLE 2-2 EMISSIONS SUMMARY FOR PRODUCTION PROCESSES

Emission Sources Assumed to be Dependent on Production Rate	Number of Reporting Processes ^a	Emission Factor (Kg emitted/Mg produced)		
		Average ^b	95th-Percentile ^c	Standard Deviation
Process Vents ^d	138	1.9	5.8	7.87
Air Oxidation Process Vents	22	2.0	6.4	2.31
Storage	89	0.31	1.3	0.51
Equipment Openings	29	0.02	0.09	0.03
Handling	48	0.25	1.1	0.43
Secondary	37	0.20	1.3	0.42

Emission Sources Assumed to be Independent of Production Rate	Number of Reporting Processes ^a	Emission Rate (Kg emitted/Yr)		
		Average ^b	95th-Percentile ^c	Standard Deviation
Equipment Leaks	71	64000	140000	70200
Liquid Spills	2	2600	5100	3500 ^e
Accidental Gas Releases	3	18	45	23 ^e
Relief Discharges	12	3600	13000	7350

^a Represents the total number of data points for which non-zero emissions were reported.

^b Represents the average of all data points for which non-zero emissions were reported.

^c 95 percent of the reported non-zero emission factors or rates are less than or equal to this value.

^d Not including process vents from air oxidation processes.

^e Represents highest emission rate, due to low number of data points.

estimate for a chemical process for which no actual emissions data are available. Figure 2-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emissions was determined for process vents. Of the 138 process vents for which emission factors could be calculated, 95 percent of the process vents (131) have emission factors equal to or less than 5.8 kg/Mg. Therefore, as Figure 2-1 shows, 5.8 kg/Mg is the 95th-percentile emission factor.

The following sections summarize the emissions data analysis for each emission type.

Process Vent Emissions

A total of 138 production facilities (excluding air oxidation processes) supplied information concerning process vent emissions. Emission factors range from 0.0002 to 83 kg emitted per megagram produced. The average emission factor is 1.9 kg/Mg and the 95th-percentile factor is 5.8 kg/Mg.

For air oxidation processes, the 22 reporting facilities had emission factors ranging from 0.0039 to 6.8 kg emitted per megagram produced. The average emission factor is 2.0 kg/Mg, and the 95th-percentile emission factor is 6.4 kg/Mg.

Storage Emissions

A total of 89 facilities supplied emission data for storage facilities. Emission factors range from 0.02 to 3.1 kg emitted per Mg produced. The average emission factor is 0.31 kg/Mg and the 95th-percentile factor is 1.3 kg/Mg.

Equipment Opening Emissions

Equipment opening emissions data were available from 29 facilities. Values for emission factor range from 0.00006 to 0.1 kg emitted per Mg produced. The average emission factor is 0.02 kg/Mg and the 95th-percentile emissions factor is 0.09 kg/Mg.

PRODUCTION PROCESSES

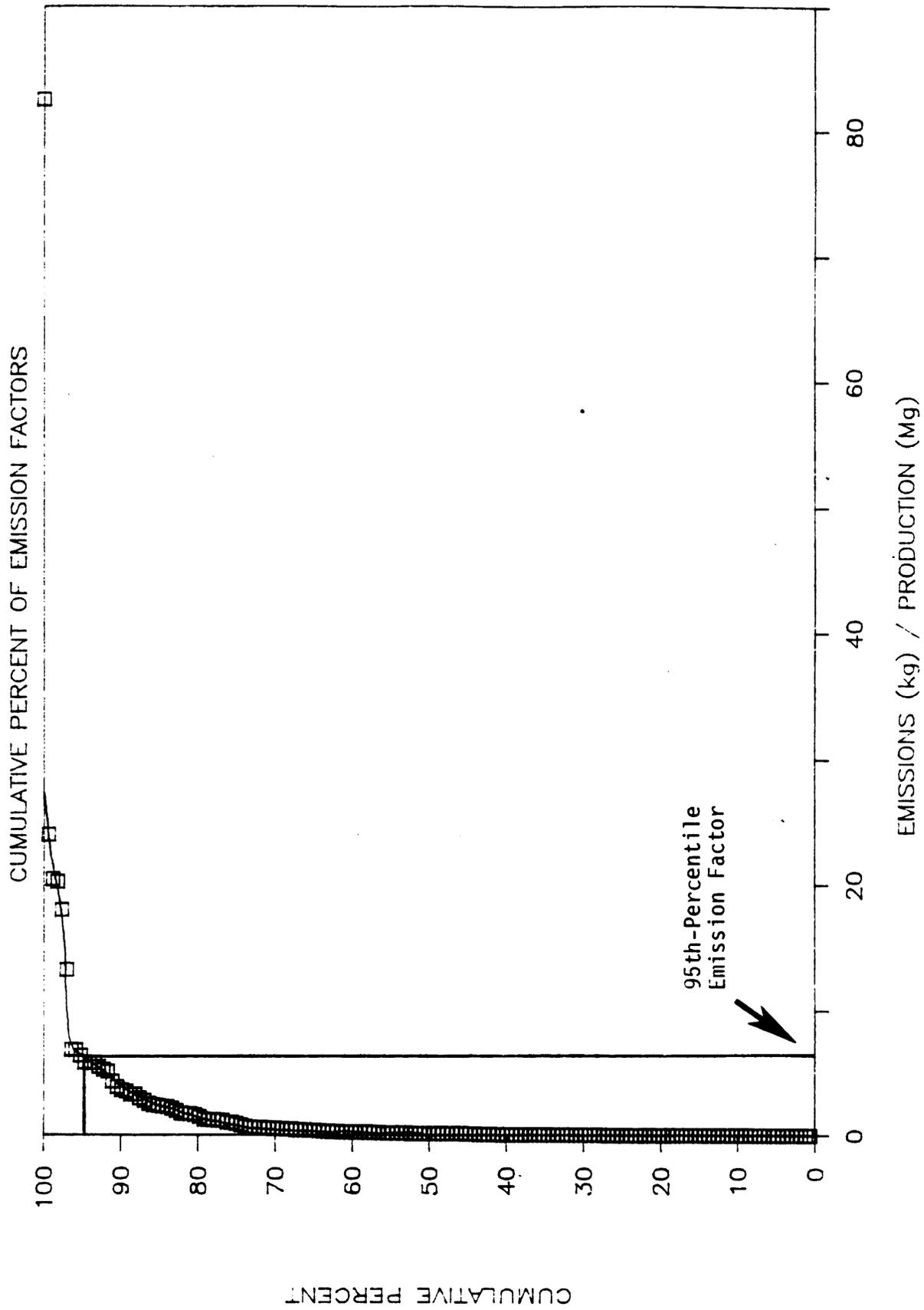


Figure 2-1. Cumulative Percent of Emission Factors for Production Processes

Handling Emissions

A total of 48 production facilities provided data concerning handling emissions. Emission factors ranged from 0.00006 to 2.4 kg submitted per Mg produced. The average emission factor for handling emissions is 0.2 kg/Mg and the 95th-percentile factor is 1.1 kg/Mg.

Secondary Emissions

Data for secondary emissions were available from 37 production facilities in this source category. Emission factors ranged from 0.00001 to 1.8 kg emitted per Mg produced. The average emission factor is 0.2 kg/Mg for secondary emission sources. The 95th-percentile factor is 1.3 kg/Mg.

Equipment Leak Emissions

Data concerning emissions from equipment leaks were available from 71 production facilities. The reported emission rates ranged from 130 kg/yr to 454,000 kg/yr. The average emission rate is 63,700 kg/yr and the 95th-percentile rate is 140,000 kg/yr.

Liquid Spills

Only 2 facilities reported emissions from liquid spills. The average emission rate is 2,600 kg/yr. Due to the low number of data points, the 95th-percentile emission rate is assumed to be the highest reported emission rate of 5,100 kg/yr.

Emission from Accidental Gaseous Releases

Three facilities reported emissions from accidental releases of gas. The emission rates range from 4.5 kg/yr to 45 kg/yr. The average emission rate is 18 kg/yr. Due to the low number of data points, the 95th-percentile rate is assumed to be the highest reported rate, or 45 kg/yr.

Emissions from Relief Device Discharges

Emissions from pressure relief discharges were reported by 12 facilities. The emission rates range from 0.4 kg/yr to 23,600 kg/yr. The average emission rate is 3,600 kg/yr and the 95th-percentile emissions rate is 13,000 kg/yr.

2.3 OTHER EMISSION PARAMETERS

Four other emission parameters are needed to perform risk modeling. These are (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 2-3 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 187 process vent heights were reported by facilities in this category. The average process vent height is 13.0 m. The average process vent diameter is 0.58 m and the average process vent discharge velocity is 12.7 m/s. The average process vent discharge temperature is 312 K. The data that were used to generate Table 2-3 are presented in Table A-2 of Appendix A.

TABLE 2-3 SUMMARY OF EMISSION PARAMETERS FOR PRODUCTION PROCESSES

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)					
	Number ^a	Average ^b										
		Range		Range		Range		Range				
Process Vents	107	13.01	0 - 75	0.58	0.1 - 10	107	12.70	0.004 - 247	105	312	243 - 533	
Storage	187	7.17	0.6 - 29.5	171	0.12	0.02 - 1.07	22	3.78	0.09 - 13	0	NA	NA
Equipment Openings	5	21.30	0.6 - 49	7	0.11	0.02 - 0.46	0	NA ^d	NA	0	NA	NA
Equipment Leaks	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Handling	2	9.43	3.7 - 15.2	7	0.52	0.15 - 0.61	0	NA	NA	0	NA	NA
Secondary	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Liquid Spills	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Accidental Gas Release	3	3.84	0.9 - 9.1	0	NA	NA	3	362	290 - 403	0	NA	NA
Relief Discharges	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA

^a Represents the total number of data points for which emission parameters were reported.

^b Represents the average of all data points for which reported data were available.

^c Represents the range of data points for which emission parameters were reported.

^d NA = Insufficient reported data were available to calculate the indicated parameter.

3.0 POLYMERIZATION PROCESSES

Information on emissions resulting from polymerization processes is summarized in this section. The values shown are for emissions of raw materials used in the polymerization process, not the polymerization product itself. The emission data are from five EPA source category concurrence investigations: (1) neoprene rubber production, (2) polybutadiene production, (3) styrene-butadiene production, (4) acrylonitrile-butadiene-styrene (ABS) resin and nitrile-butyl-rubber (NBR) production, and (5) miscellaneous butadiene polymerization production. These five data sources were combined to form the general category - polymerization. The raw material for which emission estimates were available are butadiene and acrylonitrile. All facilities in this source category grouping generate emissions from polymerization processes. Emissions data from 50 facilities are included in this analysis. A brief description of the five data sources is provided in Section 3.1, and the emission parameters are summarized in Sections 3.2 and 3.3.

3.1 DESCRIPTION OF DATA SOURCES

Data on polymerization processes were previously presented in the following source category concurrence memoranda:

- (1) Documentation of Emission Parameters at Baseline and After Candidate NESHAP Controls for Neoprene Production Facilities, dated March 17, 1986;
- (2) Estimates of Short-Term Emissions of 1,3-Butadiene from Neoprene/Chloroprene Production Facilities, dated April 7, 1986;
- (3) Documentation of Emission Parameters at Baseline and after Candidate NESHAP Controls for Polybutadiene Production Facilities, dated February 18, 1986;
- (4) Estimates of 1,3-Butadiene Emissions from Polybutadiene Facilities and Emissions Reductions Achievable with Additional Controls, dated March 27, 1986;
- (5) Estimates of Short-Term Emissions of 1,3-Butadiene from Polybutadiene Production Facilities, dated May 5, 1986;
- (6) Documentation of 1,3-Butadiene Emission Parameters at Baseline and after Candidate NESHAP Controls for Styrene-Butadiene Copolymer Facilities, dated March 13, 1986;

- (7) Estimates of 1,3-Butadiene Emissions from Styrene-Butadiene Copolymer Facilities and Emission Reductions Achievable with Additional Controls, dated April 8, 1986;
- (8) Estimates of Acrylonitrile, Butadiene, and other VOC Emissions and Controls for ABS and NBR Facilities, dated January 29, 1986;
- (9) Documentation of HEM Inputs for Butadiene Emissions Associated with the Miscellaneous Source Category, dated September 10, 1986; and
- (10) Estimates of 1,3-Butadiene Emissions from Miscellaneous Sources and Emissions Reductions Achievable with Candidate NESHAP Controls, dated September 26, 1986.

The documents shown above were generated using: (1) Section 114 questionnaire responses, (2) assessment reports of acrylonitrile emissions prepared by GCA Corporation for ABS and NBR processes, and (3) a 1981 survey by Energy and Environmental Analysis, Incorporated (EEA) of the acrylonitrile industry. Table 3-1 shows the number of facilities submitting data by the three data sources. These data include no estimated values. The data presented in this section will be used to make preliminary estimates of emissions and emission parameters for any potentially hazardous air pollutants that are used in the polymerization process.

3.2 SUMMARY OF EMISSIONS FROM POLYMERIZATION PROCESSES

Table 3-2 presents the emissions summarized by emission type for the polymerization source category. Table B-1 in Appendix B shows emissions for each process. Several facilities reported certain types of emissions aggregated for more than one process. These entries are footnoted accordingly in the appendix. For the purposes of this study it was assumed that essentially all of the emissions were derived from the process reported in Table B-1 for that facility. Emissions from process vents, storage, handling operations, secondary sources, and equipment openings are assumed to be dependent on consumption and are expressed as emission factors. Emissions from equipment leaks and pressure relief discharges are assumed to be independent of process size and are therefore presented as annual emission rates (kg/yr).

Consumption rates were obtained for each facility by one of four methods. These methods are: (1) consumption rates given on Section 114 responses,

TABLE 3-1. SUMMARY OF EMISSION DATA SOURCES FOR POLYMERIZATION^a

Process	Number of Facilities Submitting Section 114 Responses	Number of Facilities with GCA Report Data	Number of Facilities Providing Data in EEA Survey
Neoprene Rubber	2	-	-
Polybutadiene	9	-	-
Styrene-Butadiene	20	-	-
ABS Resin & Nitrile Butyl Rubber	7 ABS, 6 NBR	4 ABS, 3 NBR	7 ABS, 6 NBR
Miscellaneous Butadiene	6	-	-

^aNumber of facilities was obtained from information located in the 10 previously mentioned memoranda in Section 3.1.

TABLE 3-2. SUMMARY OF EMISSIONS FOR POLYMERIZATION PROCESSES

Emission Sources Dependent on Consumption Rate	Number of Reporting Processes	Emission Factor (kg monomer emitted/Hg consumed) ^b	
		Average	95th-percentile Standard Deviation
Process Vents	49	11.73	61.89
Storage	12	1.07	1.40
Equipment Openings	1	0.56	0.56 ^d
Secondary	11	0.87	3.10

Emission Sources Independent of Consumption Rate	Number of Reporting Processes	Emission Rate (kg monomer emitted/yr) ^b	
		Average	95th-percentile Standard Deviation
Equipment Leaks	47	32,700	95,000
Relief Discharges	2	489	960 ^d

^aRepresents the total number of non-zero data points for which emissions were reported.

^bRepresents the average and standard deviation of all the non-zero data points for which emissions were reported and consumption rates were known.

^c95 percent of the reported emission factors (or rates) are less than or equal to this value.

^dRepresents highest emission factor (or rate) due to low number of data points.

^en-r Insufficient data points to calculate standard deviation.

(2) consumption rates calculated by throughput of raw butadiene and acrylonitrile in storage given on the Section 114 responses or the GCA assessment reports, (3) consumption rates calculated by using the process design information given on the Section 114 responses or the GCA assessment reports, and (4) consumption rates calculated using production capacities for each facility. The fourth method involves calculating an industry-wide ratio for a process (e.g., neoprene) of total U. S. consumption to total U. S. production. From this ratio, the consumption rate for a facility can be estimated by multiplying this ratio by the total production capacity for each facility. This method was only employed when the other three methods could not be applied. Footnotes in Table B-1 discuss the method used to calculate consumption rate for each plant. The consumption rate of one facility in the miscellaneous process category was not available in the Section 114 responses. In addition, the consumption rate could not be estimated using the above four methods and is thus indicated as "NA" in Table B-1.

Table 3-2 presents the average and the 95th-percentile emission factor (by emission type) per process unit for polymerization facilities. The 95th-percentile number is the emission rate corresponding to the process for which 95 percent of the other processes had lower emissions. This 95th-percentile emission factor provides a conservative estimate for a polymerization facility for which no actual emission data are available. Figure 3-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emission factor was determined for process vents.

The following sections summarize the emission rate analysis for each emission type.

Process Vent Emissions. A total of 50 facilities reported process vent emissions for the five processes in this source category. Some facilities have more than one process vent. For these facilities, emissions were summed for all process vents. Total process vent emissions from the 50 facilities ranged from 0.01 to 170 kg/Mg of consumption. The 95th-percentile emission factor for process vents is 61.9 kg/Mg consumption. That is, 95 percent of

POLYMERIZATION PROCESS VENTS

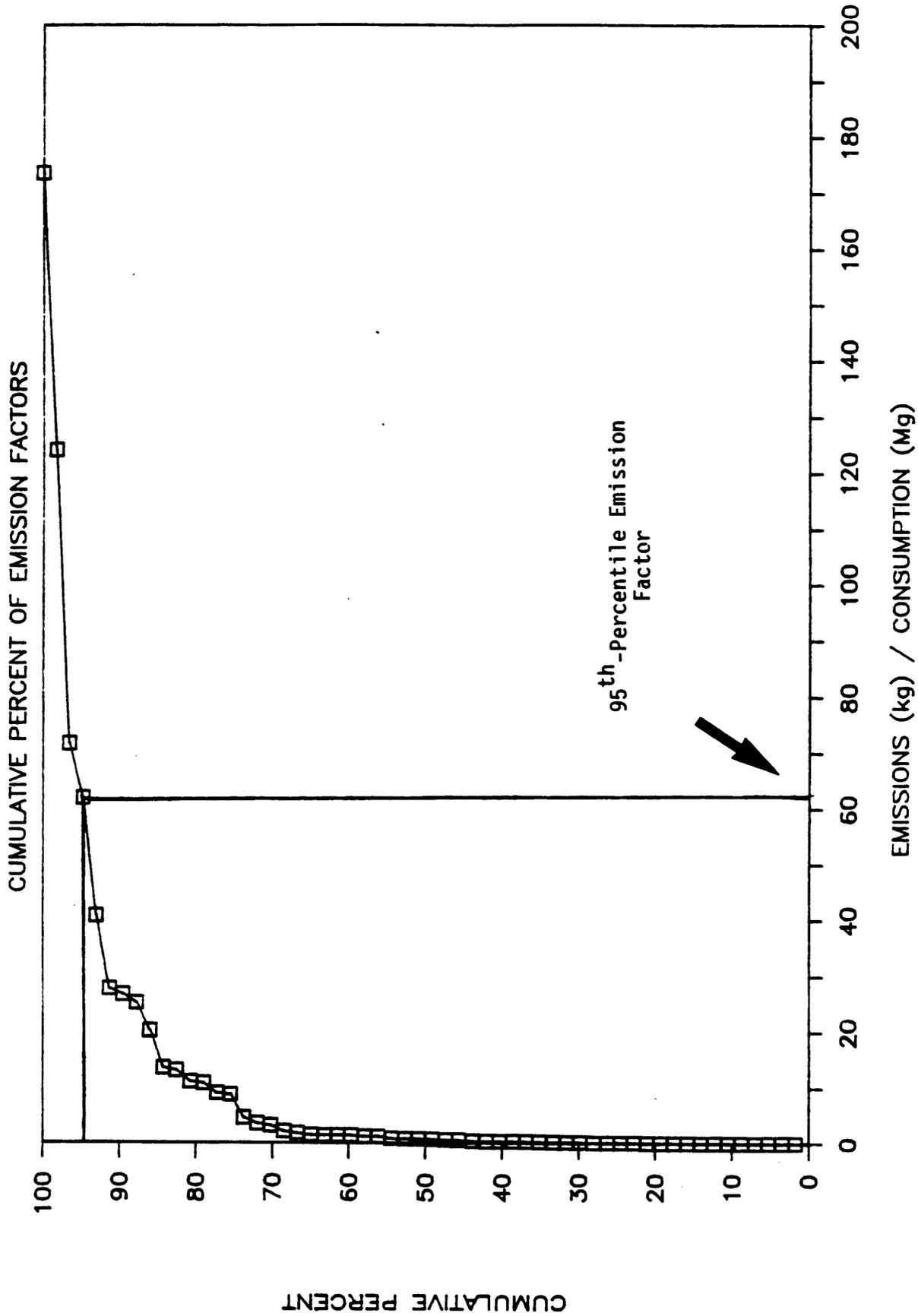


Figure 3-1. Cumulative percent of emission factors for polymerization process vents.

the plant facilities in this source category have an emission factor for process vents lower than this ratio. The average emission factor for this source category is 12 kg/Mg consumption.

Storage Emissions. Storage tank emissions were reported at 17 facilities. Total storage emissions from the 17 facilities ranged from 0 to 7.5 kg/Mg of consumption. The 95th-percentile emission factor for storage emissions is 1.4 kg/Mg consumption. The average emission factor for this source category is 1.1 kg/Mg consumption.

Handling Emissions. No facilities reported handling emissions.

Equipment Opening Emissions. Equipment opening emissions were reported for only one facility. The 95th-percentile emission factor for this emission type was taken as the one value available, 0.56 kg/Mg consumption.

Secondary Emissions. Secondary emission sources were reported from 11 facilities. Total secondary emissions from the 11 facilities ranged from 0 to 3.3 kg/Mg of consumption. The 95th-percentile emission factor for this emission type is 3.1 kg/Mg consumption. The average emission factor is 0.87 kg/Mg consumption.

Equipment Leak Emissions. Equipment leak emissions were reported by 47 facilities. Total equipment leak emissions ranged from 60 to 180,000 kg/yr. The 95th-percentile emission rate is 95,000 kg/yr. The average emission rate for equipment leaks is 33,000 kg/yr.

Pressure Relief Discharges. Only two facilities reported emissions from pressure relief discharges. The emission rates were 18 and 960 kg/yr, which results in an average emission rate of 490 kg/yr. The 95th-percentile emission rate is assumed to be the higher of the two emission rates.

3.3 OTHER EMISSION PARAMETERS

Four other emission point parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 3-3 summarizes the emission parameters for each emission type. The total number of reported data points,

TABLE 3-3. SUMMARY OF EMISSION PARAMETERS FOR POLYMERIZATION PROCESSES

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)	
	Number ^a	Average ^b						
Process Vents	135	16.6	144	0.42	127	9.51	129	321
		Range		Range		Range		Range
		1.5-49.5		0.01-2.13		0.002-38.0		278-616
Storage Vents	2	5.1 ^d	2	0.065 ^d	1	0.5	2	307
		Range		Range		Range		Range
		2.0-8.2		0.05-0.08		0.5-0.5		293-320
Secondary	6	0	4	0	0	NA ^c	0	NA ^c
		0-0		0-0		NA ^c		NA ^c
Equipment Openings	2	9.9	2	0.03	2	183	2	313
		0-19.8		0.01-0.05		0.05-366		272-353
Equipment Leaks	0	NA ^c						
		NA ^c		NA ^c		NA ^c		NA ^c
Relief Discharge	1	0	1	0.23	1	22.4	1	283
		NA ^c		0.23-0.23		22.4-22.4		283-283

^aRepresents the total number of data points for which emission parameters were reported.

^bRepresents the average of all data points for which reported data were available.

^cNA = Insufficient reported data were available to determine the indicated parameter.

^dAverage is calculated using the non-zero data points.

as well as the average and range, for each emission parameter is provided. For example, values for 135 process vent heights were reported by facilities in this category. The average process vent height is 17 m. The average process vent diameter is 0.42 m, and the average process vent discharge velocity is 9.5 m/s. The average process vent discharge temperature is 320K. The data that were used to generate Table 3-3 are presented in Table B-2.

4.0 CHEMICAL PROCESS USE OF SOLVENTS

Information on emissions resulting from the use of solvents in chemical processes is summarized in this section. The emissions data are based on responses to Section 114 questionnaires which were prepared for two EPA source category concurrence investigations - chlorine production and chemical plant chlorinated compound users. These two data sources were combined to form the source category grouping, chemical process use of solvents. All facilities in this source category grouping generate emissions from the use of solvents in chemical processes. Emissions data from 19 facilities are included in this analysis. A brief description of each of these two data sources is provided in Section 4.1, and the emission parameters are summarized in Sections 4.2 and 4.3.

