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