4.1 DESCRIPTION OF DATA SOURCES

4.1.1 Chlorine Production

Carbon tetrachloride is used as a scrubbing agent in the chlorine product recovery process, and as a diluent for nitrogen trichloride, an unstable by-product of the chlorine reaction. Twelve facilities currently use carbon tetrachloride in the chlorine production process. Five of the 12 facilities that produce chlorine use carbon tetrachloride only as a diluent. Emissions data were not evaluated for this use because it was determined to be a negligible source of carbon tetrachloride emissions. These five facilities are not included in this analysis. The remaining seven facilities use carbon tetrachloride as a scrubbing agent, which is a more significant source of emissions. Emissions data are available for six of these seven facilities, and are included in this analysis.

Emissions of carbon tetrachloride occur from the following sources in chlorine product recovery: process vents, equipment leaks, secondary waste streams, storage tanks, handling operations, relief device discharges, accidental releases, and equipment openings. Emission parameters for the six facilities are based on data presented in the memorandum, "Documentation of Controlled Emission Parameters for Carbon Tetrachloride Emissions from Chlorine Production Plants," dated December 20, 1985.

4.1.2 Chlorinated Compound Users

The use of methylene chloride, carbon tetrachloride, and perchloroethylene as solvents in chemical plants were addressed in this source category investigation. Sources of chlorinated hydrocarbon emissions from use in chemical plants include: process vents, equipment leaks, storage tanks, handling operations, equipment openings, relief device discharges, and secondary sources. Emission data for 13 facilities that use chlorinated compounds as solvents are included in this analysis. Four facilities from this source category use chlorinated hydrocarbons as reactants and are included in the chemical process use of reactants section. Emission parameters for these 13 facilities are based on data presented in the memorandum, "Documentation of Baseline and Controlled Emission Parameters for Emissions from Chemical Plants - Chlorinated Compound Users," dated June 30, 1986.

4.2 SUMMARY OF EMISSIONS FROM SOLVENTS USED IN CHEMICAL PROCESSES

This source category grouping consists of emissions data from 19 facilities. Table 4-1 presents the average and the 95th-percentile emission factor (or rate) for each emission type. The emissions data for each process are contained in Appendix C. The emission types reported include process vents, storage tank vents, handling emission sources, equipment leaks, equipment openings, secondary sources, accidental releases, and pressure relief discharges. For each process, a total emission rate was calculated by emission type. For example, the total storage vent emission rate for a process with emissions from three storage tanks is the sum of the emission rates for each storage tank.

For this analysis, five of the emission types are assumed to be a function of consumption - process vents, storage, handling, secondary, and equipment openings. For these emission types, the total emissions are expressed as a ratio of emissions of solvent to consumption of solvent. When the consumption rate was not provided by the facility, it was calculated from storage throughput or solvent make-up. The remaining emission types - equipment leaks, accidental releases, and pressure relief discharges are assumed to be independent of consumption, and are expressed as emission rates.

TABLE 4-1. SUMMARY OF EMISSIONS DATA FOR CHEMICAL PROCESS USE OF SOLVENTS

Emission Sources Dependent on Consumption Rate	Number of Reporting Processes	Emission Factor (kg solvent emitted/Mg consumed)	
		Average	95th-percentile Standard Deviation
Process Vents	33	160 ^b	820
Storage	27	3.2	9.0
Equipment Openings	24	2.4	15
Handling	18	0.9	2.1
Secondary	15	55	24
			280
			10
			5.1
			1.5
			200

Emission Sources Independent of Consumption Rate	Number of Reporting Processes	Emission Rate (kg solvent emitted/yr)	
		Average	95th-percentile Standard Deviation
Equipment Leaks	36	25,000	78,000
Accidental Releases	13	7,100	3,200
Relief Discharges	6	1,900	2,100
			42,000
			25,000
			3,600

^aRepresents the total number of non-zero data points for which emissions data were reported.

^bRepresents the average of all the non-zero data points for which emissions were reported and consumption rates were known.

^c95 percent of the reported emission factors (or rates) are less than or equal to this value.

Table 4-1 presents the average and the 95th-percentile emission factor (or rate) for each reported emission type. In order to develop conservative emission estimates, the average and 95th-percentile value are based only on data supplied by facilities that reported non-zero emission occurrences. For processes that emit more than one pollutant, emission rates (or factors) were calculated for each pollutant. The 95th-percentile factor is the emission factor that corresponds to the value for which 95 percent of the other processes reported lower emission factors. The 95th-percentile emission factor provides a conservative estimate for a chemical process for which no actual solvent emissions data are available. Figure 4-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emissions was determined for process vents. Of the 33 process vent emission occurrences for which emission factors could be calculated, 95 percent of the process vents (31) have emission factors equal to or less than 820 kg/Mg. Therefore, as Figure 4-1 shows, 820 kg/Mg is the 95th-percentile emission factor.

The following sections summarize the emissions data analysis for each emission type.

Process Vent Emissions

Eighteen facilities reported process vent emissions data. Due to multiple processes and/or pollutants at some facilities, a total of 35 data points were evaluated for this emission type. Borden Chemical (Norristown, PA) did not report any process vent emissions. Emission factors were not calculated for the Diamond Shamrock facility (Deer Park, TX) and the Dow Chemical facility (Midland, MI - process #8), because consumption rates were not available. The 95th-percentile emission factor for the remaining 33 data points is 820 kg/Mg. In other words, 95 percent of the data points (31) in this source category have an emission factor for process vents lower than 820 kg/Mg. The individual emission factors range from less than 1.0 to 1,000 kg/Mg. The average emission factor for this source category is 160 kg/Mg.

CHEMICAL PROCESS USE OF SOLVENTS

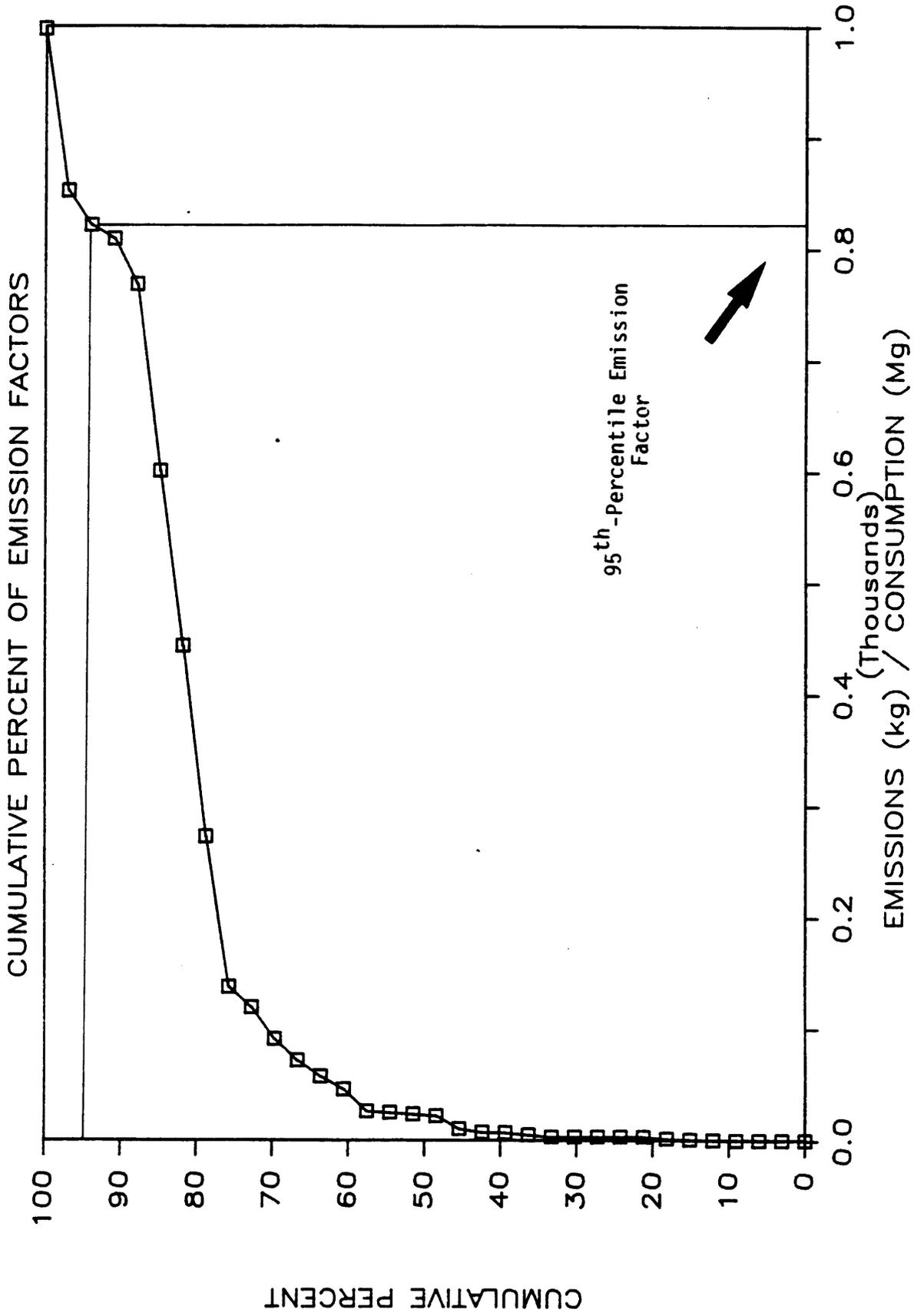


Figure 4-1. Cumulative percent of emission factors for chemical process use of solvents.

Storage Emissions

Fourteen facilities reported storage tank emissions, which represent a total of 27 storage tank data points. The 95th-percentile emission factor for the 27 data points is 9.0 kg/Mg. The individual emission factors range from less than 1.0 to 54 kg/Mg. The average emission factor for this source category grouping is 3.2 kg/Mg.

Handling Emissions

Thirteen facilities reported handling emissions, which represent a total of 18 data points. The 95th-percentile emission factor for the 18 data points is 2.1 kg/Mg and the average emission factor is 0.9 kg/Mg. The individual emission factors range from less than 1.0 to 6.4 kg/Mg.

Equipment Opening Emissions

Twelve facilities reported equipment openings, which represent 25 data points. An emission factor was not calculated for the Dow Chemical (Midland, MI - process #8), because the consumption rate was unknown. The 95th-percentile emission factor for the remaining 24 data points is 15 kg/Mg. The individual emission factors range from 1.0 to 21 kg/Mg. The average emission factor is 2.4 kg/Mg.

Secondary Emissions

Nine facilities reported secondary emissions, which represent 17 emission data points. However, emission factors for two processes could not be calculated because the consumption rates were unknown. The 95th-percentile emission factor for the remaining 15 data points is 24 kg/Mg. The individual emission factors range from less than 1.0 to 760 kg/Mg. The average emission factor is 55 kg/Mg.

Equipment Leak Emissions

Equipment leak emissions were reported for all 19 facilities. A total of 35 data points were reported by the facilities. The emission estimates are based on equipment counts supplied by the manufacturers. The 95th-percentile emission rate for the 35 data points is 78,000 kg/yr. The average

emission rate for equipment leaks is 25,000 kg/yr. The individual emission rates range from 3.0 to 230,000 kg/yr.

Pressure Relief Devices

Four facilities reported pressure relief emissions, which represent six emission data points. The 95th-percentile emission rate for pressure relief devices is 2,100 kg/yr. The individual emission rates range from 23 to 9,100 kg/yr. The average emission rate is 1,900 kg/yr.

Accidental Releases

Three facilities reported emissions from accidental releases. A total of 13 data points were reported by the three facilities. The 95th-percentile emission rate for accidental releases is 3,200 kg/yr. The individual emission rates range from less than 1.0 to 89,000 kg/yr. The average emission rate is 7,100 kg/yr.

4.3 OTHER EMISSION PARAMETERS

Four other emission parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 4-2 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 238 process vent heights were reported by facilities in this category. The average process vent height is 15 m. The average process vent diameter is 0.32 m and the average process vent discharge velocity is 12 m/s. The average process vent discharge temperature is 337K. The raw data that were used to generate Table 4-2 are presented in Appendix C.

TABLE 4-2. SUMMARY OF EMISSION PARAMETERS FOR CHEMICAL PROCESS USE OF SOLVENTS

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)					
	Number ^a	Average ^b	Range	Number	Average	Range	Number	Average	Range			
Process Vents	238	15.3	1.0-34	238	0.32	0.01-3.1	237	12.4	0.01-83.5	238	336.7	255-433
Storage Vents	57	5.3	0.6-14	59	0.06	0.02-14	4	0.2	0.12-0.28	0	NA	NA
Equipment Openings	0	NA	NA	0	NA	NA	0	NA	0.12-0.28	0	NA	NA
Equipment Leaks	0	NA ^c	NA	0	NA	NA	0	NA	0.12-0.28	0	NA	NA
Handling	5	6.0	6.0	8	0.05	0.02-.11	0	NA	0.12-0.28	0	NA	NA
Secondary	0	NA	NA	0	NA	NA	0	NA	0.12-0.28	0	NA	NA
Relief Discharge	0	NA	NA	6	0.08	NA	0	NA	0.12-0.28	0	NA	NA
Accidental Releases	9	12.6	NA	0	NA	NA	9	196.5	9.2-250	0	NA	NA

^aRepresents the total number of data points for which emission parameters were reported.

^bRepresents the average of all data points for which reported data were available.

^cNA = Insufficient data were available to calculate the indicated parameter.

5.0 CHEMICAL PROCESS USE OF REACTANTS

Information on emissions resulting from the use of reactants in chemical processes are summarized in this section. The emissions data are based on responses to Section 114 questionnaires which were prepared for four separate EPA source category concurrence investigations. These source categories include chlorofluorocarbon (CFC) production, miscellaneous butadiene uses, chlorinated compound users, and miscellaneous vinyl chloride uses. In addition to these sources, Section 114 responses and trip reports that were used to prepare the Organic Chemical Manufacturing Volumes 6 through 10 are also included in this analysis.

These five data sources were combined to form the source category grouping, chemical process use of reactants. All facilities in this category generate emissions of raw materials or reactants. Accordingly, the focus of the data analysis in this section is on reactant emissions. Emissions data from 66 facilities, which represent a total of 89 processes, are included in this analysis. A brief description of each of these five data sources is provided in Section 5.1, and the emission parameters are summarized in Sections 5.2 and 5.3.

5.1 DESCRIPTION OF DATA SOURCES

5.1.1 CFC Production

The five commercially significant CFC's are trichlorofluoromethane (CFC-11), dichlorodifluoromethane (CFC-12), chlorodifluoromethane (CFC-22), trichlorofluoroethane (CFC-113), and dichlorotetrafluoroethane (CFC-114). Carbon tetrachloride, chloroform, and perchloroethylene are reactants in the production of CFC. In general, the same manufacturing process is used to produce each of these CFC's. A chlorinated hydrocarbon (e.g., carbon tetrachloride) is reacted with anhydrous hydrogen fluoride in the presence of antimony pentachloride catalyst.

Emissions of carbon tetrachloride, chloroform, and perchloroethylene occur from the following sources in CFC production: equipment leaks, storage tanks, process vents, handling operations, equipment openings, secondary waste streams, and accidental releases. Section 114 responses were

submitted by 12 facilities representing 17 processes operated by five separate CFC producers. Emission parameters for these facilities are based on data presented in the memorandum, "Documentation of Controlled and Revised Baseline Emissions for Carbon Tetrachloride, Chloroform, and Perchloroethylene Emissions from Chlorofluorocarbon Production Plants," dated April 2, 1986. Consumption rates for these facilities were obtained from the Section 114 responses cited in the above-mentioned memorandum, unless stated otherwise.

5.1.2 Miscellaneous Butadiene

1,3-butadiene is used as a reactant in the production of various types of rubbers, resins, and plastics. The miscellaneous source category includes all known emitters of butadiene that are not included in the butadiene, polybutadiene, styrene-butadiene copolymer, acrylonitrile-butadiene-styrene (ABS), nitrile rubber, and chloroprene/neoprene rubber production source categories.

Emissions of butadiene may occur from seven general sources at facilities in the miscellaneous source category. These sources are process vents, equipment leaks, equipment openings, product storage tanks and handling emissions, secondary emissions, relief valve discharges, and accidental releases. Section 114 responses were submitted by 14 facilities, representing 12 different companies. Of the 14 facilities, five use butadiene as a reactant; only data from these five facilities are considered in this section. The other nine facilities produce butadiene, and are considered in the polymerization section. Emission parameters for these five facilities are based on data presented in the memorandum, "Documentation of HEM Inputs for Butadiene Emissions Associated with the Miscellaneous Source Category," dated October 10, 1986. Consumption rates were obtained from the Section 114 responses cited in the above-mentioned memorandum.

5.1.3 Chlorinated Compound Users

The use of methylene chloride, carbon tetrachloride, perchloroethylene, chloroform, and ethylene dichloride as reactants in chemical plants is addressed in this source category. Sources of chlorinated hydrocarbon emissions from use in chemical plants include: process vents, equipment

leaks, storage tanks, handling operations, equipment openings, and accidental releases. Section 114 responses from three facilities representing four processes that use chlorinated compounds as reactants are included in this analysis. An additional 13 Section 114 responses, in which the chlorinated hydrocarbons are used as solvents, are evaluated in Section 4.0, chemical process use of solvents. Emission parameters for these four processes are based on data presented in the memorandum, "Documentation of Baseline and Controlled Emission Parameters for Emissions from Chemical Plants - Chlorinated Compound Users," dated June 30, 1986. Consumption rates for these facilities were obtained from the Section 114 responses cited in the above-mentioned memorandum, unless otherwise noted.

5.1.4 Miscellaneous Vinyl Chloride

The miscellaneous uses of vinyl chloride as a reactant include the production of 1,1,1-trichloroethane, 1,1-dichloroethane, and some pesticides. Six production units at four locations were identified for this source category investigation. Of the six production units, only three use vinyl chloride as a reactant. The other three facilities either do not consume vinyl chloride, or it is produced as a reaction by-product. Only the three facilities that consume vinyl chloride as a reactant are considered in this analysis. Emission parameters for these three facilities are based on data presented in the memorandum, "Vinyl Chloride Standard - Review of Vinyl Chloride Emissions and Emissions Controls for Miscellaneous Sources," dated April 16, 1984.

5.1.5 Organic Chemical Manufacturing Data

The Organic Chemical Manufacturing Volumes 6 through 10 contain emissions data for 39 different manufacturing processes. The Section 114 questionnaires and trip reports that were used to characterize the 39 chemical processes are included in this analysis. Emissions resulting from the use of reactants were extracted from 58 Section 114 responses and trip reports. The reactants being emitted from each emission source vary according to what is being produced. The analysis of the Organic Chemical Manufacturing data is limited to emissions from process vents and storage tanks because this was the only

data requested. Descriptions of the 39 different manufacturing processes are available in the Organic Chemical Manufacturing Volumes 6 through 10.

5.2 SUMMARY OF EMISSIONS FROM REACTANTS USED IN CHEMICAL PROCESSES

This source category grouping, chemical process use of reactants, consists of emissions data from 66 facilities. Table 5-1 summarizes the emissions data for these facilities. Emissions data on a per-process basis are presented in Appendix D by emission type. The emission types reported include process vents, storage tank vents, handling emission sources, secondary sources, equipment leaks, equipment openings, accidental releases, and pressure relief discharges. For each process, a total emission rate was calculated by emission type. For example, the total storage tank emission rate for a process with emissions from three storage tanks is the sum of the emission rates for each storage tank.

For this analysis, five of the emission types are assumed to be a function of consumption - process vents, storage, handling, secondary, and equipment openings. For these emission types, the total emissions are expressed as a ratio of emissions of reactant to consumption of reactant. When the consumption rate was not provided by the facility, it was calculated from storage throughput or from the reaction stoichiometry and conversion rate. The remaining emission types - equipment leaks, accidental releases, and pressure relief discharges, are assumed to be independent of consumption, and are expressed as emission rates.

Table 5-1 presents the average and the 95th-percentile emission factor (or rate) for each emission type. In order to develop conservative emission estimates, the average and 95th-percentile value are based only on data supplied by facilities that reported non-zero emission values. For processes that emit more than one pollutant, emission factors (or rates) were calculated for each pollutant. Ninety-five percent of the emission factors (or rates) are equal to or less than the 95th-percentile value. The 95th-percentile emission factor provides a conservative estimate for a chemical process for which no actual reactant emissions data are available. Figure 5-1 shows an example of the graphical representation of this approach. This graph shows

TABLE 5-1. SUMMARY OF EMISSIONS DATA FOR CHEMICAL PROCESS USE OF REACTANTS

Emission Sources Dependent on Consumption Rate	Number of Reporting Processes ^a	Emission Factor (kg reactant emitted/Mg consumed)	
		Average	95th-percentile Standard Deviation
Process Vents	66	5.3	27 9.6
Storage	33	11	9.7 57
Equipment Openings	18	0.51	0.48 2.0
Handling	7	4.4	31 12
Secondary	3	.001	003 .002

Emission Sources Independent of Consumption Rate	Number of Reporting Processes ^a	Emission Rate (kg reactant emitted/yr)	
		Average	95th-percentile Standard Deviation
Equipment Leaks	30	11,000	51,000 13,000
Accidental Releases	3	95	230 120
Relief Discharges	1	0.69	0.69 -

^aRepresents the total number of non-zero data points for which emissions data were reported and consumption rates were known.

^bRepresents the average of all the non-zero data points for which non-zero emissions were reported and consumption rates were known.

^c95 percent of the reported emission factors (or rates) are less than or equal to this value.

CHEMICAL PROCESS USE OF REACTANTS

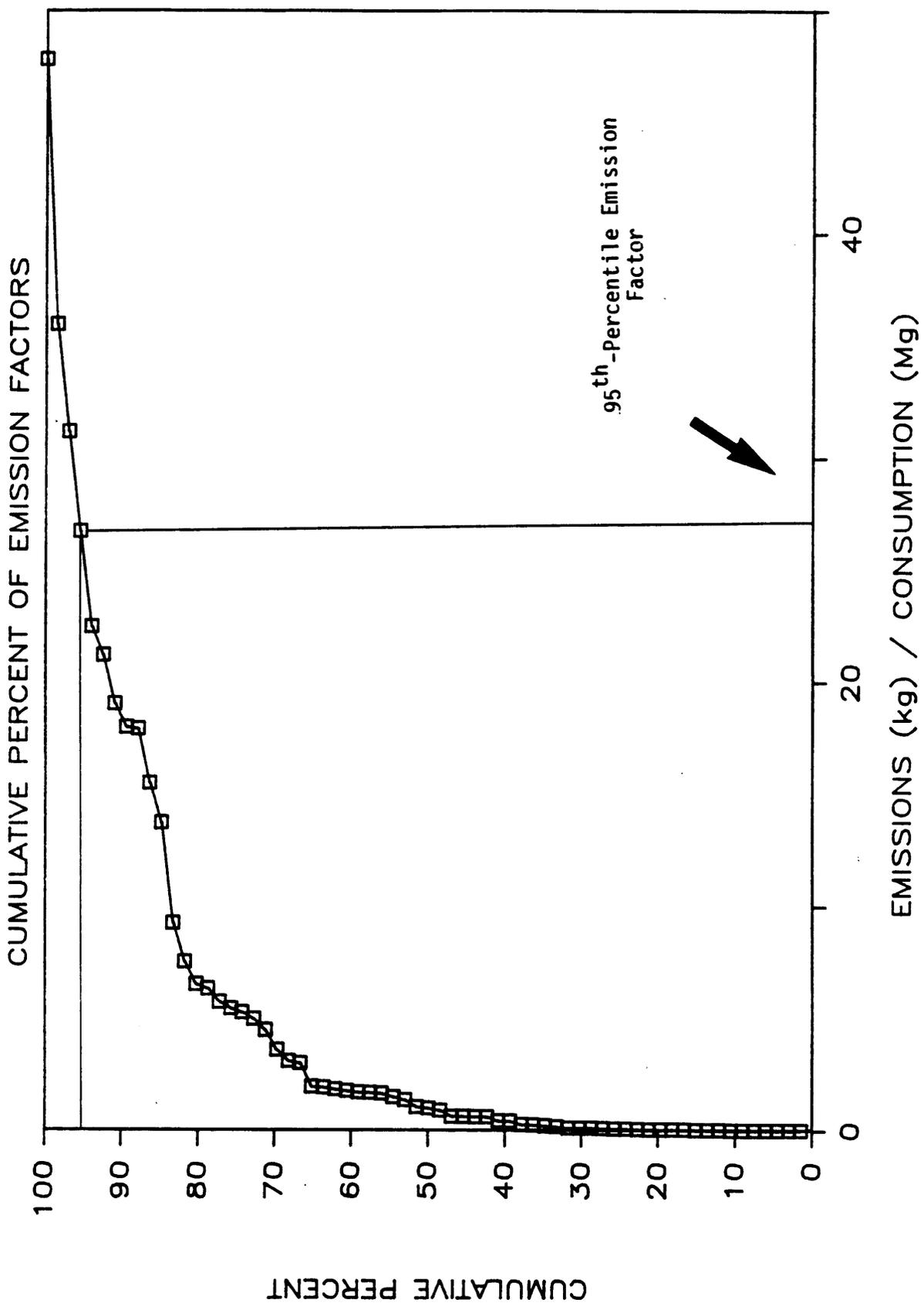


Figure 5-1. Cumulative percent of emission factors for chemical process use of reactants.

how the 95th-percentile emissions was determined for process vents. Of the 66 data points for which emission factors could be calculated, 95 percent are equal to or less than 27 kg/Mg. Therefore, as Figure 5-1 shows, 27 kg/Mg is the 95th-percentile emission factor.

The following sections summarize the emissions data analysis for each emission type.

Process Vent Emissions

Fifty-one facilities reported process vent emissions data. Due to multiple processes and/or pollutants present at some facilities, a total of 71 data points were evaluated for this emission type. Emission factors were not calculated for the Pennwalt facility (Calvert City, KY), the Racon facility (Wichita, KS), two emission occurrences from the E. I. duPont facility (Victoria, TX), and the Union Carbide facility (Institute, WV), because consumption rates were not available. The 95th-percentile emission factor for the remaining 66 data points is 27 kg/Mg. Ninety-five percent of the processes in this source category have an emission factor for process vents less than 27 kg/Mg. The average emission factor for this source category is 5.3 kg/Mg. The individual emission factors range from less than 1 kg/Mg to 48 kg/Mg.

Storage Emissions

Twenty-five facilities reported storage emissions data, which represent a total of 36 data points for this emission type. The emission factors for Pennwalt (Calvert City, KY), Phillips (Borger, TX), and Racon (Wichita, KS) were not calculated because the consumption rates were unknown. The 95th-percentile emission factor for the remaining 33 storage data points is 9.7 kg/Mg. The individual emission factors range from less than 1.0 to 330 kg/Mg. The average emission factor for this source category is 11 kg/Mg.

Handling Emissions

Six facilities reported handling emissions data, which represent a total of nine data points. Emission factors for Pennwalt (Calvert City, KY) and

E. I. duPont (Victoria, TX) were not calculated because consumption rates were not available. The individual emission factors range from less than 1.0 kg/Mg to 31 kg/Mg. The 95th-percentile emission factor for the remaining seven data points is 31 kg/Mg and the average emission factor is 4.4 kg/Mg. Due to the small number of data points, the 95th-percentile is actually the highest value.

Secondary Emissions

Two facilities reported secondary emissions data, which represent a total of four data points. An emission factor for E. I. duPont (Victoria, TX) was not calculated because the consumption rate was unknown. The 95th-percentile emission factor for this emission type is 0.003 kg/Mg. The average emission factor is 0.001 kg/Mg.

Equipment Opening Emissions

Thirteen facilities reported equipment opening emissions data, which represent a total of 20 data points. Emission factors were not calculated for Pennwalt (Calvert City, KY) and Racon (Wichita, KS), because the consumption rates were unknown. Emission factors range from less than 1.0 to 8.7 kg/Mg. The 95th-percentile emission factor for this emission type is 0.48 kg/Mg. The average emission factor is 0.51 kg/Mg.

Equipment Leak Emissions

Fifteen facilities reported equipment leak emissions data, which represent a total of 30 data points. These emission estimates are based on equipment counts supplied by the facilities. The 95th-percentile emission rate for the 30 data points is 51,000 kg/yr. Emission rates range from 29 to 52,000 kg/yr. The average emission rate for equipment leaks is 11,000 kg/yr.

Emissions from Pressure Relief Devices

Only one facility reported pressure relief device emissions data. The emissions from this single facility, 0.69 kg/yr, is used as the 95th-percentile emission rate.

Emissions from Accidental Releases

Three facilities reported accidental release emissions data, which represent three data points. The 95th-percentile emission rate for these three accidental releases is 230 kg/yr. The individual emission rates range from 3.6 to 230 kg/yr. The average emission rate is 95 kg/yr.

5.3 OTHER EMISSION PARAMETERS

Four other emission parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 5-2 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 17 process vent heights were reported by facilities in this category. The average process vent height is 30 m. The average process vent diameter is 0.64 m and the average process vent discharge velocity is 5.2 m/s. The average process vent discharge temperature is 311K. The raw data that were used to generate Table 5-2 are presented in Appendix D.

TABLE 5-2. SUMMARY OF EMISSION PARAMETERS FOR CHEMICAL PROCESS USE OF REACTANTS

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)	
	Number ^a	Average	Number	Average	Number	Average	Number	Average
Process Vents	17 ^c	29.7	20	0.64	20	5.2	81	311
				0.03-66		0.03-4.2		273-355
Storage Vents	32	7.1	31 ^d	0.13	3	4.0	0	NA
				1.5-13		0.04-0.30		1.8-8.5
Equipment Openings	8 ^d	6.4	11	.23	1	0.05	0	NA
				1.0-20		0.01-0.61		NA
Equipment Leaks	0	NA ^e	0	NA	0	NA	0	NA
				NA		NA		NA
Handling	1	7.6	2	0.11	1	0.91	0	NA
				NA		0.01-0.20		NA
Secondary	4	4.4	1	0.20	1	15.2	0	NA
				1.5-10		NA		NA
Pressure Relief Devices	0	NA	0	NA	0	NA	0	NA
				NA		NA		NA
Accidental Releases	0	NA	0	NA	0	NA	0	NA
				NA		NA		NA

^aRepresents the total number of data points for which emission parameters were reported.

^bRepresents the average of all data points for which reported data were available.

^cNegative and zero process vent emission heights were not included in calculations of average and 5th-percentile height.

^dReported diameters equal to zero were not included in calculation of average diameter.

^eNA = Insufficient data were available to calculate the indicated parameter.

6.0 BLOWING AGENTS

6.1 DESCRIPTION OF DATA SOURCES

Sections 6.2 and 6.3 summarize available emission data from the Source Category Concurrence for methylene chloride as a blowing agent used to manufacture flexible slab polyurethane foam. These data were previously presented in the following source category concurrence memoranda:

- (1) "Documentation of HEM Parameters for Methylene Chloride Emissions in the Manufacture of Flexible Slab Polyurethane Foam," dated April 25, 1986;
- (2) "Estimates of Methylene Chloride Emissions from Polyurethane Foam Slabstock Facilities and Emission Reductions Achievable with Additional Controls," dated April 28, 1986.

The Blowing Agent Source Category Concurrence documents were generated using Section 114 questionnaire responses. Section 114 responses were received from 37 facilities using methylene chloride as a blowing agent. Of the 37 responses, only 15 facilities reported emissions data for liquid spills and equipment leaks, and storage tanks. Because data on liquid spills and equipment leaks and storage tanks were required to calculate process vent emissions, the data presented in this section are only from those 15 facilities.

6.2 SUMMARY OF EMISSIONS FROM BLOWING AGENTS

Table 6-1 summarizes the emissions by type for the Blowing Agent Source Category. For this source category, the Section 114 responses presented estimates of methylene chloride emissions from process vents in both foam tunnel and the curing area, and emissions from equipment leaks, liquid spills, and storage tanks. Essentially all of the methylene chloride that is consumed by the process is eventually emitted at the foam facilities. The annual process vent emissions of methylene chloride were estimated by subtracting the amount of methylene chloride emitted from storage tanks, liquid spills, and equipment leaks from the consumption rate. This estimate is believed to be more accurate than the process vent emission estimates reported

TABLE 6-1. SUMMARY OF EMISSIONS FOR BLOWING AGENTS

Emission Sources Dependent on Consumption Rate	Number of Reporting Processes ^a	Emission Factor (kg blowing agent emitted/Mg consumed) 95th-percentile ^c	Average	Standard Deviation ^b
Process Vents	15	974	991	21
Storage	4	1.51	1.63 ^d	0.37

Emission Sources Independent of Consumption Rate	Number of Reporting Processes ^a	Emission Rate (kg blowing agent emitted/yr) Average	95th-percentile ^c	Standard Deviation ^b
Equipment Leaks	15	2,680	4,160	1,200
Liquid Spills	7	127	163 ^d	34

^aRepresents the total number of non-zero data points for which emissions were reported.

^bRepresents the average and standard deviation of all the non-zero data points for which emissions were reported and consumption rates were known.

^c95 percent of the reported emission factors (or rates) are less than or equal to this value.

^dRepresents highest emission factor (or rate) due to low number of data points.

in the Section 114 responses. Emissions from process vents and storage operations are assumed to be dependent on consumption and are expressed as emission factors. Emissions from equipment leaks and liquid spills are assumed to be independent of process size and are presented as annual emission rates (kg/yr). Consumption rates of methylene chloride were obtained directly from the Section 114 responses.

Table 6-1 also presents the average and the 95th-percentile emission factor (by emission type) for the blowing agent facilities. The 95th-percentile number is the emission rate corresponding to the process for which 95 percent of the other processes had lower emissions. This 95th-percentile emission factor provides a conservative estimate for a blowing agent facility for which no actual emission data are available. Figure 6-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emissions was determined for process vents.

The following sections summarize the emission rate analysis for each emission type for the 15 facilities which supplied emission data on all four emission types.

Process Vent Emissions. Estimates of process vent emissions calculated by the difference of consumption and other emission types range from 910 to 990 kg/Mg consumption. The 95th-percentile emission factor for process vent emissions is 990 kg/Mg consumption. That is, 95 percent of the plant facilities in this source category have an emission factor for process vents lower than this value. The average emission factor for this source category is 974 kg/Mg consumption.

Storage Emissions. Storage tank emissions ranged from 0 to 1.9 kg/Mg consumption. The 95th-percentile emission factor for storage emissions is 1.6 kg/Mg consumption. The average emission factor is 1.5 kg/Mg consumption.

Equipment Leak Emissions. Equipment leak emissions ranged from 970 to 4,400 kg/Mg consumption. The 95th-percentile emission rate is 4,200 kg/yr. The average emission rate for equipment leaks is 2,700 kg/yr.

Liquid Spills: Liquid spill emissions ranged from 0 to 160 kg/yr. The 95th-percentile emission rate is 160 kg/yr. The average emission rate for liquid spills is 130 kg/yr.

BLOWING AGENT PROCESS VENTS

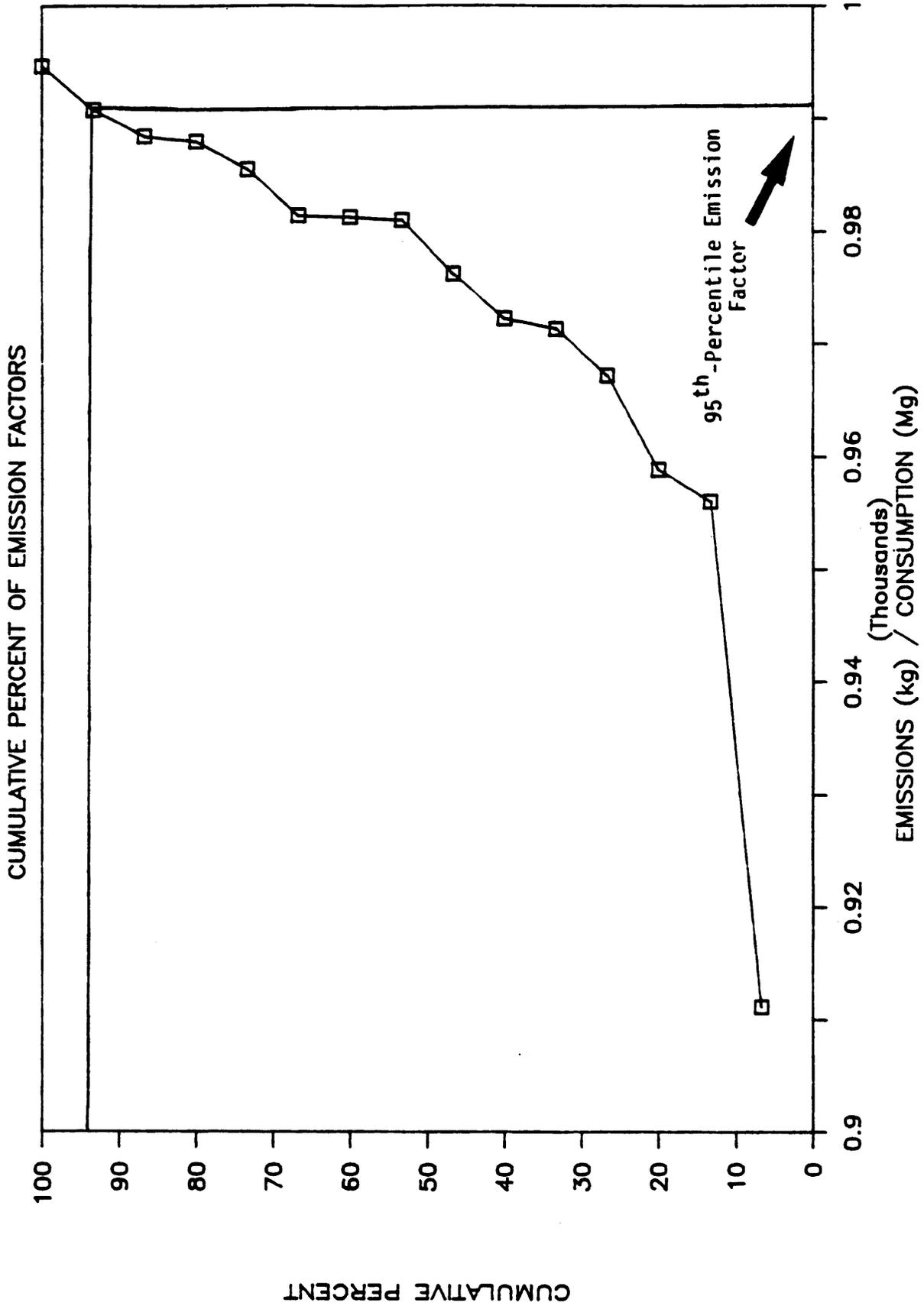


Figure 6-1. Cumulative percent of emission factors for blowing agent process vents.

6.3 OTHER EMISSION PARAMETERS

Four other emission parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 6-2 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 170 process vent heights were reported by facilities in this category. The average process vent height is 10 m. The average process vent diameter is 0.76 m, and the average process vent discharge velocity is 13 m/s. The average process vent discharge temperature is 300 K. The data that were used to generate Table 6-2 are presented in Appendix E in Table E-2.

TABLE 6-2. SUMMARY OF EMISSION PARAMETERS FOR BLOWING AGENTS

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)	
	Number ^a	Average ^b Range						
Process Vents	170	9.99 5.0-18.3	170	0.76 0.36-1.52	149	13.4 2.7-34.1	122	300 293-311
Storage Vents	7	4.64 2.4-5.9	7	0.05 0.05-0.05	0	NA ^c NA ^c	0	NA ^c NA ^c
Equipment Leaks	0	NA ^c NA ^c						

^aRepresents the total number of data points for which emission parameters were reported.

^bRepresents the average of all data points for which reported data were available.

^cNA = Insufficient reported data were available to determine the indicated parameter.

7.0 PESTICIDES PRODUCTION

The summary of available emissions data presented in this section is based on the Source Category Concurrence investigation for pesticides production. The data used for this section were previously presented in two memoranda supporting the Source Category Concurrence:

- (1) Estimates of Hazardous Compound Emissions From Pesticide Facilities and Emission Reductions Available with Additional Controls, dated July 24, 1986.
- (2) Documentation of HEM Inputs for Emissions Associated with Chlorinated Hydrocarbon Use in Pesticide Manufacturing, dated June 3, 1986.

7.1 DESCRIPTION OF DATA SOURCES

In developing these documents, Section 114 questionnaires were received from 15 facilities producing pesticides. These responses represent a total of 25 separate processes within this source category. The data summarized in this report are based only on information reported in Section 114 responses and not on any estimates made for facilities where no Section 114 information was available. Other pertinent information concerning emission sources in this source category may be found in the documents listed above. The data presented in this section will be used to make preliminary estimates of emissions and emission parameters for any potentially hazardous air pollutants that are used in the production of pesticides.

7.2 EMISSIONS SUMMARY

Table 7-1 presents a summary of the emissions data for the pesticide production source category. The data presented on a per-process basis is presented in Table F-1 of Appendix F. Several facilities gave data for more than one process at a facility, with certain types of emissions aggregated over these processes. These entries are footnoted in Table F-1 accordingly. For the purposes of this study it was assumed that these emissions were distributed equally among the processes at the facility.

TABLE 7-1 EMISSIONS SUMMARY FOR PESTICIDE PRODUCTION

Emission Sources Assumed to be Dependent on Consumption	Number of Reporting Processes ^a	Emission Factor (Kg emitted/Mg consumed)		
		Average ^b	95th-Percentile ^c	Standard Deviation
Process Vents	19	100	320	130
Storage	12	5.7	13	6.5
Equipment Openings	8	36	130 ^d	53
Handling	3	0.55	1.4 ^d	0.76
Secondary	15	150	460	200

Emission Sources Assumed to be Independent of Consumption	Number of Reporting Processes ^a	Emission Rate (Kg emitted/Yr)		
		Average ^b	95th-Percentile ^c	Standard Deviation
Equipment Leaks	25	15000	35000	33000
Liquid Spills	4	9800	12000 ^d	5090
Relief Discharges	2	150	230 ^d	47

^a Represents the total number of data points for which non-zero emissions were reported.

^b Represents the average of all data points for which non-zero emissions were reported.

^c 95 percent of the reported non-zero emission factors or rates are less than or equal to this value.

^d Represents highest emission rate, due to low number of data points.

Since emissions from some emission types are assumed to be dependent on the relative size of the process, these emission rates are expressed as a function of the consumption of the emitted chemical. The consumption rates used are as reported by the facilities in Section 114 responses. For this source category, emission rates are based on full operating capacity of the process. Since consumption is as reported by the facility for a given year, it is possible for the emission factor to exceed unity (1 Mg emitted/Mg consumed).

Emissions from process vents, storage, handling operations, secondary sources, and equipment openings are assumed to be dependent on consumption and are, therefore, expressed as emission factors. Emissions from equipment leaks, pressure relief discharges, and liquid spills are assumed to be independent of process size and, are, therefore presented as annual emission rates.

Table 7-1 presents the average and the 95th-percentile emissions (by emission type) for pesticide facilities. In order to develop conservative emission estimates, these values are based only on data supplied by facilities that reported non-zero emission occurrences. The 95th-percentile number is the emission rate corresponding to the process for which 95 percent of the other processes had lower emissions. This 95th-percentile emission factor provides a conservative estimate of emissions for a pesticide production facility for which no actual emissions data are available. Figure 7-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emission factor was determined for process vents.

The following sections summarize the emission rate analysis for each emission type.

Process Vent Emissions.

A total of 34 process vent emission points were reported from the 25 processes in this source category. Emission factors range from 0.013 to 350 kg/Mg consumption. The 95th-percentile emission factor for process vents is 320 kg/Mg consumption of the emitted chemical. That is, 95 percent of the processes in this source category have an emission factor for process vents lower than 320 kg/Mg. The average emission factor for this source category is 100 kg/Mg consumption.

PESTICIDES PRODUCTION

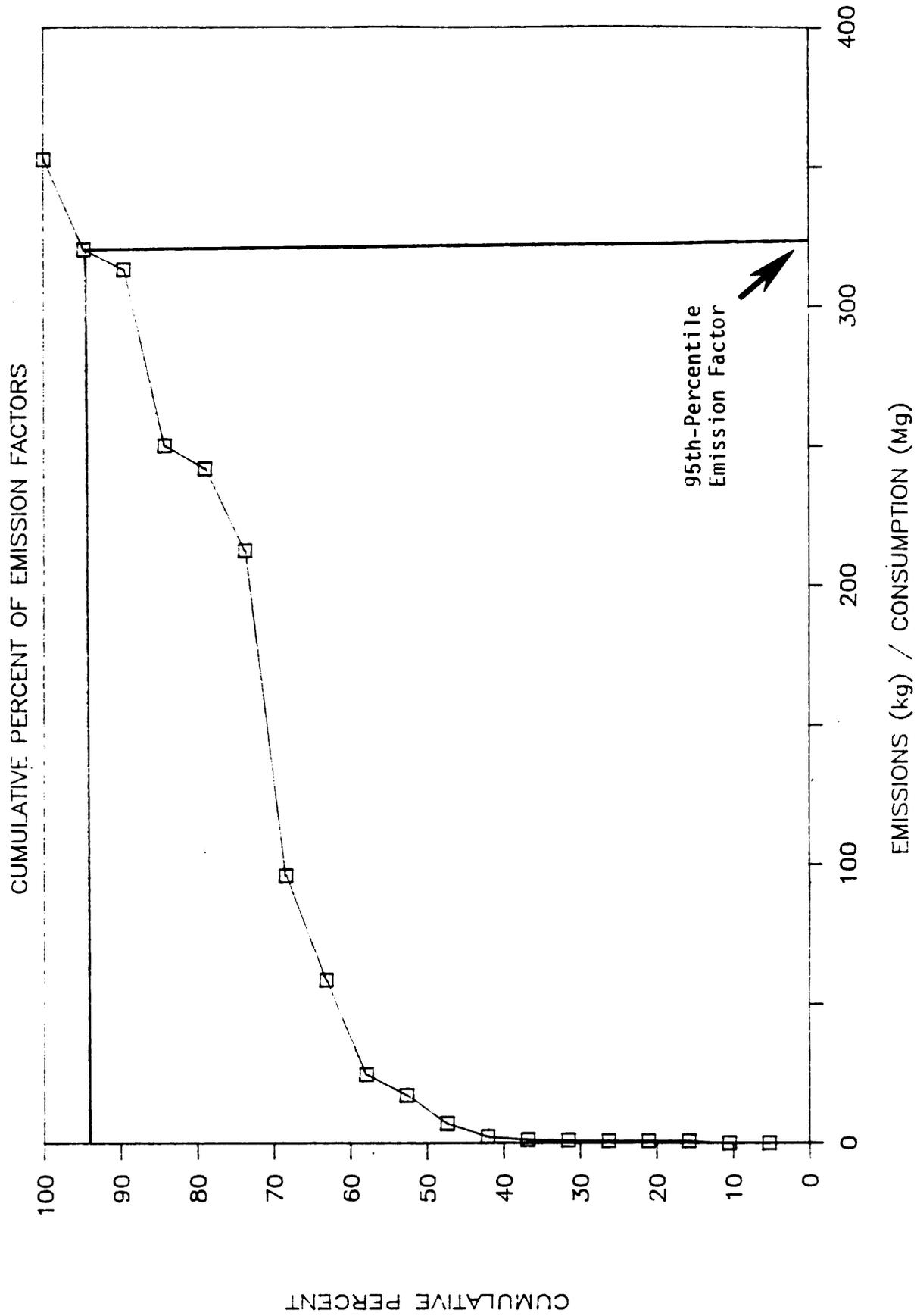


Figure 7-1. Cumulative Percent of Emission Factors for Pesticide Production

Storage Emissions.

A total of 28 storage tank emission points were reported from processes in this source category. Emission factors ranged from 0.008 to 17 kg/Mg consumption. The 95th-percentile emission factor for storage emissions is 13 kg/Mg consumption. The average emission factor per consumption ratio for this source category is 5.7 kg/Mg consumption.

Handling Emissions.

Only three processes reported emissions from handling operations. Therefore, the highest emission factor reported was assumed to be the 95th-percentile emission factor to ensure that the estimate would be conservative. The factor chosen was 1.4 kg/Mg consumption. The average emission factor for handling operations is 0.55 kg/Mg consumption.

Equipment Opening Emissions.

Emissions from equipment openings were reported for only nine processes. Emission factors ranged from 0.007 to 130 kg/Mg. Due to the low number of data points, the 95th-percentile factor is the highest reported factor. The 95th-percentile emission factor for this emission type is 130 kg/Mg consumption. The average emission factor is 36 kg/Mg consumption.

Secondary Emissions.

A total of 11 secondary emission sources were reported from processes in this source category. Emission factors ranged from 0.003 to 530 kg/Mg. The 95th-percentile emission factor for this emission type is 460 kg/Mg consumption. The average emission factor is 150 kg/Mg consumption.

Equipment Leak Emissions.

Equipment leak emissions have been estimated for all facilities in this source category. These estimates are based on equipment counts supplied by the plants. In some cases facilities, combined equipment counts for more than one process, and these entries are footnoted in Table F-1 accordingly. Emission rates ranged from 12 to 100,000 kg/yr. The 95th-percentile emission rate is 35,000 kg/yr. The average emission rate for equipment leaks on a per-process basis is 15,000 kg/yr.

Relief Device Discharges.

Emissions from pressure relief discharges were reported for only two processes. Therefore, the 95th-percentile emission rate was is the highest reported emission rate for this emission type. The 95th-percentile emission rate is 230 kg/yr, and the average emission rate is 150 kg/yr.

Emissions from Accidental Liquid Spills.

Emissions from liquid spills were reported for only four processes. Again, the highest reported rate is used as the 95th-percentile emission rate due to the low number of data points. The 95th-percentile emission rate for liquid spills is 12,000 kg/yr. The average emission rate is 9,800 kg/yr.

7.3 OTHER EMISSION PARAMETERS

Four other emission point parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 7-2 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 34 process vent heights were reported by facilities in this category. The average process vent height is 22.7 m, the average process vent diameter is 0.48 m, and the average process vent stream velocity is 54.06 m/s. The average process vent temperature is 335 K. The data that were used to generate Table 7-2 are presented in Table F-2 of Appendix F.

TABLE 7-2 SUMMARY OF EMISSION PARAMETERS FOR PESTICIDE PRODUCTION

Emission Type	Number ^a	Height (m) Average ^b	Range	Number ^a	Diameter (m) Average ^b	Range	Number ^a	Velocity (m/s) Average ^b	Range	Number ^a	Temperature (K) Average ^b	Range
Process Vents	34	22.71	5.2 - 76.2	34	0.48	0.051 - 1.68	34	54.06	0.001 - 517	33	317	136 - 561
Storage	28	4.14	1.2 - 10.3	28	0.08	0.01 - 0.508	0	NA ^d	NA	0	NA	NA
Equipment Openings	21	6.46	0.9 - 18.3	16	0.15	0.051 - 0.457	0	NA	NA	0	NA	NA
Equipment Leaks	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Handling	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Secondary	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Liquid Spills	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
Relief Discharges	4	13.95	7 - 27.4	4	0.09	0.076 - 0.102	0	NA	NA	0	NA	NA

^a Represents the total number of data points for which emission parameters were reported.

^b Represents the average of all data points for which reported data were available.

^c Represents the range of data points for which emission parameters were reported.

^d NA = Insufficient reported data were available to calculate the indicated parameter.

8.0 PHARMACEUTICAL PRODUCTION

The summary of available emissions data presented in this section is based on the Source Category Concurrence for pharmaceutical production. The data used for this section were previously presented in two memoranda supporting the Source Category Concurrence. The first memorandum is titled, "Estimates of Potentially Hazardous Compound Emissions From Pharmaceutical Facilities and Emission Reductions Available with Additional Controls," and is dated September 17, 1986. The second is titled, "Documentation of HEM Inputs for Emissions Associated with Chlorinated Hydrocarbon Use in the Manufacture of Pharmaceuticals," and is dated July 9, 1986.

The emissions data that were used to develop these documents are from responses to Section 114 questionnaires concerning the use of methylene chloride in the production of pharmaceuticals. Section 114 responses were received from 9 manufacturers of pharmaceuticals which represent 20 facilities and a total of 23 processes. The data summarized in this section are based only on information reported in Section 114 responses and not on any estimates made for facilities where no Section 114 information was available. Other pertinent information concerning emission sources in this source category may be found in the documents listed above. The data presented in this section will be used to make preliminary estimates of emissions and emission parameters for any potentially hazardous air pollutants that are used in the production of pharmaceuticals.

8.1 SUMMARY OF EMISSIONS FROM PHARMACEUTICAL PRODUCTION

Table 8-1 presents a summary of the emission data for the pharmaceuticals source category by emission type. Emissions from process vents, storage, handling operations, secondary sources, and equipment openings are assumed to be dependent on consumption and are expressed as emission factors. The consumption rates used were extracted from the Section 114 responses for each process. Emissions from equipment leaks and liquid spills are assumed to be independent of process size and are therefore presented as annual emission rates. Emissions from pressure relief discharges were not requested in the Section 114 questionnaires for this source category.

TABLE 8-1. SUMMARY OF EMISSIONS DATA FOR PHARMACEUTICAL PRODUCTION

Emission Sources Dependent on Consumption Rate	Number of Reporting Processes ^a	Average Emission Factor (kg emitted/Mg consumed) 95th-percentile	Standard Deviation
Process Vents	23	600	2,000 ^e 1,500
Storage	16	27	160.5 55
Equipment Openings	9	24	160.4 51
Handling	5	7.3	31 ^d 14
Secondary	11	63	144 82

Emission Sources Independent of Consumption Rate	Number of Reporting Processes ^a	Average Emission Rate (kg emitted/yr) 95th-percentile	Standard Deviation
Equipment Leaks	20	17,000	71,000 24,000
Liquid Spills	5	1,300	2,800 950

^aRepresents the total number of non-zero data points for which emissions data were reported and consumption rates were known.

^bRepresents the average of all the non-zero data points for which emissions were reported and consumption rates were known.

^c95 percent of the reported emission factors (or rates) are less than or equal to this value.

^dRepresents highest emission rate, due to low number of data points.

^eEmission rate may exceed consumption rate because emissions were reported at full capacity, and consumption rate was reported at actual capacity.

Table 8-1 presents the average and the 95th-percentile emission factors for the 20 pharmaceutical facilities. In order to develop conservative emission estimates, the average and 95th-percentile are based only on non-zero emissions data supplied by the facilities. The emissions data for each process are contained in Appendix G. Ninety-five percent of the emission factors (or rates) are less than or equal to the 95th-percentile value. This 95th-percentile emission factor provides a conservative estimate of emissions for a pharmaceutical production facility for which no actual emissions data are available. Figure 8-1 shows an example of the graphical representation of this approach. This graph shows how the 95th-percentile emission factor was determined for process vents.

The following sections summarize the emission rate analysis for each emission type.

Process Vent Emissions. Process vent emission points were reported for 23 processes in this source category. The 95th-percentile emission factor for the 23 processes is 2,000 kg/Mg. Ninety-five percent of the processes in this source category have an emission factor for process vents lower than 2,000 kg/Mg. The individual emission factors range from less than 1.0 to 7,100 kg/Mg. The average emission factor for this source category is 600 kg/Mg.

Storage Emissions. Storage tank emission points were reported for 16 processes. The 95th-percentile emission factor for the 16 processes is 160 kg/Mg. The individual emission factors range from less than 1.0 to 170 kg/Mg. The average emission factor for this source category is 27 kg/Mg.

Handling Emissions. Emissions from handling operations were reported for only five processes. The 95th-percentile emission factor for handling emissions is 31 kg/Mg. The individual emission factors range from less than 1.0 to 31 kg/Mg. The average emission factor for this source category is 7.3 kg/Mg.

PHARMACEUTICAL PROCESS VENTS

CUMULATIVE PERCENT OF EMISSION FACTORS

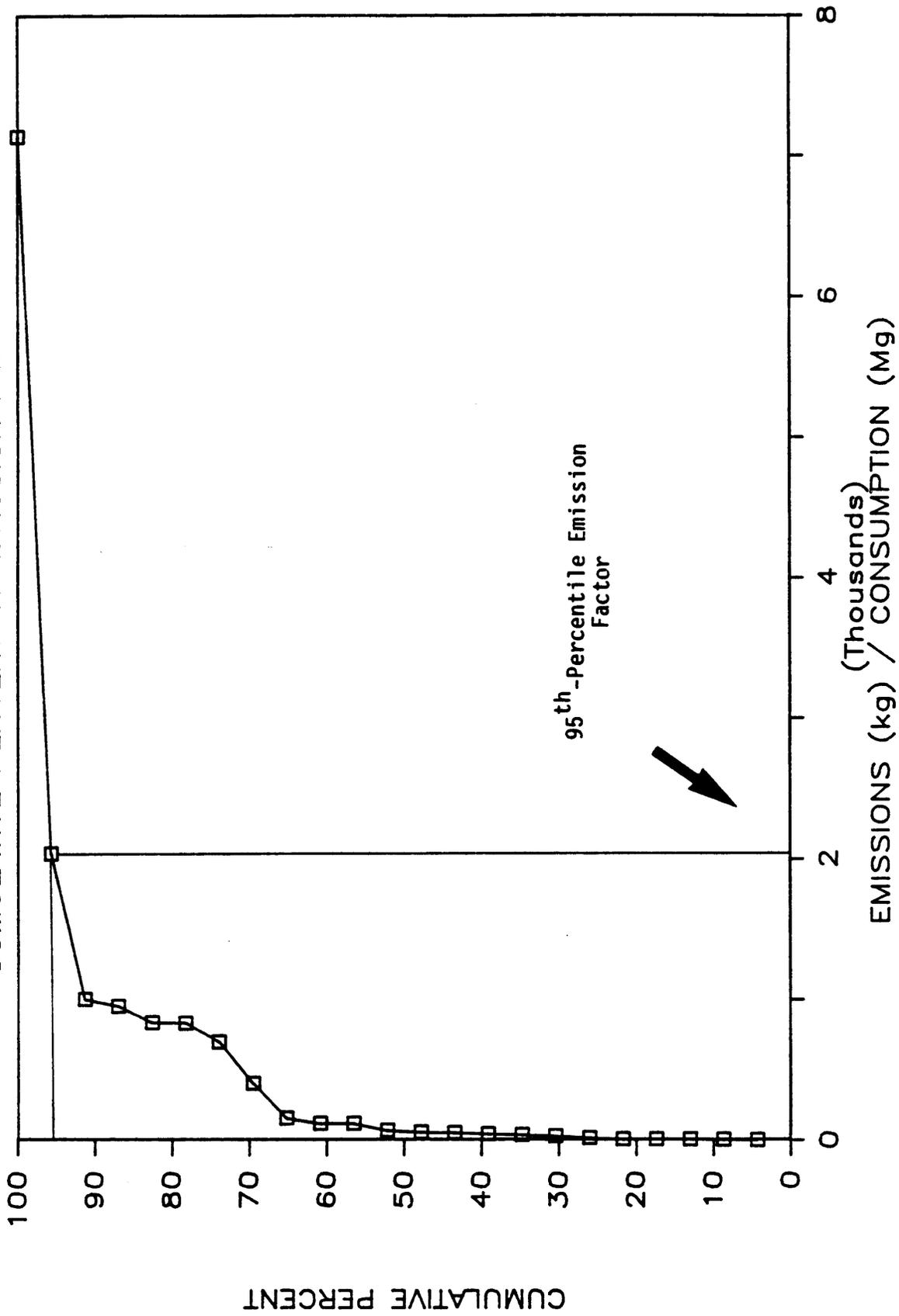


Figure 8-1. Cumulative percent of emission factors for pharmaceutical process vents.

Equipment Opening Emissions. Nine facilities reported equipment opening emissions. The 95th-percentile emission factor for the nine processes is 160 kg/Mg. The individual emission factors range from less than 1.0 to 200 kg/Mg. The average emission factor is 24 kg/Mg.

Secondary Emissions. Eleven facilities reported secondary emissions. The 95th-percentile emission factor for the 11 processes is 144 kg/Mg. The individual emission factors range from 1.0 to 230 kg/Mg. The average emission factor is 63 kg/Mg.

Equipment Leak Emissions. Equipment leak emissions have been estimated for 20 of the 23 processes in this source category. These estimates are based on equipment counts supplied by the manufacturers. Emission estimates are not available for two facilities. In addition, one facility combined equipment counts for two processes. For this study, it was assumed that emissions were distributed evenly between the two processes. The 95th-percentile emission rate for the 20 processes is 71,000 kg/yr. The individual emission rates range from 370 to 73,000 kg/yr. The average emission rate for equipment leaks on a per process basis is 17,000 kg/yr.

Emissions from Liquid Spills. Emissions from liquid spills were reported for five processes. In order to develop a conservative estimate, the 95th-percentile emission rate is based only on the five spill emissions reported. The 95th-percentile emission rate for liquid spills is 2,800 kg/yr. The individual emission rates range from 280 to 2,800 kg/yr. The average emission rate is 1,300 kg/yr.

8.2 OTHER EMISSION PARAMETERS

Four other emission parameters are needed to perform risk modeling. These are: (1) height of release, (2) diameter of release, (3) velocity of release, and (4) temperature of release. Table 8-2 summarizes the emission parameters for each emission type. The total number of reported data points, as well as the average and range, for each emission parameter is provided. For example, values for 534 process vent heights were reported by facilities in this category. The average process vent height is 13 m. The average

TABLE 8-2. SUMMARY OF EMISSION DATA PARAMETERS FOR PHARMACEUTICAL PRODUCTION

Emission Type	Height (m)		Diameter (m)		Velocity (m/s)		Temperature (K)	
	Number ^a	Average ^b	Number	Average	Number	Average	Number	Average
Process Vents	534	12.9	529	0.2	466	3.6	534	294
								231-373
Storage Vents	60	8.0	60	0.1	2	0.05	0	NA
Equipment Openings	19	9.8	14	0.5	9	15.1	0	NA
Equipment Leaks	0	NA ^c	0	NA ^c	0	NA ^c	0	NA ^c
Handling	1	8.8	0	NA ^c	0	NA ^c	0	NA ^c
Secondary	3	12.0	3	0.06	2	7.6	0	NA ^c
								0.1-15
Liquid Spills	0	NA ^c	0	NA ^c	0	NA ^c	0	NA ^c

^aRepresents the total number of data points for which emission parameters were reported.

^bRepresents the average of all data points for which reported data were available.

^cNA = Insufficient reported data were available to calculate the indicated parameter.

process vent diameter is 0.20 m and the average process vent discharge velocity is 3.6 m/s. The average process vent discharge temperature is 294K. The raw data that were used to generate Table 8-2 are presented in Appendix G.

Appendix A
Production Processes

TABLE A-1. SUMMARY OF EMISSIONS FOR PRODUCTION PROCESSES
(SORTED IN ASCENDING ORDER FOR EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg emitted/Mg produced)						EMISSION RATE (kg emitted per yr)			
	AIR OXIDATION PROCESS VENTS	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES	LIQUID SPILLS	
1.80E-05	0.004	2.32E-08	5.74E-05	1.03E-05	5.49E-05	130	0.4	4.5	90.7	
3.67E-05	0.042	1.34E-05	4.00E-04	9.19E-05	1.47E-04	2300	3.2	5.7	5100.0	
5.00E-05	0.154	2.00E-04	0.001	1.03E-04	3.00E-04	2720	6	45.0	NR	
6.01E-05	0.174	0.001	0.002	1.86E-04	0.001	3600	45	NR	NR	
6.20E-05	0.220	0.001	0.004	2.11E-04	0.001	3940	46	NR	NR	
8.12E-05	0.263	0.001	0.009	2.75E-04	0.001	4560	102	NR	NR	
1.24E-04	0.367	0.001	0.011	4.41E-04	0.001	5690	190	NR	NR	
1.98E-04	0.407	0.002	0.011	0.001	0.002	7900	544	NR	NR	
2.64E-04	0.496	0.002	0.016	0.002	0.002	12300	1900	NR	NR	
3.12E-04	0.502	0.002	0.020	0.002	0.002	12700	3400	NR	NR	
3.46E-04	0.657	0.003	0.025	0.003	0.003	14600	13300	NR	NR	
0.001	1.016	0.004	0.025	0.005	0.003	15700	23587	NR	NR	
0.001	1.619	0.005	0.025	0.005	0.004	16000	NR	NR	NR	
0.001	1.717	0.006	0.027	0.008	0.004	18649	NR	NR	NR	
0.002	1.931	0.008	0.029	0.009	0.007	19800	NR	NR	NR	
0.002	2.113	0.009	0.031	0.012	0.009	20300	NR	NR	NR	
0.002	2.380	0.009	0.045	0.014	0.010	23200	NR	NR	NR	
0.002	5.091	0.011	0.046	0.016	0.010	24000	NR	NR	NR	
0.003	5.475	0.013	0.046	0.016	0.011	25200	NR	NR	NR	
0.003	5.781	0.019	0.048	0.021	0.013	27300	NR	NR	NR	
0.003	6.354	0.020	0.048	0.054	0.016	28300	NR	NR	NR	
0.004	6.816	0.020	0.052	0.057	0.025	29200	NR	NR	NR	
0.004	NR	0.022	0.066	0.059	0.050	30000	NR	NR	NR	
0.004	NR	0.035	0.071	0.062	0.065	30000	NR	NR	NR	
0.005	NR	0.037	0.072	0.066	0.077	34200	NR	NR	NR	
0.005	NR	0.037	0.089	0.072	0.081	34500	NR	NR	NR	
0.009	NR	0.048	0.090	0.087	0.085	36100	NR	NR	NR	
0.009	NR	0.049	0.092	0.120	0.088	37000	NR	NR	NR	
0.012	NR	0.053	0.102	0.164	0.098	39200	NR	NR	NR	
0.012	NR	0.057	0.124	0.285	NR	39400	NR	NR	NR	
0.012	NR	0.065	0.126	0.295	NR	40200	NR	NR	NR	
0.015	NR	0.066	0.134	0.309	NR	40300	NR	NR	NR	
0.015	NR	0.071	0.138	0.316	NR	41200	NR	NR	NR	
0.015	NR	0.074	0.140	0.830	NR	43836	NR	NR	NR	
0.015	NR	0.084	0.184	1.271	NR	45000	NR	NR	NR	
0.015	NR	0.085	0.224	1.387	NR	45200	NR	NR	NR	
0.015	NR	0.096	0.341	1.785	NR	45900	NR	NR	NR	
0.020	NR	0.098	0.417	NR	NR	45900	NR	NR	NR	
0.022	NR	0.101	0.468	NR	NR	47000	NR	NR	NR	
0.024	NR	0.105	0.580	NR	NR	47100	NR	NR	NR	
0.025	NR	0.123	0.600	NR	NR	48900	NR	NR	NR	
0.026	NR	0.127	0.625	NR	NR	49700	NR	NR	NR	
0.027	NR	0.132	0.654	NR	NR	54900	NR	NR	NR	
0.027	NR	0.133	0.758	NR	NR	56200	NR	NR	NR	
0.027	NR	0.135	0.763	NR	NR	59300	NR	NR	NR	
0.029	NR	0.137	1.055	NR	NR	72000	NR	NR	NR	
0.030	NR	0.137	1.340	NR	NR	73000	NR	NR	NR	

TABLE A-1. SUMMARY OF EMISSIONS FOR PRODUCTION PROCESSES
(SORTED IN ASCENDING ORDER FOR EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg emitted/Mg produced)				EMISSION RATE (kg emitted per yr)				
	AIR OXIDATION PROCESS VENTS	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES	LIQUID SPILLS
0.030	NR	0.146	2.363	NR	NR	75400	NR	NR	NR
0.032	NR	0.147	NR	NR	NR	75400	NR	NR	NR
0.034	NR	0.151	NR	NR	NR	75400	NR	NR	NR
0.034	NR	0.157	NR	NR	NR	83000	NR	NR	NR
0.035	NR	0.175	NR	NR	NR	83600	NR	NR	NR
0.040	NR	0.188	NR	NR	NR	83700	NR	NR	NR
0.041	NR	0.196	NR	NR	NR	84400	NR	NR	NR
0.042	NR	0.201	NR	NR	NR	85000	NR	NR	NR
0.042	NR	0.212	NR	NR	NR	89100	NR	NR	NR
0.043	NR	0.232	NR	NR	NR	89400	NR	NR	NR
0.048	NR	0.242	NR	NR	NR	92800	NR	NR	NR
0.058	NR	0.245	NR	NR	NR	99900	NR	NR	NR
0.060	NR	0.254	NR	NR	NR	104400	NR	NR	NR
0.069	NR	0.274	NR	NR	NR	104500	NR	NR	NR
0.070	NR	0.286	NR	NR	NR	108700	NR	NR	NR
0.082	NR	0.290	NR	NR	NR	116500	NR	NR	NR
0.087	NR	0.311	NR	NR	NR	127400	NR	NR	NR
0.103	NR	0.321	NR	NR	NR	127400	NR	NR	NR
0.109	NR	0.328	NR	NR	NR	131000	NR	NR	NR
0.124	NR	0.346	NR	NR	NR	135900	NR	NR	NR
0.126	NR	0.350	NR	NR	NR	140200	NR	NR	NR
0.127	NR	0.369	NR	NR	NR	166400	NR	NR	NR
0.131	NR	0.407	NR	NR	NR	342100	NR	NR	NR
0.134	NR	0.469	NR	NR	NR	454400	NR	NR	NR
0.135	NR	0.476	NR	NR	NR	NR	NR	NR	NR
0.135	NR	0.489	NR	NR	NR	NR	NR	NR	NR
0.147	NR	0.509	NR	NR	NR	NR	NR	NR	NR
0.147	NR	0.534	NR	NR	NR	NR	NR	NR	NR
0.152	NR	0.563	NR	NR	NR	NR	NR	NR	NR
0.155	NR	0.577	NR	NR	NR	NR	NR	NR	NR
0.170	NR	0.600	NR	NR	NR	NR	NR	NR	NR
0.175	NR	0.646	NR	NR	NR	NR	NR	NR	NR
0.182	NR	0.674	NR	NR	NR	NR	NR	NR	NR
0.184	NR	0.750	NR	NR	NR	NR	NR	NR	NR
0.186	NR	0.960	NR	NR	NR	NR	NR	NR	NR
0.202	NR	1.076	NR	NR	NR	NR	NR	NR	NR
0.210	NR	1.264	NR	NR	NR	NR	NR	NR	NR
0.227	NR	1.344	NR	NR	NR	NR	NR	NR	NR
0.244	NR	1.666	NR	NR	NR	NR	NR	NR	NR
0.245	NR	1.985	NR	NR	NR	NR	NR	NR	NR
0.255	NR	2.062	NR	NR	NR	NR	NR	NR	NR
0.259	NR	3.083	NR	NR	NR	NR	NR	NR	NR
0.259	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.293	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.300	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.311	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.343	NR	NR	NR	NR	NR	NR	NR	NR	NR

TABLE A-1. SUMMARY OF EMISSIONS FOR PRODUCTION PROCESSES
(SORTED IN ASCENDING ORDER FOR EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg emitted/Mg produced)										EMISSION RATE (kg emitted per yr)				
	AIR OXIDATION PROCESS VENTS	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES	LIQUID SPILLS						
0.377	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.400	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.413	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.498	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.502	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.561	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.566	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.574	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.585	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.587	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.638	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.801	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.900	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
0.995	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.180	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.180	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.200	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.211	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.251	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.468	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.688	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1.690	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.260	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.300	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.346	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.489	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.742	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2.958	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3.248	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3.266	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3.500	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3.600	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3.827	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4.287	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
5.216	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
5.780	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
5.814	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6.860	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
13.172	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
18.080	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
20.254	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
20.455	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
24.000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
82.552	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
138	22	89	48	37	29	71	12	3	2						
AVERAGE:	1.98	0.31	0.25	0.20	0.02	63724	3594	18	2595						
95TH-PERCENTILE:	5.81	1.34	1.05	1.27	0.09	135900	13300	45	5100						
STANDARD DEVIATION:	7.87	2.31	0.43	0.42	0.03	70224	7347	23	3542						

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
1	PV	75.0	10.00	247.00	533
2	PV	61.3	7.30	237.00	473
3	PV	47.0	6.10	161.00	438
4	PV	45.7	5.50	161.00	422
5	PV	43.0	5.50	63.30	422
6	PV	36.6	3.70	55.29	399
7	PV	35.7	1.30	31.90	399
8	PV	35.7	1.22	28.90	373
9	PV	31.1	1.10	28.90	373
10	PV	31.1	0.88	26.10	366
11	PV	30.5	0.81	25.80	355
12	PV	30.5	0.81	20.70	353
13	PV	27.4	0.75	16.10	348
14	PV	25.9	0.75	15.00	339
15	PV	25.9	0.61	13.45	339
16	PV	22.9	0.61	13.40	339
17	PV	20.0	0.61	13.00	339
18	PV	20.0	0.61	12.90	339
19	PV	20.0	0.61	12.50	339
20	PV	20.0	0.61	12.10	339
21	PV	20.0	0.61	12.10	335
22	PV	20.0	0.61	9.10	333
23	PV	18.6	0.61	9.10	333
24	PV	18.3	0.51	9.00	330
25	PV	18.3	0.51	7.90	328
26	PV	18.3	0.46	7.90	322
27	PV	18.3	0.46	7.90	318
28	PV	16.8	0.46	7.90	316
29	PV	15.2	0.46	7.90	316
30	PV	15.2	0.46	7.90	313
31	PV	15.2	0.44	7.90	313
32	PV	15.2	0.30	7.76	311
33	PV	15.2	0.30	5.60	311
34	PV	15.2	0.30	4.36	311
35	PV	13.8	0.25	4.36	308
36	PV	13.7	0.25	4.36	305
37	PV	13.0	0.25	3.83	305
38	PV	13.0	0.25	3.76	305
39	PV	12.2	0.25	2.86	305
40	PV	12.2	0.25	2.86	304
41	PV	12.2	0.24	2.62	304
42	PV	12.2	0.17	2.62	303
43	PV	12.2	0.17	2.25	303
44	PV	12.2	0.15	2.25	303
45	PV	12.0	0.15	2.10	300
46	PV	12.0	0.15	2.00	300
47	PV	10.7	0.15	1.78	300
48	PV	10.7	0.15	1.78	300

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
49	PV	10.4	0.15	1.60	300
50	PV	10.4	0.10	1.60	299
51	PV	10.0	0.10	1.40	299
52	PV	10.0	0.10	0.92	298
53	PV	10.0	0.10	0.72	298
54	PV	10.0	0.08	0.41	298
55	PV	9.2	0.08	0.40	298
56	PV	9.1	0.08	0.37	298
57	PV	9.1	0.08	0.37	298
58	PV	9.1	0.08	0.34	298
59	PV	9.1	0.07	0.34	298
60	PV	9.1	0.05	0.34	296
61	PV	9.0	0.05	0.31	295
62	PV	9.0	0.05	0.31	295
63	PV	8.8	0.05	0.27	294
64	PV	7.6	0.05	0.24	294
65	PV	7.6	0.05	0.24	294
66	PV	7.6	0.05	0.21	294
67	PV	7.6	0.05	0.16	294
68	PV	7.6	0.05	0.15	294
69	PV	7.6	0.05	0.12	294
70	PV	7.5	0.05	0.12	293
71	PV	7.5	0.05	0.12	293
72	PV	6.1	0.05	0.12	293
73	PV	6.1	0.05	0.12	293
74	PV	6.0	0.05	0.12	293
75	PV	5.5	0.05	0.08	293
76	PV	5.5	0.05	0.08	293
77	PV	5.2	0.05	0.06	293
78	PV	5.2	0.05	0.06	293
79	PV	5.2	0.05	0.06	293
80	PV	4.6	0.05	0.05	293
81	PV	4.6	0.05	0.05	293
82	PV	4.0	0.05	0.04	293
83	PV	4.0	0.05	0.04	293
84	PV	3.7	0.05	0.04	293
85	PV	3.7	0.05	0.03	293
86	PV	3.1	0.05	0.03	293
87	PV	3.1	0.05	0.03	293
88	PV	2.5	0.05	0.02	291
89	PV	2.4	0.04	0.02	289
90	PV	2.4	0.04	0.02	289
91	PV	2.4	0.04	0.02	288
92	PV	2.4	0.04	0.02	283
93	PV	1.5	0.04	0.01	283
94	PV	1.5	0.04	0.01	283
95	PV	0.6	0.03	0.01	283
96	PV	0.2	0.03	0.01	283

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
97	PV	0.2	0.03	0.01	283
98	PV	0.0	0.03	0.01	283
99	PV	0.0	0.03	0.01	267
100	PV	0.0	0.03	0.01	267
101	PV	0.0	0.03	0.01	258
102	PV	0.0	0.03	0.01	258
103	PV	0.0	0.02	0.007	253
104	PV	0.0	0.02	0.006	243
105	PV	0.0	0.01	0.006	243
106	PV	0.0	-	0.005	-
107	PV	0.0	-	0.004	-
1	ST	29.5	1.07	13.00	-
2	ST	26.2	1.07	7.90	-
3	ST	15.6	0.61	7.90	-
4	ST	15.3	0.61	7.90	-
5	ST	15.0	0.41	7.90	-
6	ST	13.4	0.30	7.90	-
7	ST	13.0	0.25	7.90	-
8	ST	13.0	0.25	7.90	-
9	ST	13.0	0.25	1.78	-
10	ST	12.8	0.25	1.78	-
11	ST	12.7	0.25	1.78	-
12	ST	12.2	0.25	1.78	-
13	ST	12.2	0.20	1.78	-
14	ST	12.2	0.20	1.78	-
15	ST	12.2	0.20	1.78	-
16	ST	12.2	0.20	1.78	-
17	ST	12.2	0.20	0.16	-
18	ST	12.2	0.15	0.13	-
19	ST	12.2	0.15	0.10	-
20	ST	12.2	0.15	0.10	-
21	ST	12.2	0.15	0.09	-
22	ST	12.2	0.15	0.09	-
23	ST	12.2	0.15	-	-
24	ST	12.2	0.15	-	-
25	ST	12.1	0.15	-	-
26	ST	12.0	0.15	-	-
27	ST	12.0	0.15	-	-
28	ST	12.0	0.15	-	-
29	ST	12.0	0.15	-	-
30	ST	11.4	0.15	-	-
31	ST	11.4	0.15	-	-
32	ST	11.1	0.15	-	-
33	ST	10.9	0.15	-	-
34	ST	10.0	0.15	-	-
35	ST	10.0	0.15	-	-
36	ST	9.8	0.15	-	-
37	ST	9.8	0.15	-	-

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
38	ST	9.8	0.15	-	-
39	ST	9.8	0.15	-	-
40	ST	9.8	0.15	-	-
41	ST	9.8	0.15	-	-
42	ST	9.7	0.15	-	-
43	ST	9.7	0.15	-	-
44	ST	9.7	0.15	-	-
45	ST	9.7	0.15	-	-
46	ST	9.4	0.15	-	-
47	ST	9.3	0.15	-	-
48	ST	9.2	0.15	-	-
49	ST	9.2	0.15	-	-
50	ST	9.2	0.15	-	-
51	ST	9.1	0.15	-	-
52	ST	9.1	0.15	-	-
53	ST	9.1	0.10	-	-
54	ST	9.1	0.10	-	-
55	ST	9.1	0.10	-	-
56	ST	9.1	0.10	-	-
57	ST	9.0	0.10	-	-
58	ST	9.0	0.10	-	-
59	ST	9.0	0.10	-	-
60	ST	8.9	0.10	-	-
61	ST	8.8	0.10	-	-
62	ST	8.5	0.10	-	-
63	ST	8.0	0.10	-	-
64	ST	7.9	0.10	-	-
65	ST	7.9	0.10	-	-
66	ST	7.7	0.10	-	-
67	ST	7.5	0.10	-	-
68	ST	7.3	0.10	-	-
69	ST	7.3	0.10	-	-
70	ST	7.3	0.10	-	-
71	ST	7.3	0.10	-	-
72	ST	7.3	0.10	-	-
73	ST	7.3	0.10	-	-
74	ST	7.3	0.10	-	-
75	ST	7.3	0.10	-	-
76	ST	7.3	0.10	-	-
77	ST	7.3	0.10	-	-
78	ST	7.3	0.10	-	-
79	ST	7.3	0.10	-	-
80	ST	7.2	0.10	-	-
81	ST	7.0	0.10	-	-
82	ST	6.9	0.10	-	-
83	ST	6.7	0.10	-	-
84	ST	6.4	0.10	-	-
85	ST	6.4	0.10	-	-

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
86	ST	6.3	0.08	-	-
87	ST	6.1	0.08	-	-
88	ST	6.1	0.08	-	-
89	ST	6.1	0.08	-	-
90	ST	6.1	0.08	-	-
91	ST	6.1	0.08	-	-
92	ST	6.1	0.08	-	-
93	ST	6.1	0.08	-	-
94	ST	6.1	0.08	-	-
95	ST	6.1	0.08	-	-
96	ST	6.1	0.08	-	-
97	ST	6.1	0.08	-	-
98	ST	6.1	0.08	-	-
99	ST	6.1	0.08	-	-
100	ST	6.1	0.08	-	-
101	ST	6.1	0.08	-	-
102	ST	6.1	0.08	-	-
103	ST	6.1	0.08	-	-
104	ST	6.1	0.08	-	-
105	ST	6.1	0.08	-	-
106	ST	6.1	0.08	-	-
107	ST	6.1	0.08	-	-
108	ST	6.1	0.07	-	-
109	ST	6.1	0.07	-	-
110	ST	6.0	0.07	-	-
111	ST	6.0	0.07	-	-
112	ST	6.0	0.07	-	-
113	ST	5.9	0.05	-	-
114	ST	5.9	0.05	-	-
115	ST	5.8	0.05	-	-
116	ST	5.6	0.05	-	-
117	ST	5.5	0.05	-	-
118	ST	5.5	0.05	-	-
119	ST	5.5	0.05	-	-
120	ST	5.5	0.05	-	-
121	ST	5.5	0.05	-	-
122	ST	5.5	0.05	-	-
123	ST	5.5	0.05	-	-
124	ST	5.5	0.05	-	-
125	ST	5.5	0.05	-	-
126	ST	5.4	0.05	-	-
127	ST	5.3	0.05	-	-
128	ST	5.3	0.05	-	-
129	ST	5.3	0.05	-	-
130	ST	5.3	0.05	-	-
131	ST	5.2	0.05	-	-
132	ST	5.0	0.05	-	-
133	ST	5.0	0.05	-	-

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
134	ST	4.9	0.05	-	-
135	ST	4.9	0.05	-	-
136	ST	4.9	0.05	-	-
137	ST	4.9	0.05	-	-
138	ST	4.9	0.05	-	-
139	ST	4.8	0.05	-	-
140	ST	4.5	0.05	-	-
141	ST	4.0	0.05	-	-
142	ST	4.0	0.05	-	-
143	ST	4.0	0.05	-	-
144	ST	4.0	0.05	-	-
145	ST	4.0	0.05	-	-
146	ST	4.0	0.05	-	-
147	ST	4.0	0.05	-	-
148	ST	4.0	0.05	-	-
149	ST	4.0	0.05	-	-
150	ST	4.0	0.05	-	-
151	ST	4.0	0.05	-	-
152	ST	4.0	0.05	-	-
153	ST	4.0	0.05	-	-
154	ST	3.9	0.05	-	-
155	ST	3.9	0.05	-	-
156	ST	3.9	0.05	-	-
157	ST	3.9	0.05	-	-
158	ST	3.9	0.05	-	-
159	ST	3.8	0.04	-	-
160	ST	3.7	0.04	-	-
161	ST	3.7	0.04	-	-
162	ST	3.7	0.04	-	-
163	ST	3.7	0.04	-	-
164	ST	3.2	0.04	-	-
165	ST	3.1	0.04	-	-
166	ST	3.1	0.04	-	-
167	ST	3.1	0.04	-	-
168	ST	3.1	0.03	-	-
169	ST	3.1	0.03	-	-
170	ST	2.9	0.03	-	-
171	ST	2.8	0.03	-	-
172	ST	2.8	-	-	-
173	ST	2.8	-	-	-
174	ST	2.7	-	-	-
175	ST	2.7	-	-	-
176	ST	2.7	-	-	-
177	ST	2.7	-	-	-
178	ST	2.4	-	-	-
179	ST	2.4	-	-	-
180	ST	2.0	-	-	-
181	ST	2.0	-	-	-

TABLE A-2 REPORTED EMISSION PARAMETERS FOR PRODUCTION PROCESSES

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
182	ST	1.8	-	-	-
183	ST	1.3	-	-	-
184	ST	1.2	-	-	-
185	ST	1.0	-	-	-
186	ST	1.0	-	-	-
187	ST	0.6	-	-	-
1	EO	49.0	0.46	-	-
2	EO	48.8	0.10	-	-
3	EO	7.6	0.05	-	-
4	EO	0.6	0.05	-	-
5	EO	0.6	0.03	-	-
6	EO	-	0.03	-	-
7	EO	-	0.02	-	-
1	H	15.2	0.61	-	-
2	H	3.7	0.61	-	-
3	H	-	0.61	-	-
4	H	-	0.61	-	-
5	H	-	0.61	-	-
6	H	-	0.46	-	-
7	H	-	0.15	-	-
1	ARGAS	9.1	-	403	-
2	ARGAS	1.5	-	394	-
3	ARGAS	0.9	-	290	-

KEY: PV = PROCESS VENTS
 ST = STORAGE
 EO = EQUIPMENT OPENINGS
 S2 = SECONDARY
 RD = RELIEF DISCHARGES
 "-" Not reported.

Appendix B
Polymerization Processes

TABLE B-1. SUMMARY OF EMISSIONS FOR POLYMERIZATION PROCESSES
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg monomer emitted/Mg monomer consumed)			EMISSION RATE (kg monomer emitted/yr)		
	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES
4.5E-05	0.028	NR	2.5E-05	0.563	60	18
0.001	0.037	NR	0.016	NR	300	960
0.004	0.058	NR	0.215	NR	400	NR
0.004	0.107	NR	0.253	NR	500	NR
0.005	0.181	NR	0.273	NR	800	NR
0.005	0.385	NR	0.288	NR	800	NR
0.009	0.511	NR	0.433	NR	900	NR
0.010	0.602	NR	0.496	NR	910	NR
0.011	0.727	NR	1.143	NR	2500	NR
0.011	1.266	NR	3.100	NR	2600	NR
0.020	1.405	NR	3.306	NR	2800	NR
0.029	7.511	NR	NR	NR	4600	NR
0.040	NR	NR	NR	NR	5900	NR
0.046	NR	NR	NR	NR	6080	NR
0.052	NR	NR	NR	NR	7100	NR
0.092	NR	NR	NR	NR	8000	NR
0.122	NR	NR	NR	NR	8000	NR
0.158	NR	NR	NR	NR	12600	NR
0.161	NR	NR	NR	NR	15200	NR
0.214	NR	NR	NR	NR	15800	NR
0.273	NR	NR	NR	NR	16720	NR
0.300	NR	NR	NR	NR	19100	NR
0.301	NR	NR	NR	NR	20100	NR
0.343	NR	NR	NR	NR	22100	NR
0.414	NR	NR	NR	NR	25600	NR
0.532	NR	NR	NR	NR	26200	NR
0.559	NR	NR	NR	NR	27400	NR
0.719	NR	NR	NR	NR	35500	NR
0.748	NR	NR	NR	NR	35800	NR
0.797	NR	NR	NR	NR	38600	NR
0.819	NR	NR	NR	NR	38700	NR
1.219	NR	NR	NR	NR	39900	NR
1.262	NR	NR	NR	NR	44800	NR
1.439	NR	NR	NR	NR	46200	NR
1.453	NR	NR	NR	NR	46200	NR
1.488	NR	NR	NR	NR	46200	NR
1.565	NR	NR	NR	NR	46200	NR
1.876	NR	NR	NR	NR	48400	NR
2.190	NR	NR	NR	NR	52900	NR
3.232	NR	NR	NR	NR	54600	NR

TABLE B-1. SUMMARY OF EMISSIONS FOR POLYMERIZATION PROCESSES
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

EMISSION FACTOR (kg monomer emitted/Mg monomer consumed)					EMISSION RATE (kg monomer emitted/yr)	
PROCESS VENTS	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES
3.579	NR	NR	NR	NR	74600	NR
4.638	NR	NR	NR	NR	88000	NR
8.731	NR	NR	NR	NR	95000	NR
9.013	NR	NR	NR	NR	129100	NR
10.748	NR	NR	NR	NR	129500	NR
11.068	NR	NR	NR	NR	173000	NR
13.051	NR	NR	NR	NR	175800	NR
13.539	NR	NR	NR	NR	NR	NR
20.195	NR	NR	NR	NR	NR	NR
25.642	NR	NR	NR	NR	NR	NR
26.756	NR	NR	NR	NR	NR	NR
27.788	NR	NR	NR	NR	NR	NR
40.772	NR	NR	NR	NR	NR	NR
61.887	NR	NR	NR	NR	NR	NR
71.646	NR	NR	NR	NR	NR	NR
124.051	NR	NR	NR	NR	NR	NR
173.554	NR	NR	NR	NR	NR	NR
AVERAGES						
11.730	1.068	-	0.866	0.563	32700	489
95th-PERCENTILES						
61.887	1.405	-	3.100	0.563	95000	960

NOTE: NR = not reported.

TABLE B-2. EMISSION PARAMETERS FOR POLYMERIZATION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
1	PV	1.50	0.01	0.00	278
2	PV	1.90	0.02	0.02	283
3	PV	2.40	0.03	0.09	283
4	PV	3.00	0.03	0.11	283
5	PV	4.90	0.03	0.11	289
6	PV	5.30	0.03	0.21	289
7	PV	5.50	0.03	0.28	290
8	PV	6.00	0.03	0.34	292
9	PV	6.00	0.04	0.35	293
10	PV	6.10	0.05	0.43	293
11	PV	6.40	0.05	0.45	293
12	PV	7.20	0.05	0.62	294
13	PV	7.63	0.05	0.67	294
14	PV	8.20	0.05	0.72	294
15	PV	8.20	0.05	0.76	294
16	PV	9.10	0.05	0.79	294
17	PV	9.10	0.05	0.80	294
18	PV	9.10	0.05	0.80	294
19	PV	9.10	0.05	0.85	294
20	PV	9.10	0.05	0.94	294
21	PV	9.15	0.05	0.94	294
22	PV	9.15	0.05	1.00	294
23	PV	10.00	0.05	1.00	295
24	PV	10.40	0.05	1.03	295
25	PV	10.70	0.06	1.13	295
26	PV	10.70	0.07	1.20	295
27	PV	10.70	0.07	1.22	296
28	PV	11.00	0.08	1.22	296
29	PV	11.00	0.08	1.22	296
30	PV	11.28	0.08	1.22	296
31	PV	11.28	0.08	1.23	297
32	PV	11.89	0.08	1.23	298
33	PV	12.00	0.08	1.23	298
34	PV	12.10	0.08	1.23	298
35	PV	12.10	0.08	1.60	300
36	PV	12.20	0.08	1.83	300
37	PV	12.20	0.10	1.83	300
38	PV	12.80	0.10	2.00	300
39	PV	12.80	0.10	2.30	300
40	PV	12.80	0.10	2.40	300
41	PV	13.00	0.10	2.67	300
42	PV	13.40	0.10	3.60	300
43	PV	13.40	0.10	3.70	300
44	PV	13.41	0.10	3.70	300
45	PV	13.50	0.10	3.90	300

TABLE B-2. EMISSION PARAMETERS FOR POLYMERIZATION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
46	PV	13.50	0.13	4.60	300
47	PV	13.50	0.13	4.60	301
48	PV	13.50	0.15	4.60	302
49	PV	13.50	0.15	5.10	302
50	PV	13.50	0.15	5.10	302
51	PV	13.50	0.15	5.50	302
52	PV	13.50	0.15	5.60	302
53	PV	13.70	0.18	5.80	302
54	PV	13.70	0.20	5.96	302
55	PV	13.70	0.20	6.02	303
56	PV	13.70	0.20	6.40	303
57	PV	13.70	0.20	6.46	303
58	PV	13.70	0.20	6.46	304
59	PV	14.30	0.20	6.70	304
60	PV	14.33	0.20	6.70	304
61	PV	14.60	0.20	6.90	305
62	PV	14.60	0.20	7.00	306
63	PV	14.63	0.20	7.20	307
64	PV	15.00	0.20	7.20	308
65	PV	15.20	0.20	7.40	308
66	PV	15.20	0.21	7.50	308
67	PV	15.20	0.21	7.70	309
68	PV	15.20	0.21	8.14	309
69	PV	15.20	0.21	8.28	311
70	PV	15.20	0.21	8.32	311
71	PV	15.24	0.21	8.50	311
72	PV	15.24	0.21	8.70	311
73	PV	15.80	0.21	8.90	313
74	PV	15.80	0.21	9.00	320
75	PV	15.90	0.25	9.10	321
76	PV	16.50	0.25	9.40	321
77	PV	16.70	0.25	10.60	322
78	PV	16.70	0.25	10.60	322
79	PV	16.70	0.25	10.70	322
80	PV	16.80	0.27	11.00	323
81	PV	17.70	0.27	11.28	323
82	PV	17.70	0.30	11.61	325
83	PV	17.70	0.30	11.61	326
84	PV	17.70	0.30	11.90	326
85	PV	17.70	0.31	12.06	327
86	PV	17.70	0.35	12.11	327
87	PV	17.80	0.36	12.20	328
88	PV	18.29	0.36	13.00	337
89	PV	18.29	0.40	13.00	337
90	PV	18.30	0.40	13.10	337

TABLE B-2. EMISSION PARAMETERS FOR POLYMERIZATION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	EMISSION HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
91	PV	18.30	0.40	13.20	338
92	PV	18.30	0.40	14.40	338
93	PV	18.30	0.46	15.00	338
94	PV	18.30	0.46	15.02	338
95	PV	18.30	0.46	15.20	339
96	PV	18.30	0.46	15.20	339
97	PV	18.30	0.50	16.15	339
98	PV	18.90	0.50	16.20	339
99	PV	18.90	0.51	16.20	339
100	PV	18.90	0.51	16.80	340
101	PV	20.00	0.60	17.43	340
102	PV	20.00	0.60	17.80	340
103	PV	20.00	0.60	18.60	343
104	PV	20.00	0.61	18.60	343
105	PV	20.00	0.61	19.40	344
106	PV	20.00	0.61	19.40	344
107	PV	20.00	0.61	19.40	344
108	PV	20.12	0.61	19.50	347
109	PV	20.12	0.62	19.80	350
110	PV	20.70	0.62	19.80	350
111	PV	20.90	0.70	19.80	355
112	PV	21.00	0.76	20.10	359
113	PV	21.00	0.76	20.20	361
114	PV	21.30	0.80	20.23	363
115	PV	21.30	0.81	20.70	363
116	PV	21.30	0.83	20.70	373
117	PV	21.90	0.84	20.86	390
118	PV	21.90	0.84	21.10	411
119	PV	22.60	0.89	21.70	414
120	PV	24.00	0.90	24.00	422
121	PV	24.40	0.90	25.00	450
122	PV	26.50	0.90	30.00	466
123	PV	27.10	0.91	30.60	616
124	PV	30.50	0.91	30.99	-
125	PV	30.50	0.91	32.20	-
126	PV	33.00	0.91	34.40	-
127	PV	33.53	0.93	38.00	-
128	PV	36.60	1.00	-	-
129	PV	38.00	1.02	-	-
130	PV	38.00	1.06	-	-
131	PV	38.00	1.06	-	-
132	PV	38.00	1.10	-	-
133	PV	40.00	1.12	-	-
134	PV	46.20	1.16	-	-
135	PV	49.50	1.20	-	-

TABLE B-2. EMISSION PARAMETERS FOR POLYMERIZATION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	EMISSION HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
136	PV	-	1.20	-	-
137	PV	-	1.20	-	-
138	PV	-	1.22	-	-
139	PV	-	1.22	-	-
140	PV	-	1.22	-	-
141	PV	-	1.40	-	-
142	PV	-	1.53	-	-
143	PV	-	1.53	-	-
144	PV	-	2.13	-	-

1	ST	0.00	0.00	-	293
2	ST	2.00	0.05	0.50	320
3	ST	8.20	0.08	-	-

1	EO	0.00	0.01	0.05	272
2	EO	19.80	0.05	366.00	353

1	S2	0.00	0.00	-	-
2	S2	0.00	0.00	-	-
3	S2	0.00	0.00	-	-
4	S2	0.00	0.00	-	-
5	S2	0.00	-	-	-
6	S2	0.00	-	-	-

1	RD	0.000	0.23	22.40	283
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KEY: PV = PROCESS VENTS
ST = STORAGE
EO = EQUIPMENT OPENINGS
S2 = SECONDARY
RD = RELIEF DISCHARGES
"- " Not reported.

Appendix C
Chemical Process Use of Solvents

TABLE C-1. SUMMARY OF EMISSIONS FOR CHEMICAL PROCESS USE OF SOLVENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENT	EMISSION FACTOR (kg solvent emitted/ Mg solvent consumed)				EMISSION RATE (kg solvent emitted per year)		
	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES
0.01	4E-03	0.02	0.2	0.02	3	23.0	0.1
0.01	9E-03	0.1	0.4	0.03	9	45.0	0.5
3E-02	0.01	0.1	0.4	0.03	1999	90.9	1.4
0.1	0.03	0.1	0.4	0.04	1999	117.0	13.6
0.4	0.1	0.2	0.4	0.1	1999	2050.0	13.5
1.2	0.1	0.3	0.4	0.2	1999	9090.0	13.5
2.7	0.1	0.3	0.4	0.2	1999	NR	13.5
2.7	0.2	0.5	1.4	0.2	2743	NR	13.6
2.7	0.2	0.6	2.6	0.2	3580	NR	18.1
2.7	0.2	0.6	3.3	0.2	3590	NR	22.9
2.7	0.2	0.6	3.4	0.2	3935	NR	56.7
3.5	0.2	0.6	6.0	0.3	4523	NR	3224.9
3.8	0.3	0.6	15.8	0.4	5297	NR	88840.0
4.6	0.4	0.8	24.2	0.6	6231	NR	NR
6.1	0.5	0.9	760.0	0.6	6260	NR	NR
10.3	0.5	1.0	NR	1.0	6269	NR	NR
23.8	0.6	2.1	NR	1.3	7350	NR	NR
24.8	0.7	6.4	NR	1.5	7480	NR	NR
25.3	0.8	NR	NR	2.0	7856	NR	NR
26.7	1.1	NR	NR	2.7	8980	NR	NR
46.2	1.2	NR	NR	3.5	9208	NR	NR
46.3	2.4	NR	NR	6.0	10195	NR	NR
72.0	2.6	NR	NR	15.2	12679	NR	NR
72.9	5.0	NR	NR	21.0	16458	NR	NR
78.9	5.9	NR	NR	NR	19195	NR	NR
273.2	8.9	NR	NR	NR	23900	NR	NR
444.4	53.8	NR	NR	NR	27250	NR	NR
566.2	NR	NR	NR	NR	38500	NR	NR
601.0	NR	NR	NR	NR	38697	NR	NR
614.5	NR	NR	NR	NR	49556	NR	NR
639.1	NR	NR	NR	NR	50006	NR	NR
821.3	NR	NR	NR	NR	53751	NR	NR
997.5	NR	NR	NR	NR	60285	NR	NR
NR	NR	NR	NR	NR	78200	NR	NR
NR	NR	NR	NR	NR	94107	NR	NR
NR	NR	NR	NR	NR	227184	NR	NR

AVERAGES							
189.1	3.8	1.2	60.9	2.8	24504.1	1661.6	2492.8
95 th-PERCENTILES							
821.3	9	2.1	24.2	15.2	78200	2050	3224.9

"NR" INDICATES THAT DATA WERE NOT PROVIDED BY THE FACILITY.

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
1	ST	0.60	0.020	0.120	-
2	ST	1.50	0.030	0.280	-
3	ST	1.50	0.030	0.280	-
4	ST	1.50	0.030	0.280	-
5	ST	1.60	0.030	-	-
6	ST	1.80	0.030	-	-
7	ST	1.83	0.030	-	-
8	ST	2.00	0.030	-	-
9	ST	2.00	0.030	-	-
10	ST	2.10	0.030	-	-
11	ST	2.30	0.030	-	-
12	ST	2.40	0.040	-	-
13	ST	2.60	0.040	-	-
14	ST	2.60	0.040	-	-
15	ST	2.60	0.040	-	-
16	ST	2.60	0.050	-	-
17	ST	2.60	0.050	-	-
18	ST	2.60	0.050	-	-
19	ST	2.66	0.050	-	-
20	ST	2.67	0.050	-	-
21	ST	3.00	0.050	-	-
22	ST	3.05	0.050	-	-
23	ST	3.20	0.050	-	-
24	ST	3.35	0.050	-	-
25	ST	3.66	0.050	-	-
26	ST	3.70	0.050	-	-
27	ST	3.70	0.050	-	-
28	ST	4.26	0.050	-	-
29	ST	4.26	0.050	-	-
30	ST	4.27	0.050	-	-
31	ST	4.80	0.050	-	-
32	ST	4.88	0.050	-	-
33	ST	4.88	0.050	-	-
34	ST	4.88	0.050	-	-
35	ST	5.59	0.050	-	-
36	ST	6.00	0.050	-	-
37	ST	6.00	0.050	-	-
38	ST	6.00	0.050	-	-
39	ST	6.00	0.050	-	-
40	ST	6.00	0.050	-	-
41	ST	6.10	0.080	-	-
42	ST	6.70	0.080	-	-
43	ST	6.70	0.080	-	-
44	ST	7.32	0.080	-	-
45	ST	8.50	0.100	-	-
46	ST	9.60	0.100	-	-
47	ST	9.60	0.100	-	-
48	ST	9.74	0.100	-	-

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
49	ST	10.40	0.100	-	-
50	ST	10.67	0.100	-	-
51	ST	10.67	0.100	-	-
52	ST	10.67	0.110	-	-
53	ST	10.80	0.120	-	-
54	ST	10.80	0.120	-	-
55	ST	14.00	0.120	-	-
56	ST	14.00	0.150	-	-
57	ST	14.00	0.150	-	-
58	ST	-	0.150	-	-
59	ST	-	0.160	-	-
1	RD	-	0.01	-	-
2	RD	-	0.050	-	-
3	RD	-	0.050	-	-
4	RD	-	0.050	-	-
5	RD	-	0.150	-	-
6	RD	-	0.180	-	-
1	PV	1.00	0.010	0.010	255
2	PV	1.00	0.030	0.020	261
3	PV	1.00	0.030	0.020	264
4	PV	1.00	0.030	0.020	264
5	PV	3.00	0.040	0.040	265
6	PV	4.00	0.040	0.060	268
7	PV	4.60	0.040	0.060	268
8	PV	5.00	0.050	0.060	273
9	PV	5.00	0.050	0.070	278
10	PV	5.00	0.050	0.090	280
11	PV	5.20	0.050	0.100	283
12	PV	6.00	0.050	0.110	283
13	PV	6.00	0.050	0.120	283
14	PV	6.00	0.050	0.130	283
15	PV	6.00	0.050	0.220	285
16	PV	6.10	0.050	0.230	288
17	PV	6.10	0.050	0.280	288
18	PV	6.40	0.050	0.320	288
19	PV	7.00	0.050	0.380	289
20	PV	7.00	0.050	0.380	291
21	PV	7.60	0.050	0.420	293
22	PV	7.60	0.050	0.580	293
23	PV	7.60	0.050	0.600	293
24	PV	7.60	0.050	0.600	293
25	PV	9.00	0.050	0.670	293
26	PV	9.00	0.050	0.760	293
27	PV	10.00	0.080	0.910	293
28	PV	10.00	0.080	0.960	293
29	PV	10.00	0.080	0.960	293
30	PV	10.00	0.080	1.070	293

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
31	PV	10.00	0.080	1.500	298
32	PV	10.00	0.080	1.500	298
33	PV	10.00	0.080	1.580	298
34	PV	10.00	0.080	1.680	298
35	PV	10.00	0.080	1.680	298
36	PV	10.00	0.080	1.700	298
37	PV	10.00	0.080	1.900	298
38	PV	10.00	0.080	1.900	298
39	PV	10.00	0.100	1.900	298
40	PV	10.00	0.100	1.900	298
41	PV	10.06	0.100	1.900	298
42	PV	12.00	0.100	1.900	298
43	PV	12.00	0.100	2.190	298
44	PV	12.00	0.100	2.400	298
45	PV	12.00	0.100	2.600	298
46	PV	12.00	0.100	2.600	298
47	PV	12.19	0.100	2.880	298
48	PV	12.20	0.100	2.880	298
49	PV	13.00	0.100	2.930	298
50	PV	13.00	0.100	3.340	298
51	PV	13.00	0.100	3.380	298
52	PV	13.00	0.100	3.600	298
53	PV	13.00	0.100	3.750	298
54	PV	13.00	0.100	4.500	298
55	PV	13.00	0.100	4.500	298
56	PV	13.00	0.120	4.500	298
57	PV	13.00	0.120	4.500	298
58	PV	13.00	0.120	4.500	298
59	PV	13.00	0.120	4.500	298
60	PV	13.00	0.120	4.500	298
61	PV	13.00	0.120	4.500	298
62	PV	13.00	0.120	4.500	298
63	PV	13.00	0.120	4.500	298
64	PV	13.00	0.120	4.500	298
65	PV	13.00	0.120	4.500	298
66	PV	13.00	0.120	4.500	298
67	PV	13.00	0.120	4.500	298
68	PV	13.00	0.120	4.500	298
69	PV	13.00	0.150	4.500	298
70	PV	13.00	0.150	4.500	298
71	PV	13.00	0.150	4.800	298
72	PV	13.00	0.150	4.800	298
73	PV	13.00	0.150	4.800	298
74	PV	13.00	0.150	4.800	298
75	PV	13.00	0.150	5.340	298
76	PV	13.00	0.150	5.770	298
77	PV	13.00	0.150	5.870	298
78	PV	13.00	0.150	6.200	298
79	PV	13.00	0.150	6.250	298

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
80	PV	13.00	0.150	6.700	298
81	PV	13.00	0.150	6.800	298
82	PV	13.00	0.150	6.800	298
83	PV	13.00	0.200	6.800	298
84	PV	13.00	0.200	6.800	298
85	PV	13.00	0.200	6.800	298
86	PV	13.00	0.200	6.800	298
87	PV	13.00	0.200	6.800	298
88	PV	13.00	0.200	6.800	298
89	PV	13.00	0.250	6.800	298
90	PV	13.00	0.250	6.800	298
91	PV	13.00	0.250	6.800	298
92	PV	13.00	0.250	6.800	298
93	PV	13.00	0.250	6.800	298
94	PV	13.00	0.250	6.800	299
95	PV	13.00	0.250	6.800	299
96	PV	13.00	0.250	6.800	299
97	PV	13.00	0.250	6.800	299
98	PV	13.00	0.250	6.800	299
99	PV	13.00	0.250	6.800	299
100	PV	13.00	0.250	6.800	300
101	PV	13.00	0.250	6.800	300
102	PV	13.00	0.250	6.800	300
103	PV	13.00	0.250	6.800	300
104	PV	13.00	0.250	6.800	300
105	PV	13.00	0.250	6.800	300
106	PV	13.00	0.250	6.800	302
107	PV	13.00	0.250	6.800	302
108	PV	13.00	0.250	6.800	302
109	PV	13.00	0.250	6.800	303
110	PV	13.00	0.250	6.800	303
111	PV	13.00	0.250	6.800	303
112	PV	13.00	0.250	6.800	303
113	PV	13.00	0.250	6.800	305
114	PV	13.00	0.250	6.800	305
115	PV	13.00	0.250	6.800	305
116	PV	13.00	0.250	6.800	305
117	PV	13.00	0.250	6.800	305
118	PV	13.00	0.250	6.800	305
119	PV	13.00	0.250	6.800	305
120	PV	13.00	0.250	6.800	305
121	PV	13.00	0.250	6.800	305
122	PV	13.00	0.250	7.200	305
123	PV	13.00	0.250	7.200	305
124	PV	13.00	0.250	7.200	305
125	PV	13.00	0.250	7.200	305
126	PV	13.00	0.250	7.200	308
127	PV	13.00	0.250	7.200	311
128	PV	13.00	0.250	7.200	311

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
129	PV	13.00	0.250	7.480	311
130	PV	13.00	0.250	7.500	312
131	PV	13.00	0.250	7.500	313
132	PV	13.00	0.250	7.500	313
133	PV	13.00	0.250	7.530	313
134	PV	13.00	0.250	7.700	316
135	PV	13.00	0.250	7.700	333
136	PV	13.00	0.250	7.700	339
137	PV	13.00	0.250	7.700	355
138	PV	13.00	0.250	7.700	355
139	PV	13.00	0.250	7.700	355
140	PV	13.00	0.250	7.700	355
141	PV	13.00	0.300	7.700	355
142	PV	13.00	0.300	7.700	355
143	PV	13.00	0.300	7.700	355
144	PV	13.00	0.300	7.700	355
145	PV	13.00	0.300	7.700	355
146	PV	13.00	0.300	7.700	355
147	PV	13.70	0.320	7.700	355
148	PV	13.70	0.350	7.700	373
149	PV	14.00	0.360	7.700	393
150	PV	14.00	0.360	7.700	393
151	PV	14.00	0.400	7.700	393
152	PV	15.00	0.400	7.700	393
153	PV	15.00	0.400	7.700	393
154	PV	15.00	0.400	7.700	393
155	PV	15.00	0.400	7.700	393
156	PV	15.00	0.400	7.700	393
157	PV	15.00	0.400	7.700	393
158	PV	15.00	0.400	7.700	393
159	PV	15.00	0.400	7.700	393
160	PV	15.25	0.400	7.700	393
161	PV	15.60	0.400	7.700	393
162	PV	15.80	0.400	7.700	393
163	PV	16.80	0.400	7.700	393
164	PV	17.10	0.400	7.700	393
165	PV	18.00	0.400	7.700	393
166	PV	18.00	0.400	7.700	393
167	PV	18.00	0.400	7.700	393
168	PV	18.00	0.400	7.700	393
169	PV	18.00	0.400	7.700	393
170	PV	18.30	0.400	7.700	393
171	PV	18.30	0.400	7.700	393
172	PV	18.30	0.400	7.700	393
173	PV	18.30	0.400	7.700	393
174	PV	18.30	0.400	7.700	393
175	PV	18.30	0.400	7.700	393
176	PV	18.30	0.400	7.700	393
177	PV	18.30	0.400	7.700	393

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
178	PV	18.30	0.460	7.700	393
179	PV	18.30	0.460	7.910	393
180	PV	18.30	0.470	8.000	393
181	PV	18.90	0.470	8.000	393
182	PV	18.90	0.470	8.500	393
183	PV	18.90	0.470	9.520	393
184	PV	19.80	0.470	9.900	393
185	PV	20.70	0.470	10.000	393
186	PV	21.00	0.470	10.000	393
187	PV	21.00	0.470	10.000	393
188	PV	21.00	0.470	10.000	393
189	PV	21.00	0.470	10.000	393
190	PV	21.00	0.470	10.020	393
191	PV	21.00	0.470	12.500	393
192	PV	21.00	0.470	12.500	393
193	PV	21.00	0.470	12.500	393
194	PV	21.00	0.470	12.500	393
195	PV	21.00	0.470	12.500	393
196	PV	22.80	0.470	12.500	393
197	PV	22.80	0.470	12.500	393
198	PV	22.80	0.470	12.500	393
199	PV	22.80	0.470	13.200	393
200	PV	22.80	0.470	14.650	393
201	PV	23.00	0.470	15.890	393
202	PV	23.00	0.470	20.000	393
203	PV	24.00	0.470	20.900	393
204	PV	24.00	0.470	22.800	393
205	PV	24.00	0.470	23.100	393
206	PV	24.00	0.470	25.370	393
207	PV	24.00	0.470	25.500	393
208	PV	24.00	0.470	26.000	393
209	PV	24.00	0.470	26.000	393
210	PV	24.40	0.470	26.020	393
211	PV	25.90	0.470	30.100	393
212	PV	26.00	0.470	31.000	393
213	PV	26.00	0.470	31.000	393
214	PV	26.00	0.470	31.000	393
215	PV	26.00	0.470	31.000	393
216	PV	26.00	0.470	31.000	393
217	PV	26.00	0.470	36.400	393
218	PV	26.00	0.470	45.200	393
219	PV	26.00	0.470	45.200	393
220	PV	26.00	0.470	45.200	393
221	PV	26.00	0.530	45.200	393
222	PV	26.00	0.590	45.200	393
223	PV	26.00	0.600	45.200	393
224	PV	26.00	0.630	48.100	393
225	PV	26.00	0.660	52.000	393
226	PV	26.00	0.740	60.100	393

TABLE C-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF SOLVENTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSIONS TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
227	PV	26.00	0.750	67.600	393
228	PV	26.00	0.760	80.000	393
229	PV	26.00	0.760	80.000	393
230	PV	26.00	1.120	83.500	393
231	PV	26.00	1.290	83.500	393
232	PV	27.30	1.290	83.500	393
233	PV	30.50	1.290	83.500	393
234	PV	30.50	1.290	83.500	393
235	PV	30.50	1.290	83.500	398
236	PV	30.50	1.290	83.500	398
237	PV	30.50	1.290	83.500	422
238	PV	34.25	3.050	-	433
1	H	6.00	0.020	-	-
2	H	6.00	0.025	-	-
3	H	6.00	0.050	-	-
4	H	6.00	0.050	-	-
5	H	6.00	0.050	-	-
6	H	-	0.050	-	-
7	H	-	0.050	-	-
8	H	-	0.110	-	-
1	AR	6.1	-	9.2	-
2	AR	6.4	-	9.9	-
3	AR	6.4	-	234	-
4	AR	14.3	-	234	-
5	AR	14.3	-	234	-
6	AR	14.3	-	234	-
7	AR	14.3	-	234	-
8	AR	14.3	-	246	-
9	AR	22.9	-	333	-

ST= STORAGE
PV= PROCESS
S2= SECONDARY
H= HANDLING
EO= EQUIPMENT LEAK
EO= EQUIPMENT OPENING
EL= EQUIPMENT LEAK
AR= ACCIDENTAL RELEASE
RD= RELIEF DEVICE

Appendix D
Chemical Process Use of Reactants

TABLE D-1. SUMMARY OF EMISSIONS FOR PROCESS USE OF REACTANTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

EMISSION FACTOR (kg reactant emitted/Mg reactant consumed)				EMISSION RATE (kg reactant emitted per yr)			
PROCESS VENTS	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES
1.9E-07	3.0E-05	3.3E-04	9.0E-06	1.6E-06	29	0.693	3.6
7.8E-06	0.0003	0.003	3.8E-04	4.2E-06	525	NR	50
1.0E-04	0.001	0.003	0.003	3.1E-05	2670	NR	230.2
0.001	0.004	0.009	NR	4.1E-05	3140	NR	NR
0.001	0.008	0.009	NR	3.2E-04	4090	NR	NR
0.003	0.016	0.017	NR	0.001	4940	NR	NR
0.009	0.022	30.816	NR	0.001	5140	NR	NR
0.015	0.024	NR	NR	0.001	5200	NR	NR
0.025	0.025	NR	NR	0.002	5230	NR	NR
0.025	0.027	NR	NR	0.002	5390	NR	NR
0.029	0.034	NR	NR	0.003	5780	NR	NR
0.035	0.043	NR	NR	0.003	5800	NR	NR
0.035	0.052	NR	NR	0.003	6670	NR	NR
0.045	0.056	NR	NR	0.004	6930	NR	NR
0.055	0.057	NR	NR	0.021	6970	NR	NR
0.077	0.083	NR	NR	0.058	7250	NR	NR
0.077	0.116	NR	NR	0.480	7270	NR	NR
0.099	0.117	NR	NR	8.672	7910	NR	NR
0.107	0.132	NR	NR	NR	8100	NR	NR
0.109	0.177	NR	NR	NR	8390	NR	NR
0.118	0.185	NR	NR	NR	8983	NR	NR
0.170	0.195	NR	NR	NR	10700	NR	NR
0.204	0.237	NR	NR	NR	11400	NR	NR
0.259	0.293	NR	NR	NR	11800	NR	NR
0.274	0.402	NR	NR	NR	12700	NR	NR
0.420	0.414	NR	NR	NR	14800	NR	NR
0.452	1.130	NR	NR	NR	22050	NR	NR
0.610	1.557	NR	NR	NR	31700	NR	NR
0.619	1.720	NR	NR	NR	51000	NR	NR
0.629	2.413	NR	NR	NR	52017	NR	NR
0.632	9.710	NR	NR	NR	NR	NR	NR
0.842	16.063	NR	NR	NR	NR	NR	NR
0.900	327.189	NR	NR	NR	NR	NR	NR
1.060	NR	NR	NR	NR	NR	NR	NR
1.360	NR	NR	NR	NR	NR	NR	NR
1.500	NR	NR	NR	NR	NR	NR	NR
1.650	NR	NR	NR	NR	NR	NR	NR
1.700	NR	NR	NR	NR	NR	NR	NR
1.707	NR	NR	NR	NR	NR	NR	NR
1.770	NR	NR	NR	NR	NR	NR	NR
1.844	NR	NR	NR	NR	NR	NR	NR
1.930	NR	NR	NR	NR	NR	NR	NR
1.969	NR	NR	NR	NR	NR	NR	NR
3.010	NR	NR	NR	NR	NR	NR	NR
3.114	NR	NR	NR	NR	NR	NR	NR

TABLE D-1. SUMMARY OF EMISSIONS FOR PROCESS USE OF REACTANTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg reactant emitted/Mg reactant consumed)				EMISSION RATE (kg reactant emitted per yr)			
	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	RELIEF DEVICES	ACCIDENTAL RELEASES	
3.620	NR	NR	NR	NR	NR	NR	NR	
4.505	NR	NR	NR	NR	NR	NR	NR	
4.993	NR	NR	NR	NR	NR	NR	NR	
5.291	NR	NR	NR	NR	NR	NR	NR	
5.470	NR	NR	NR	NR	NR	NR	NR	
5.746	NR	NR	NR	NR	NR	NR	NR	
6.350	NR	NR	NR	NR	NR	NR	NR	
6.543	NR	NR	NR	NR	NR	NR	NR	
7.540	NR	NR	NR	NR	NR	NR	NR	
9.270	NR	NR	NR	NR	NR	NR	NR	
11.662	NR	NR	NR	NR	NR	NR	NR	
13.740	NR	NR	NR	NR	NR	NR	NR	
15.500	NR	NR	NR	NR	NR	NR	NR	
18.020	NR	NR	NR	NR	NR	NR	NR	
19.060	NR	NR	NR	NR	NR	NR	NR	
21.232	NR	NR	NR	NR	NR	NR	NR	
22.500	NR	NR	NR	NR	NR	NR	NR	
26.730	NR	NR	NR	NR	NR	NR	NR	
31.190	NR	NR	NR	NR	NR	NR	NR	
35.975	NR	NR	NR	NR	NR	NR	NR	
47.800	NR	NR	NR	NR	NR	NR	NR	
AVERAGES	5.337	10.985	4.408	0.001	0.514	11152	0.693	94.6
95th-PERCENTILES	26.730	9.710	30.816	0.003	0.480	51000	0.693	230.2

TABLE D-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF REACTANTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
1	ST	1.50	0.04	1.78	-
2	ST	1.80	0.04	1.78	-
3	ST	2.49	0.04	8.50	-
4	ST	2.59	0.05	-	-
5	ST	3.05	0.05	-	-
6	ST	3.20	0.05	-	-
7	ST	4.50	0.05	-	-
8	ST	5.50	0.05	-	-
9	ST	5.79	0.08	-	-
10	ST	6.10	0.08	-	-
11	ST	6.10	0.08	-	-
12	ST	6.40	0.10	-	-
13	ST	6.49	0.10	-	-
14	ST	6.55	0.10	-	-
15	ST	6.60	0.10	-	-
16	ST	6.60	0.10	-	-
17	ST	6.70	0.10	-	-
18	ST	7.01	0.10	-	-
19	ST	7.31	0.10	-	-
20	ST	7.32	0.10	-	-
21	ST	7.93	0.15	-	-
22	ST	7.93	0.15	-	-
23	ST	8.20	0.20	-	-
24	ST	8.80	0.25	-	-
25	ST	9.76	0.25	-	-
26	ST	10.67	0.25	-	-
27	ST	10.67	0.25	-	-
28	ST	10.80	0.25	-	-
29	ST	11.30	0.25	-	-
30	ST	11.30	0.25	-	-
31	ST	12.80	0.30	-	-
32	ST	13.40	-	-	-
1	S2	1.52	0.20	15.20	-
2	S2	3.00	-	-	-
3	S2	3.00	-	-	-
4	S2	10.00	-	-	-
1	PV	2.50	0.03	0.01	273
2	PV	4.60	0.03	0.05	289
3	PV	6.20	0.03	0.07	289
4	PV	7.62	0.05	0.08	289
5	PV	9.10	0.05	0.22	289
6	PV	10.00	0.05	0.36	293

PV=PROCESS VENT NR=NOT REPORTED

TABLE D-2. SUMMARY OF EMISSION PARAMETERS FOR
CHEMICAL PROCESS USE OF REACTANTS

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
7	PV	10.00	0.05	0.72	293
8	PV	18.30	0.10	1.00	293
9	PV	33.50	0.10	2.35	293
10	PV	36.60	0.15	3.00	293
11	PV	39.60	0.20	3.90	293
12	PV	45.70	0.20	4.50	308
13	PV	45.70	0.20	4.82	313
14	PV	45.70	0.25	6.30	323
15	PV	58.50	0.50	7.30	422
16	PV	66.00	0.50	11.00	422
17	PV	66.00	0.76	14.60	-
18	PV	-	1.23	14.60	-
19	PV	-	4.20	15.00	-
20	PV	-	4.20	15.00	-
1	H	7.60	0.01	0.91	-
2	H	-	0.20	-	-
1	EO	1.00	0.01	0.05	-
2	EO	1.52	0.01	-	-
3	EO	1.52	0.05	-	-
4	EO	3.05	0.08	-	-
5	EO	4.27	0.08	-	-
6	EO	4.57	0.30	-	-
7	EO	15.20	0.30	-	-
8	EO	19.80	0.31	-	-
9	EO	-	0.36	-	-
10	EO	-	0.46	-	-
11	EO	-	0.61	-	-
1	EL	-	0.01	-	-
2	EL	-	0.01	-	-

ST=STORAGE
PV=PROCESS
S2=SECONDARY
H=HANDLING
EO=EQUIPMENT OPENING
EL=EQUIPMENT LEAK
AR=ACCIDENTAL RELEASE

A "-" INDICATES THAT DATA WERE NOT PROVIDED BY THE FACILITY.

Appendix E
Blowing Agents

TABLE E-1. SUMMARY OF EMISSIONS FOR BLOWING AGENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg emitted/Mg consumed)			EMISSION RATE (kg emitted/yr)		
	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	LIQUID SPILLS
911	0.000	NR	NR	NR	970	0
956	0.000	NR	NR	NR	1350	0
959	0.000	NR	NR	NR	1350	0
967	0.000	NR	NR	NR	1350	0
971	0.000	NR	NR	NR	1350	0
972	0.000	NR	NR	NR	2550	0
976	0.000	NR	NR	NR	2640	0
981	0.000	NR	NR	NR	2670	0
981	0.000	NR	NR	NR	2700	76
981	0.000	NR	NR	NR	2870	98
986	0.000	NR	NR	NR	3550	120
988	1.044	NR	NR	NR	4160	120
988	1.436	NR	NR	NR	4160	152
991	1.631	NR	NR	NR	4160	163
995	1.925	NR	NR	NR	4350	163
AVERAGES		^a				^a
974	1.509	-	-	-	2679	127
95th-PERCENTILES						
991	1.631	-	-	-	4160	163

NOTES: a

Represents the average of all non-zero data points for which emissions were reported.

NR = not reported.

"-" can not be determined due to no data were reported.

TABLE E-2. EMISSION PARAMETERS FOR BLOWING AGENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION HEIGHT TYPE	(m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
1	PV	5.00	0.36	2.70	293
2	PV	5.20	0.46	2.70	293
3	PV	5.30	0.46	2.70	293
4	PV	6.10	0.46	3.70	293
5	PV	7.00	0.46	3.70	293
6	PV	7.01	0.46	4.30	293
7	PV	7.01	0.46	4.30	293
8	PV	7.30	0.46	4.60	293
9	PV	7.30	0.51	4.60	293
10	PV	7.30	0.51	4.60	293
11	PV	7.30	0.61	4.94	293
12	PV	7.30	0.61	5.33	293
13	PV	7.30	0.61	5.40	293
14	PV	7.30	0.61	5.40	293
15	PV	7.30	0.61	5.55	293
16	PV	7.30	0.61	5.70	293
17	PV	7.30	0.61	5.80	293
18	PV	7.60	0.61	5.80	293
19	PV	7.60	0.61	6.19	293
20	PV	7.60	0.61	6.20	293
21	PV	7.60	0.61	6.20	293
22	PV	7.60	0.61	6.20	293
23	PV	7.60	0.61	6.20	293
24	PV	7.60	0.61	6.20	293
25	PV	7.60	0.61	6.60	293
26	PV	7.60	0.61	7.25	294
27	PV	7.60	0.61	7.47	294
28	PV	7.60	0.61	7.60	294
29	PV	7.60	0.61	7.70	294
30	PV	7.60	0.61	7.74	294
31	PV	7.60	0.61	8.00	294
32	PV	7.60	0.61	8.00	294
33	PV	7.60	0.61	8.30	294
34	PV	7.60	0.61	8.70	294
35	PV	7.60	0.61	8.70	294
36	PV	7.60	0.61	8.94	294
37	PV	7.60	0.61	9.20	294
38	PV	7.60	0.61	9.20	294
39	PV	7.60	0.61	9.20	294
40	PV	7.60	0.61	9.20	294
41	PV	7.60	0.61	9.40	294
42	PV	7.60	0.61	9.40	295
43	PV	7.60	0.61	9.40	295
44	PV	7.60	0.61	9.40	296
45	PV	7.60	0.61	9.40	296
46	PV	7.60	0.61	9.40	296

TABLE E-2. EMISSION PARAMETERS FOR BLOWING AGENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
47	PV	7.60	0.61	9.70	297
48	PV	7.60	0.61	9.70	297
49	PV	8.23	0.61	9.70	297
50	PV	8.23	0.61	9.70	297
51	PV	8.23	0.61	9.70	297
52	PV	8.23	0.61	9.70	300
53	PV	8.23	0.61	10.00	300
54	PV	8.23	0.61	10.00	300
55	PV	8.23	0.61	10.00	300
56	PV	8.23	0.61	10.00	300
57	PV	8.23	0.61	10.60	300
58	PV	8.23	0.61	10.60	300
59	PV	8.50	0.61	10.88	300
60	PV	8.70	0.61	10.88	300
61	PV	8.70	0.61	10.89	300
62	PV	8.70	0.61	10.90	300
63	PV	8.80	0.61	11.31	300
64	PV	8.84	0.61	11.40	300
65	PV	8.84	0.61	11.40	300
66	PV	9.10	0.61	11.40	300
67	PV	9.10	0.61	11.40	300
68	PV	9.60	0.61	11.60	300
69	PV	9.60	0.61	11.60	300
70	PV	9.80	0.66	11.60	300
71	PV	9.80	0.66	12.30	300
72	PV	9.80	0.71	12.61	300
73	PV	9.80	0.71	12.61	300
74	PV	9.80	0.71	12.61	300
75	PV	9.80	0.71	12.61	300
76	PV	9.80	0.71	12.80	300
77	PV	10.10	0.71	12.80	300
78	PV	10.10	0.76	12.80	300
79	PV	10.10	0.76	12.80	300
80	PV	10.10	0.76	12.80	300
81	PV	10.10	0.76	12.80	300
82	PV	10.10	0.76	12.80	300
83	PV	10.10	0.76	12.80	300
84	PV	10.10	0.76	12.80	300
85	PV	10.20	0.76	13.10	300
86	PV	10.20	0.76	13.10	300
87	PV	10.67	0.76	13.10	300
88	PV	10.67	0.76	13.10	300
89	PV	10.67	0.76	13.60	300
90	PV	10.67	0.76	13.60	300
91	PV	10.67	0.76	13.60	300
92	PV	10.70	0.76	14.50	300

TABLE E-2. EMISSION PARAMETERS FOR BLOWING AGENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
93	PV	10.70	0.76	14.50	300
94	PV	10.70	0.76	14.50	300
95	PV	10.70	0.76	15.20	300
96	PV	10.70	0.76	15.20	300
97	PV	10.70	0.76	15.20	301
98	PV	10.70	0.76	15.80	311
99	PV	10.70	0.76	15.80	311
100	PV	10.70	0.76	15.80	311
101	PV	10.70	0.76	16.10	311
102	PV	10.70	0.76	16.10	311
103	PV	10.70	0.76	16.10	311
104	PV	10.70	0.76	16.16	311
105	PV	10.70	0.76	16.20	311
106	PV	10.70	0.81	16.20	311
107	PV	10.70	0.84	16.20	311
108	PV	10.70	0.86	16.50	311
109	PV	10.70	0.86	16.50	311
110	PV	10.70	0.86	16.50	311
111	PV	10.70	0.86	16.50	311
112	PV	10.70	0.91	16.50	311
113	PV	10.70	0.91	16.93	311
114	PV	10.70	0.91	17.00	311
115	PV	10.70	0.91	17.00	311
116	PV	10.70	0.91	17.00	311
117	PV	10.70	0.91	17.00	311
118	PV	10.70	0.91	17.20	311
119	PV	10.70	0.91	17.20	311
120	PV	10.70	0.91	17.30	311
121	PV	10.70	0.91	17.30	311
122	PV	10.70	0.91	18.70	311
123	PV	10.70	0.91	18.70	-
124	PV	10.70	0.91	21.47	-
125	PV	11.00	0.91	21.47	-
126	PV	11.00	0.91	21.47	-
127	PV	11.00	0.91	21.60	-
128	PV	11.30	0.91	22.10	-
129	PV	11.30	0.91	22.30	-
130	PV	11.30	0.91	22.30	-
131	PV	11.30	0.91	22.30	-
132	PV	11.30	0.91	23.60	-
133	PV	11.60	0.91	23.90	-
134	PV	11.60	0.91	24.20	-
135	PV	11.60	0.91	24.20	-
136	PV	11.60	0.91	24.20	-
137	PV	11.90	0.91	24.20	-
138	PV	11.90	0.91	24.20	-

TABLE E-2. EMISSION PARAMETERS FOR BLOWING AGENTS
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	EMISSION HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
139	PV	11.90	0.91	24.20	-
140	PV	11.90	0.91	24.27	-
141	PV	11.90	0.91	24.27	-
142	PV	11.90	0.91	25.30	-
143	PV	11.90	0.91	25.30	-
144	PV	11.90	0.91	25.60	-
145	PV	11.90	0.91	25.60	-
146	PV	11.90	0.91	25.60	-
147	PV	12.20	0.91	27.00	-
148	PV	12.20	0.91	34.10	-
149	PV	12.20	0.91	34.10	-
150	PV	12.20	0.91	-	-
151	PV	12.20	0.91	-	-
152	PV	12.20	0.91	-	-
153	PV	12.20	0.91	-	-
154	PV	13.40	1.03	-	-
155	PV	13.40	1.03	-	-
156	PV	13.40	1.03	-	-
157	PV	13.40	1.03	-	-
158	PV	13.70	1.03	-	-
159	PV	13.70	1.03	-	-
160	PV	13.70	1.07	-	-
161	PV	13.70	1.07	-	-
162	PV	14.30	1.07	-	-
163	PV	14.60	1.07	-	-
164	PV	14.60	1.07	-	-
165	PV	15.80	1.07	-	-
166	PV	15.80	1.07	-	-
167	PV	15.80	1.07	-	-
168	PV	15.80	1.07	-	-
169	PV	15.80	1.52	-	-
170	PV	18.30	1.52	-	-
1	ST	2.40	0.05	-	-
2	ST	3.40	0.05	-	-
3	ST	4.90	0.05	-	-
4	ST	4.90	0.05	-	-
5	ST	5.50	0.05	-	-
6	ST	5.50	0.05	-	-
7	ST	5.90	0.05	-	-

KEY: PV = PROCESS VENTS
ST = STORAGE
"- " Not reported.

Appendix F
Pesticides Production

TABLE F-1. SUMMARY OF EMISSIONS FOR PESTICIDES PRODUCTION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENTS	EMISSION FACTOR (kg emitted/Mg consumed)			EMISSION RATE (kg emitted per year)			
	STORAGE	HANDLING	EQUIPMENT OPENINGS	SECONDARY	EQUIPMENT LEAKS	RELIEF DISCHARGES	LIQUID SPILLS
0.013	0.008	0.027	0.007	0.003	12	68	154
0.050	0.037	0.207	0.077	0.147	17	225	4536 ^a
0.748	0.470	1.419	0.203	0.430	418 ^c	NR	24705 ^a
0.756	0.593	NR	0.241	1.106	2162	NR	NR
0.800	0.721	NR	8.375	1.493	3524	NR	NR
1.106	1.457	NR	41.767	8.628 ^a	8603	NR	NR
1.218	2.569	NR	101.628	13.355	9032 ^b	NR	NR
2.293	6.040	NR	134.880	58.233	9446	NR	NR
7.060	12.540	NR	NR	85.401	9446	NR	NR
17.229	12.806	NR	NR	313.353	9507	NR	NR
24.725	13.321	NR	NR	352.897	13889	NR	NR
58.586	17.392	NR	NR	376.450	18807	NR	NR
96.038	NR	NR	NR	455.182	23820	NR	NR
212.689	NR	NR	NR	529.784	27301	NR	NR
241.997	NR	NR	NR	NR	34847	NR	NR
250.383	NR	NR	NR	NR	99963 ^c	NR	NR
313.065	NR	NR	NR	NR	113687 ^c	NR	NR
320.301	NR	NR	NR	NR	NR	NR	NR
352.690	NR	NR	NR	NR	NR	NR	NR
NUMBER:	19	12	8	15	25	2	4
AVERAGE:	100.09	5.66	35.90	146.43	15379	147	9798
95TH-PERCENTILE:	320.30	13.32	134.88	455.81	34847	225	12000
STANDARD DEV:	132.24	6.49	53.49	199.74	33295	46	5086

^a Represents emissions from two processes combined.
^b Represents emissions from three processes combined.
^c Represents emissions from four processes combined.

NR = not reported.

Table F-2 Emission Parameters for Pesticides Production

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
1	PV	76.20	1.680	517.400	561
2	PV	39.62	1.520	517.400	523
3	PV	36.60	1.370	517.400	378
4	PV	36.60	1.220	46.900	378
5	PV	36.60	1.220	30.500	371
6	PV	35.80	1.220	19.200	344
7	PV	35.80	1.200	18.600	311
8	PV	34.14	1.067	18.600	311
9	PV	33.53	0.920	18.600	302
10	PV	33.53	0.610	18.210	302
11	PV	33.53	0.610	16.900	302
12	PV	33.50	0.558	14.600	300
13	PV	25.60	0.305	14.600	300
14	PV	25.60	0.305	12.900	298
15	PV	25.60	0.305	11.100	297
16	PV	25.00	0.305	10.566	297
17	PV	24.30	0.203	6.700	295
18	PV	18.30	0.203	6.180	295
19	PV	18.29	0.152	5.752	295
20	PV	17.98	0.152	5.600	295
21	PV	12.20	0.152	3.870	294
22	PV	12.20	0.152	2.630	294
23	PV	12.19	0.152	1.119	294
24	PV	12.00	0.101	0.750	294
25	PV	9.14	0.100	0.720	289
26	PV	9.10	0.100	0.671	280
27	PV	9.10	0.091	0.302	280
28	PV	8.23	0.076	0.145	278
29	PV	7.62	0.076	0.118	278
30	PV	7.62	0.052	0.097	266
31	PV	7.62	0.052	0.016	259
32	PV	7.62	0.052	0.005	136
33	PV	6.10	0.051	0.003	136
34	PV	5.20	0.051	0.001	-
1	ST	10.30	0.508	-	-
2	ST	10.05	0.114	-	-
3	ST	9.63	0.102	-	-
4	ST	9.14	0.076	-	-
5	ST	6.10	0.076	-	-
6	ST	5.90	0.076	-	-
7	ST	4.75	0.076	-	-
8	ST	4.75	0.076	-	-
9	ST	4.72	0.076	-	-
10	ST	4.30	0.076	-	-
11	ST	4.10	0.051	-	-
12	ST	4.10	0.051	-	-
13	ST	3.70	0.051	-	-
14	ST	3.66	0.051	-	-
15	ST	3.17	0.051	-	-

Table F-2 Emission Parameters for Pesticides Production

ID	Type	Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
16	ST	3.17	0.051	-	-
17	ST	3.10	0.051	-	-
18	ST	3.10	0.051	-	-
19	ST	2.44	0.051	-	-
20	ST	2.44	0.051	-	-
21	ST	2.44	0.051	-	-
22	ST	2.24	0.051	-	-
23	ST	1.83	0.051	-	-
24	ST	1.50	0.051	-	-
25	ST	1.50	0.051	-	-
26	ST	1.50	0.051	-	-
27	ST	1.20	0.051	-	-
28	ST	1.20	0.010	-	-
1	EO	18.30	0.457	-	-
2	EO	18.29	0.457	-	-
3	EO	11.20	0.457	-	-
4	EO	10.03	0.457	-	-
5	EO	9.40	0.457	-	-
6	EO	7.60	0.457	-	-
7	EO	7.14	0.457	-	-
8	EO	6.60	0.457	-	-
9	EO	6.10	0.152	-	-
10	EO	6.10	0.152	-	-
11	EO	6.10	0.150	-	-
12	EO	6.10	0.101	-	-
13	EO	6.10	0.101	-	-
14	EO	4.60	0.051	-	-
15	EO	4.60	0.051	-	-
16	EO	4.57	0.051	-	-
17	EO	4.57	-	-	-
18	EO	3.05	-	-	-
19	EO	2.60	-	-	-
20	EO	0.90	-	-	-
21	EO	0.90	-	-	-
1	RD	27.40	0.102	-	-
2	RD	10.70	0.101	-	-
3	RD	10.70	0.076	-	-
4	RD	7.00	0.076	-	-

KEY: PV = PROCESS VENTS
 ST = STORAGE
 EO = EQUIPMENT OPENINGS
 S2 = SECONDARY
 RD = RELIEF DISCHARGES
 "-" Not reported.

Appendix G
Pharmaceutical Production

TABLE G-1. SUMMARY OF EMISSIONS FOR PHARMACEUTICAL PRODUCTION
(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

PROCESS VENT	EMISSION FACTOR (kg emitted/Mg consumed)				EMISSION RATE (kg emitted per year)	
	STORAGE	HANDLING	SECONDARY	EQUIPMENT OPENINGS	EQUIPMENT LEAKS	LIQUID SPILLS
0.03	0.01	0.01	0.09	0.03	372.00	278.00
0.32	0.02	0.05	0.86	0.14	922.00	782.00
0.44	0.02	1.34	1.64	0.25	927.00	1090.00
0.65	0.42	3.37	1.74	5.28	1033.00	1361.00
5.13	0.88	31.49	3.39	8.52	1249.00	2812.00
15.53	1.84	NR	8.35	13.69	1306.00	NR
28.49	2.13	NR	41.45	14.97	1517.00	NR
34.97	2.45	NR	111.44	15.62	2103.00	NR
35.93	4.70	NR	142.81	160.43	2336.00	NR
37.67	4.91	NR	144.31	NR	3755.00	NR
50.80	6.57	NR	232.83	NR	6134.00	NR
68.94	9.86	NR	NR	NR	7192.00	NR
103.96	28.04	NR	NR	NR	7200.00	NR
117.24	36.93	NR	NR	NR	12834.00	NR
137.26	160.49	NR	NR	NR	21690.00	NR
249.42	171.55	NR	NR	NR	22217.00	NR
400.05	NR	NR	NR	NR	45440.00	NR
543.40	NR	NR	NR	NR	54084.00	NR
833.93	NR	NR	NR	NR	71415.00	NR
950.71	NR	NR	NR	NR	73303.00	NR
1000.00	NR	NR	NR	NR	NR	NR
2036.40	NR	NR	NR	NR	NR	NR
7135.72	NR	NR	NR	NR	NR	NR
AVERAGES						
599.43	26.93	7.25	62.63	24.33	16851.45	1264.60
95th-PERCENTILES						
2036.40	160.49	31.49	144.31	160.43	71415.00	2812.00

NR = not reported.

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
1	ST	1.83	0.04	0.05	-
2	ST	3.05	0.04	0.05	-
3	ST	3.15	0.05	-	-
4	ST	3.65	0.05	-	-
5	ST	3.66	0.05	-	-
6	ST	3.66	0.05	-	-
7	ST	3.66	0.05	-	-
8	ST	3.66	0.05	-	-
9	ST	3.66	0.05	-	-
10	ST	3.66	0.05	-	-
11	ST	3.70	0.05	-	-
12	ST	3.96	0.05	-	-
13	ST	4.04	0.05	-	-
14	ST	4.57	0.05	-	-
15	ST	4.57	0.05	-	-
16	ST	4.57	0.05	-	-
17	ST	4.57	0.05	-	-
18	ST	4.57	0.05	-	-
19	ST	4.79	0.05	-	-
20	ST	5.49	0.05	-	-
21	ST	6.40	0.05	-	-
22	ST	7.30	0.05	-	-
23	ST	7.30	0.05	-	-
24	ST	7.32	0.08	-	-
25	ST	7.62	0.08	-	-
26	ST	7.77	0.08	-	-
27	ST	7.77	0.08	-	-
28	ST	7.77	0.08	-	-
29	ST	7.82	0.08	-	-
30	ST	8.08	0.08	-	-
31	ST	8.08	0.08	-	-
32	ST	9.10	0.08	-	-
33	ST	9.10	0.08	-	-
34	ST	9.10	0.08	-	-
35	ST	9.10	0.08	-	-
36	ST	9.14	0.08	-	-
37	ST	9.45	0.08	-	-
38	ST	9.45	0.08	-	-
39	ST	9.45	0.08	-	-
40	ST	9.45	0.08	-	-
41	ST	9.75	0.08	-	-
42	ST	9.75	0.08	-	-
43	ST	9.75	0.08	-	-
44	ST	9.75	0.08	-	-
45	ST	10.39	0.08	-	-

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
46	ST	10.39	0.08	-	-
47	ST	10.39	0.10	-	-
48	ST	10.39	0.10	-	-
49	ST	10.39	0.10	-	-
50	ST	10.70	0.10	-	-
51	ST	10.70	0.10	-	-
52	ST	10.70	0.10	-	-
53	ST	10.70	0.10	-	-
54	ST	10.97	0.10	-	-
55	ST	10.97	0.10	-	-
56	ST	12.80	0.10	-	-
57	ST	20.70	0.10	-	-
58	ST	20.70	0.36	-	-
59	ST	21.90	0.76	-	-
60	ST	21.95	0.76	-	-
1	S2	7.62	0.04	0.10	-
2	S2	13.11	0.05	15.00	-
3	S2	15.24	0.10	-	-
1	PV	0.31	0.01	0.02	231
2	PV	0.31	0.02	0.02	245
3	PV	0.31	0.02	0.02	248
4	PV	1.52	0.02	0.02	248
5	PV	1.52	0.03	0.02	248
6	PV	1.52	0.03	0.02	248
7	PV	1.52	0.03	0.02	252
8	PV	1.52	0.03	0.02	253
9	PV	1.52	0.03	0.02	253
10	PV	1.80	0.03	0.02	260
11	PV	2.40	0.03	0.02	260
12	PV	3.00	0.03	0.02	260
13	PV	3.00	0.03	0.02	260
14	PV	3.00	0.03	0.03	260
15	PV	3.00	0.03	0.03	260
16	PV	3.00	0.03	0.03	260
17	PV	3.00	0.03	0.03	260
18	PV	3.00	0.03	0.03	260
19	PV	3.00	0.03	0.03	260
20	PV	3.00	0.03	0.03	260
21	PV	3.00	0.03	0.03	260
22	PV	3.05	0.03	0.03	263
23	PV	3.05	0.03	0.03	263
24	PV	3.05	0.03	0.03	263
25	PV	3.05	0.03	0.03	263

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
26	PV	3.05	0.03	0.03	263
27	PV	3.05	0.03	0.03	263
28	PV	3.05	0.03	0.03	264
29	PV	3.05	0.03	0.03	264
30	PV	3.05	0.03	0.03	264
31	PV	3.05	0.03	0.03	264
32	PV	3.05	0.03	0.04	264
33	PV	3.05	0.03	0.04	267
34	PV	3.05	0.03	0.04	267
35	PV	3.05	0.03	0.04	267
36	PV	4.27	0.03	0.04	267
37	PV	4.57	0.03	0.04	267
38	PV	4.57	0.03	0.04	267
39	PV	4.57	0.03	0.04	268
40	PV	4.57	0.03	0.04	268
41	PV	4.57	0.03	0.04	268
42	PV	4.60	0.03	0.04	268
43	PV	4.88	0.03	0.05	268
44	PV	4.88	0.03	0.05	271
45	PV	4.88	0.03	0.05	271
46	PV	5.18	0.03	0.05	273
47	PV	5.49	0.03	0.05	273
48	PV	5.49	0.03	0.05	273
49	PV	5.49	0.03	0.05	273
50	PV	5.49	0.03	0.05	273
51	PV	5.49	0.04	0.06	273
52	PV	5.49	0.04	0.06	273
53	PV	5.49	0.04	0.06	273
54	PV	5.49	0.04	0.06	273
55	PV	5.49	0.04	0.06	273
56	PV	5.49	0.04	0.07	273
57	PV	5.49	0.04	0.07	273
58	PV	5.49	0.04	0.07	273
59	PV	5.49	0.04	0.07	275
60	PV	5.49	0.04	0.07	275
61	PV	5.49	0.04	0.07	275
62	PV	5.49	0.04	0.07	275
63	PV	6.10	0.04	0.07	276
64	PV	6.10	0.04	0.08	276
65	PV	6.10	0.04	0.08	276
66	PV	6.10	0.04	0.08	276
67	PV	6.10	0.04	0.08	276
68	PV	6.10	0.04	0.08	276
69	PV	6.10	0.04	0.08	278
70	PV	6.10	0.04	0.08	278

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
71	PV	6.10	0.04	0.08	278
72	PV	6.10	0.04	0.08	278
73	PV	6.10	0.04	0.08	278
74	PV	6.10	0.04	0.08	278
75	PV	6.10	0.04	0.08	278
76	PV	6.10	0.04	0.08	278
77	PV	6.10	0.04	0.08	278
78	PV	6.10	0.04	0.09	279
79	PV	6.10	0.04	0.09	279
80	PV	6.10	0.04	0.09	280
81	PV	6.10	0.04	0.09	280
82	PV	6.10	0.04	0.09	280
83	PV	6.10	0.04	0.09	280
84	PV	6.10	0.04	0.09	280
85	PV	6.10	0.05	0.09	280
86	PV	6.10	0.05	0.10	280
87	PV	6.10	0.05	0.10	280
88	PV	6.10	0.05	0.10	280
89	PV	6.10	0.05	0.10	280
90	PV	6.10	0.05	0.10	280
91	PV	6.10	0.05	0.11	280
92	PV	6.10	0.05	0.11	282
93	PV	6.10	0.05	0.12	283
94	PV	6.10	0.05	0.12	283
95	PV	6.10	0.05	0.12	283
96	PV	6.70	0.05	0.12	283
97	PV	6.80	0.05	0.12	283
98	PV	7.31	0.05	0.12	283
99	PV	7.31	0.05	0.12	283
100	PV	7.31	0.05	0.12	283
101	PV	7.31	0.05	0.12	283
102	PV	7.31	0.05	0.12	283
103	PV	7.31	0.05	0.13	283
104	PV	7.31	0.05	0.14	283
105	PV	7.31	0.05	0.14	283
106	PV	7.31	0.05	0.14	283
107	PV	7.31	0.05	0.14	283
108	PV	7.31	0.05	0.14	283
109	PV	7.31	0.05	0.14	283
110	PV	7.31	0.05	0.14	283
111	PV	7.31	0.05	0.14	283
112	PV	7.31	0.05	0.15	283
113	PV	7.31	0.05	0.15	283
114	PV	7.62	0.05	0.15	283
115	PV	7.62	0.05	0.15	283

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
116	PV	7.62	0.05	0.15	283
117	PV	7.62	0.05	0.15	283
118	PV	7.62	0.05	0.15	283
119	PV	7.62	0.05	0.15	283
120	PV	7.62	0.05	0.15	283
121	PV	8.53	0.05	0.15	284
122	PV	8.53	0.05	0.16	285
123	PV	8.53	0.05	0.16	285
124	PV	8.53	0.05	0.16	285
125	PV	8.53	0.05	0.16	288
126	PV	8.53	0.05	0.17	288
127	PV	8.53	0.05	0.17	288
128	PV	8.53	0.05	0.18	289
129	PV	8.53	0.05	0.18	289
130	PV	8.53	0.05	0.18	289
131	PV	8.53	0.05	0.18	289
132	PV	8.53	0.05	0.18	289
133	PV	8.53	0.05	0.18	289
134	PV	8.53	0.05	0.18	289
135	PV	8.53	0.05	0.18	289
136	PV	8.53	0.05	0.18	289
137	PV	8.53	0.05	0.19	289
138	PV	8.84	0.05	0.20	289
139	PV	8.84	0.05	0.21	289
140	PV	9.10	0.05	0.21	289
141	PV	9.10	0.05	0.21	289
142	PV	9.10	0.05	0.21	289
143	PV	9.10	0.05	0.22	289
144	PV	9.14	0.05	0.22	289
145	PV	9.14	0.05	0.22	289
146	PV	9.14	0.05	0.22	290
147	PV	9.14	0.05	0.22	291
148	PV	9.14	0.05	0.22	291
149	PV	9.14	0.05	0.22	291
150	PV	9.14	0.05	0.22	291
151	PV	9.14	0.05	0.22	291
152	PV	9.14	0.05	0.22	291
153	PV	9.14	0.05	0.22	291
154	PV	9.14	0.05	0.22	291
155	PV	9.14	0.05	0.22	291
156	PV	9.45	0.05	0.22	291
157	PV	9.45	0.05	0.22	291
158	PV	9.45	0.05	0.22	291
159	PV	9.45	0.05	0.22	291
160	PV	9.60	0.05	0.23	291

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
161	PV	9.60	0.05	0.23	291
162	PV	9.60	0.05	0.23	291
163	PV	9.60	0.05	0.24	291
164	PV	9.60	0.05	0.24	291
165	PV	9.60	0.05	0.24	291
166	PV	9.60	0.05	0.24	291
167	PV	9.60	0.05	0.24	291
168	PV	9.60	0.05	0.24	291
169	PV	9.75	0.05	0.24	291
170	PV	9.75	0.05	0.24	291
171	PV	9.75	0.05	0.24	291
172	PV	10.06	0.05	0.25	291
173	PV	10.06	0.05	0.25	291
174	PV	10.10	0.05	0.26	291
175	PV	10.10	0.05	0.27	291
176	PV	10.10	0.05	0.28	292
177	PV	10.67	0.05	0.28	292
178	PV	10.67	0.05	0.28	292
179	PV	10.67	0.05	0.28	292
180	PV	10.67	0.05	0.28	292
181	PV	10.67	0.05	0.28	293
182	PV	10.67	0.05	0.29	293
183	PV	10.67	0.05	0.29	293
184	PV	10.67	0.05	0.29	293
185	PV	10.67	0.05	0.29	293
186	PV	10.67	0.05	0.29	293
187	PV	10.67	0.05	0.29	293
188	PV	10.67	0.05	0.29	293
189	PV	10.67	0.05	0.29	293
190	PV	10.67	0.05	0.30	293
191	PV	10.67	0.05	0.31	293
192	PV	10.67	0.05	0.31	293
193	PV	10.67	0.05	0.31	293
194	PV	10.67	0.05	0.32	293
195	PV	10.67	0.05	0.35	293
196	PV	10.67	0.05	0.35	293
197	PV	10.67	0.05	0.35	293
198	PV	10.67	0.05	0.35	293
199	PV	10.67	0.05	0.35	293
200	PV	10.67	0.05	0.35	293
201	PV	10.67	0.05	0.35	294
202	PV	10.67	0.05	0.35	294
203	PV	10.70	0.05	0.35	294
204	PV	10.70	0.05	0.35	294
205	PV	10.70	0.05	0.35	294

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
206	PV	10.70	0.05	0.35	294
207	PV	10.70	0.05	0.36	294
208	PV	10.70	0.05	0.36	294
209	PV	10.70	0.05	0.38	294
210	PV	10.70	0.05	0.41	294
211	PV	10.70	0.05	0.41	294
212	PV	10.70	0.05	0.42	294
213	PV	10.97	0.05	0.42	294
214	PV	10.97	0.05	0.42	294
215	PV	10.97	0.05	0.42	294
216	PV	10.97	0.05	0.42	294
217	PV	10.97	0.05	0.42	294
218	PV	10.97	0.05	0.42	294
219	PV	10.97	0.05	0.42	294
220	PV	10.97	0.05	0.43	294
221	PV	10.97	0.05	0.44	294
222	PV	10.97	0.05	0.44	294
223	PV	10.97	0.05	0.46	294
224	PV	10.97	0.05	0.47	294
225	PV	10.97	0.05	0.47	294
226	PV	10.97	0.05	0.47	294
227	PV	10.97	0.05	0.47	294
228	PV	10.97	0.05	0.47	294
229	PV	10.97	0.05	0.47	294
230	PV	10.97	0.05	0.47	294
231	PV	10.97	0.05	0.47	294
232	PV	10.97	0.05	0.48	295
233	PV	10.97	0.05	0.49	295
234	PV	10.97	0.05	0.50	295
235	PV	10.97	0.05	0.51	295
236	PV	10.97	0.05	0.51	295
237	PV	10.97	0.05	0.51	295
238	PV	10.97	0.05	0.52	295
239	PV	10.97	0.05	0.55	295
240	PV	10.97	0.05	0.55	295
241	PV	11.28	0.05	0.55	295
242	PV	11.28	0.05	0.56	295
243	PV	11.28	0.05	0.60	295
244	PV	11.60	0.05	0.62	295
245	PV	11.60	0.05	0.66	295
246	PV	12.19	0.05	0.67	295
247	PV	12.19	0.05	0.67	295
248	PV	12.19	0.05	0.67	295
249	PV	12.19	0.05	0.67	295
250	PV	12.19	0.05	0.67	295

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
251	PV	12.19	0.06	0.67	295
252	PV	12.19	0.06	0.67	296
253	PV	12.19	0.06	0.67	296
254	PV	12.19	0.06	0.67	296
255	PV	12.19	0.06	0.67	296
256	PV	12.19	0.06	0.67	296
257	PV	12.19	0.06	0.67	296
258	PV	12.19	0.06	0.67	297
259	PV	12.19	0.06	0.69	297
260	PV	12.19	0.06	0.69	297
261	PV	12.19	0.06	0.69	297
262	PV	12.19	0.06	0.69	297
263	PV	12.19	0.06	0.69	297
264	PV	12.19	0.06	0.69	297
265	PV	12.19	0.08	0.69	297
266	PV	12.19	0.08	0.69	297
267	PV	12.19	0.08	0.69	297
268	PV	12.19	0.08	0.69	297
269	PV	12.19	0.08	0.69	297
270	PV	12.19	0.08	0.69	297
271	PV	12.19	0.08	0.69	297
272	PV	12.19	0.08	0.69	297
273	PV	12.20	0.08	0.69	297
274	PV	12.20	0.08	0.69	297
275	PV	12.20	0.08	0.69	297
276	PV	12.50	0.08	0.69	297
277	PV	12.50	0.08	0.69	297
278	PV	12.50	0.08	0.69	297
279	PV	12.50	0.08	0.69	297
280	PV	12.50	0.08	0.69	297
281	PV	12.50	0.08	0.69	297
282	PV	12.50	0.08	0.69	297
283	PV	12.50	0.08	0.69	297
284	PV	12.80	0.08	0.69	297
285	PV	12.80	0.08	0.69	297
286	PV	12.80	0.08	0.69	297
287	PV	12.80	0.08	0.69	297
288	PV	12.80	0.08	0.70	297
289	PV	12.80	0.08	0.70	297
290	PV	12.80	0.08	0.70	297
291	PV	12.80	0.08	0.70	297
292	PV	12.80	0.08	0.70	298
293	PV	12.80	0.08	0.70	298
294	PV	12.80	0.08	0.71	298
295	PV	12.80	0.08	0.73	298

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
296	PV	12.80	0.08	0.73	298
297	PV	12.80	0.08	0.73	298
298	PV	12.80	0.08	0.75	298
299	PV	12.80	0.08	0.82	298
300	PV	12.80	0.08	0.83	298
301	PV	12.80	0.08	0.85	298
302	PV	12.80	0.08	0.88	298
303	PV	12.80	0.08	0.88	298
304	PV	12.80	0.08	0.94	298
305	PV	12.80	0.08	0.96	298
306	PV	12.80	0.08	0.96	298
307	PV	12.80	0.08	1.11	298
308	PV	12.80	0.08	1.14	298
309	PV	12.80	0.08	1.15	298
310	PV	12.80	0.08	1.15	298
311	PV	12.80	0.08	1.18	298
312	PV	12.80	0.08	1.23	298
313	PV	12.80	0.08	1.25	298
314	PV	12.80	0.08	1.25	298
315	PV	12.80	0.08	1.25	298
316	PV	12.80	0.08	1.25	298
317	PV	12.80	0.08	1.25	298
318	PV	12.80	0.08	1.25	298
319	PV	12.80	0.08	1.25	298
320	PV	12.80	0.08	1.25	298
321	PV	12.80	0.08	1.25	298
322	PV	12.80	0.08	1.25	298
323	PV	12.80	0.08	1.25	298
324	PV	12.80	0.08	1.25	298
325	PV	12.80	0.08	1.25	298
326	PV	12.80	0.08	1.25	298
327	PV	12.80	0.08	1.27	298
328	PV	12.80	0.08	1.30	298
329	PV	12.80	0.08	1.30	298
330	PV	12.80	0.08	1.31	298
331	PV	12.80	0.08	1.34	298
332	PV	12.80	0.08	1.40	298
333	PV	12.80	0.08	1.60	298
334	PV	12.80	0.08	1.60	298
335	PV	12.80	0.08	1.62	298
336	PV	12.80	0.08	1.79	298
337	PV	12.80	0.08	1.85	298
338	PV	12.80	0.08	1.85	298
339	PV	12.80	0.08	1.85	298
340	PV	12.80	0.08	1.85	298

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
341	PV	12.80	0.08	1.85	298
342	PV	12.80	0.09	1.85	298
343	PV	12.80	0.09	1.85	298
344	PV	12.80	0.09	1.85	298
345	PV	12.80	0.09	1.85	298
346	PV	12.80	0.09	1.85	298
347	PV	12.80	0.09	1.85	298
348	PV	13.11	0.09	1.85	298
349	PV	13.11	0.09	1.85	298
350	PV	13.11	0.09	1.85	298
351	PV	13.11	0.09	1.92	298
352	PV	13.11	0.09	2.00	298
353	PV	13.72	0.09	2.00	298
354	PV	13.72	0.09	2.00	298
355	PV	13.72	0.09	2.00	298
356	PV	14.60	0.09	2.00	298
357	PV	14.93	0.09	2.00	298
358	PV	14.93	0.09	2.00	298
359	PV	14.93	0.09	2.00	298
360	PV	14.93	0.09	2.08	298
361	PV	15.20	0.09	2.08	298
362	PV	15.20	0.09	2.11	298
363	PV	15.20	0.09	2.14	298
364	PV	15.24	0.09	2.16	298
365	PV	15.24	0.09	2.21	298
366	PV	15.50	0.09	2.21	298
367	PV	15.54	0.09	2.26	298
368	PV	15.85	0.09	2.29	298
369	PV	15.85	0.09	2.31	298
370	PV	16.50	0.09	2.50	298
371	PV	16.76	0.09	2.54	298
372	PV	16.76	0.10	2.54	298
373	PV	18.28	0.10	2.54	298
374	PV	18.28	0.10	2.54	298
375	PV	18.29	0.10	2.54	298
376	PV	18.29	0.10	2.54	298
377	PV	18.29	0.10	2.54	298
378	PV	18.29	0.10	2.54	298
379	PV	18.29	0.10	2.54	298
380	PV	18.29	0.10	2.54	298
381	PV	18.29	0.10	2.54	298
382	PV	18.29	0.10	2.54	298
383	PV	18.29	0.10	2.54	298
384	PV	18.29	0.10	2.61	298
385	PV	18.29	0.10	2.79	298

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
386	PV	18.29	0.10	2.89	298
387	PV	18.29	0.10	2.91	298
388	PV	18.29	0.10	2.95	298
389	PV	18.29	0.10	3.02	298
390	PV	18.29	0.10	3.08	298
391	PV	18.29	0.10	3.30	298
392	PV	18.29	0.10	3.30	298
393	PV	18.29	0.10	3.33	298
394	PV	18.29	0.10	3.33	298
395	PV	18.29	0.10	3.34	298
396	PV	18.29	0.10	3.36	298
397	PV	18.29	0.10	3.47	298
398	PV	18.29	0.10	4.17	298
399	PV	18.29	0.10	4.48	298
400	PV	18.29	0.10	4.62	298
401	PV	18.29	0.10	4.70	298
402	PV	18.29	0.10	4.70	298
403	PV	18.29	0.10	5.04	298
404	PV	18.29	0.10	5.48	298
405	PV	18.30	0.10	5.55	298
406	PV	18.30	0.10	5.55	298
407	PV	18.30	0.10	5.55	298
408	PV	18.30	0.10	5.55	298
409	PV	18.30	0.10	5.78	298
410	PV	18.30	0.10	5.86	298
411	PV	18.30	0.10	5.89	299
412	PV	18.30	0.10	5.89	299
413	PV	18.30	0.10	7.42	299
414	PV	18.30	0.10	7.42	299
415	PV	18.30	0.10	7.52	299
416	PV	18.30	0.10	7.69	299
417	PV	18.30	0.10	8.01	299
418	PV	18.30	0.10	8.24	299
419	PV	18.30	0.10	8.62	299
420	PV	18.30	0.10	8.62	299
421	PV	18.30	0.10	8.62	299
422	PV	18.30	0.10	8.62	299
423	PV	18.30	0.10	8.62	299
424	PV	18.30	0.10	9.18	299
425	PV	18.30	0.15	9.29	299
426	PV	18.30	0.15	10.00	299
427	PV	18.30	0.15	10.06	299
428	PV	18.30	0.15	10.16	299
429	PV	18.30	0.15	10.16	299
430	PV	18.30	0.15	10.16	299

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
431	PV	18.30	0.15	10.16	299
432	PV	18.30	0.15	10.16	299
433	PV	18.30	0.15	10.16	299
434	PV	18.30	0.15	10.16	299
435	PV	18.90	0.15	10.16	299
436	PV	18.90	0.15	10.16	299
437	PV	19.20	0.15	10.62	299
438	PV	19.40	0.15	10.69	299
439	PV	19.40	0.15	10.73	300
440	PV	19.40	0.15	10.98	300
441	PV	19.40	0.15	11.56	300
442	PV	19.40	0.15	11.56	300
443	PV	19.40	0.15	11.60	300
444	PV	19.50	0.16	11.79	300
445	PV	19.50	0.18	12.22	300
446	PV	20.70	0.18	14.00	300
447	PV	20.70	0.18	14.54	300
448	PV	20.70	0.18	17.16	300
449	PV	20.70	0.18	18.31	300
450	PV	20.70	0.18	18.31	300
451	PV	20.70	0.20	18.31	300
452	PV	20.70	0.20	20.70	300
453	PV	20.70	0.24	20.70	300
454	PV	20.70	0.24	20.90	300
455	PV	20.70	0.25	21.61	300
456	PV	20.70	0.25	26.00	300
457	PV	20.70	0.25	28.30	300
458	PV	20.70	0.25	41.63	300
459	PV	20.70	0.25	43.80	300
460	PV	20.70	0.31	46.20	300
461	PV	20.70	0.31	58.28	300
462	PV	20.70	0.34	76.28	300
463	PV	20.70	0.37	78.69	300
464	PV	20.70	0.46	90.57	300
465	PV	20.70	0.46	165.58	300
466	PV	20.70	0.46	165.58	300
467	PV	20.70	0.46	-	300
468	PV	20.70	0.46	-	300
469	PV	20.70	0.46	-	300
470	PV	20.73	0.51	-	300
471	PV	20.73	0.51	-	300
472	PV	21.30	0.52	-	300
473	PV	21.30	0.52	-	300
474	PV	21.64	0.52	-	300
475	PV	21.64	0.52	-	301

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
476	PV	21.64	0.52	-	301
477	PV	21.64	0.52	-	301
478	PV	21.64	0.56	-	301
479	PV	21.64	0.61	-	301
480	PV	21.64	0.61	-	301
481	PV	21.64	0.61	-	301
482	PV	22.10	0.61	-	302
483	PV	22.10	0.61	-	302
484	PV	22.10	0.61	-	302
485	PV	22.10	0.61	-	303
486	PV	22.10	0.61	-	303
487	PV	22.10	0.66	-	303
488	PV	22.10	1.01	-	303
489	PV	22.10	1.16	-	303
490	PV	22.10	1.17	-	303
491	PV	22.86	1.17	-	303
492	PV	22.86	1.17	-	303
493	PV	22.86	1.17	-	303
494	PV	22.86	1.17	-	303
495	PV	22.86	1.17	-	303
496	PV	22.86	1.17	-	303
497	PV	22.86	1.17	-	303
498	PV	22.86	1.17	-	303
499	PV	22.86	1.17	-	303
500	PV	22.86	1.17	-	303
501	PV	22.86	1.17	-	303
502	PV	22.86	1.17	-	303
503	PV	22.86	1.17	-	303
504	PV	22.86	1.17	-	303
505	PV	22.86	1.17	-	305
506	PV	22.86	1.17	-	305
507	PV	22.90	1.17	-	305
508	PV	22.90	1.17	-	305
509	PV	22.90	1.17	-	305
510	PV	22.90	1.17	-	305
511	PV	22.90	1.17	-	308
512	PV	22.90	1.17	-	308
513	PV	22.90	1.17	-	308
514	PV	22.90	1.17	-	308
515	PV	22.90	1.17	-	309
516	PV	22.90	1.17	-	311
517	PV	22.90	1.17	-	315
518	PV	22.90	1.52	-	316
519	PV	22.90	1.52	-	323
520	PV	24.38	1.52	-	323

TABLE G-2. SUMMARY OF EMISSION PARAMETERS FOR
PHARMACEUTICAL PROCESSES.

(SORTED IN ASCENDING ORDER FOR EACH EMISSION TYPE)

RANK	EMISSION TYPE	HEIGHT (m)	DIAMETER (m)	VELOCITY (m/s)	TEMP (K)
521	PV	24.38	1.52	-	325
522	PV	24.38	1.52	-	339
523	PV	24.38	1.52	-	339
524	PV	24.38	2.00	-	339
525	PV	24.38	2.00	-	339
526	PV	24.38	2.00	-	363
527	PV	24.38	2.00	-	363
528	PV	24.38	3.66	-	363
529	PV	24.38	3.66	-	363
530	PV	24.40	-	-	363
531	PV	27.00	-	-	373
532	PV	27.00	-	-	373
533	PV	27.00	-	-	373
534	PV	27.43	-	-	-
1	H	8.84	-	-	-
1	EO	0.31	0.15	2.59	-
2	EO	1.00	0.20	9.02	-
3	EO	2.50	0.20	15.01	-
4	EO	4.57	0.20	18.17	-
5	EO	4.57	0.20	18.17	-
6	EO	4.60	0.20	18.17	-
7	EO	6.10	0.20	18.17	-
8	EO	6.10	0.31	18.17	-
9	EO	9.14	0.51	18.17	-
10	EO	10.67	0.58	-	-
11	EO	11.60	0.61	-	-
12	EO	12.19	0.71	-	-
13	EO	12.19	1.22	-	-
14	EO	12.80	1.52	-	-
15	EO	14.60	0.00	-	-
16	EO	14.60	0.00	-	-
17	EO	18.28	-	-	-
18	EO	18.28	-	-	-
19	EO	22.86	-	-	-

ST=STORAGE
PV=PROCESS
S2=SECONDARY
H=HANDLING
EO=EQUIPMENT OPENING
EL=EQUIPMENT LEAK
AR=ACCIDENTAL RELEASE

A "-" INDICATES THAT DATA WERE NOT PROVIDED BY THE FACILITY.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 450/3-87-020 (Sep 1987)		2.	3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Summary of Continuous Emissions Data Collected from Seven Source Categories Producing or Using Hazardous Organic Compounds			5. REPORT DATE March 1987	
			6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S) R. Howle, G. Bockol, J. Martinez, E. Epner, Radian Corp. M. Meech, OAQPS/ESED/CPB			8. PERFORMING ORGANIZATION REPORT NO. 87-231-020-35-07	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Radian Corporation Post Office Box 13000 Research Triangle Park, N.C. 27709			10. PROGRAM ELEMENT NO.	
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12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Emission Standards and Engineering Division Chemicals and Petroleum Branch, RTP, NC 27711			13. TYPE OF REPORT AND PERIOD COVERED December 1986 - March 1987	
			14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES				
16. ABSTRACT This report presents a complete summary of the continuous emissions data collected by the Environmental Protection Agency (EPA) under the authority of Section 114 of the Clean Air Act (CAA). Continuous emissions data were collected for the production and use of eight potentially hazardous organic compounds: (1) butadiene, (2) ethylene dichloride, (3) ethylene oxide, (4) chloroform, (5) carbon tetrachloride, (6) methylene chloride, (7) perchloroethylene, and (8) trichloroethylene. Emissions data for these eight pollutants were gathered during the period 1984-1986. These chemicals and data are reported into seven source categories that best describe the scope of use of these chemicals.				
17. KEY WORDS AND DOCUMENT ANALYSIS				
a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS		c. COSATI Field/Group
Butadiene Carbon Tetrachloride Chloroform Continuous Emissions Ethylene Dichloride Ethylene Oxide Methylene Chloride		Perchloroethylene Trichloroethylene Air Pollution Continuous Emissions Hazardous Organic Compounds		
18. DISTRIBUTION STATEMENT Unlimited		19. SECURITY CLASS (This Report) Unclassified		21. NO. OF PAGES
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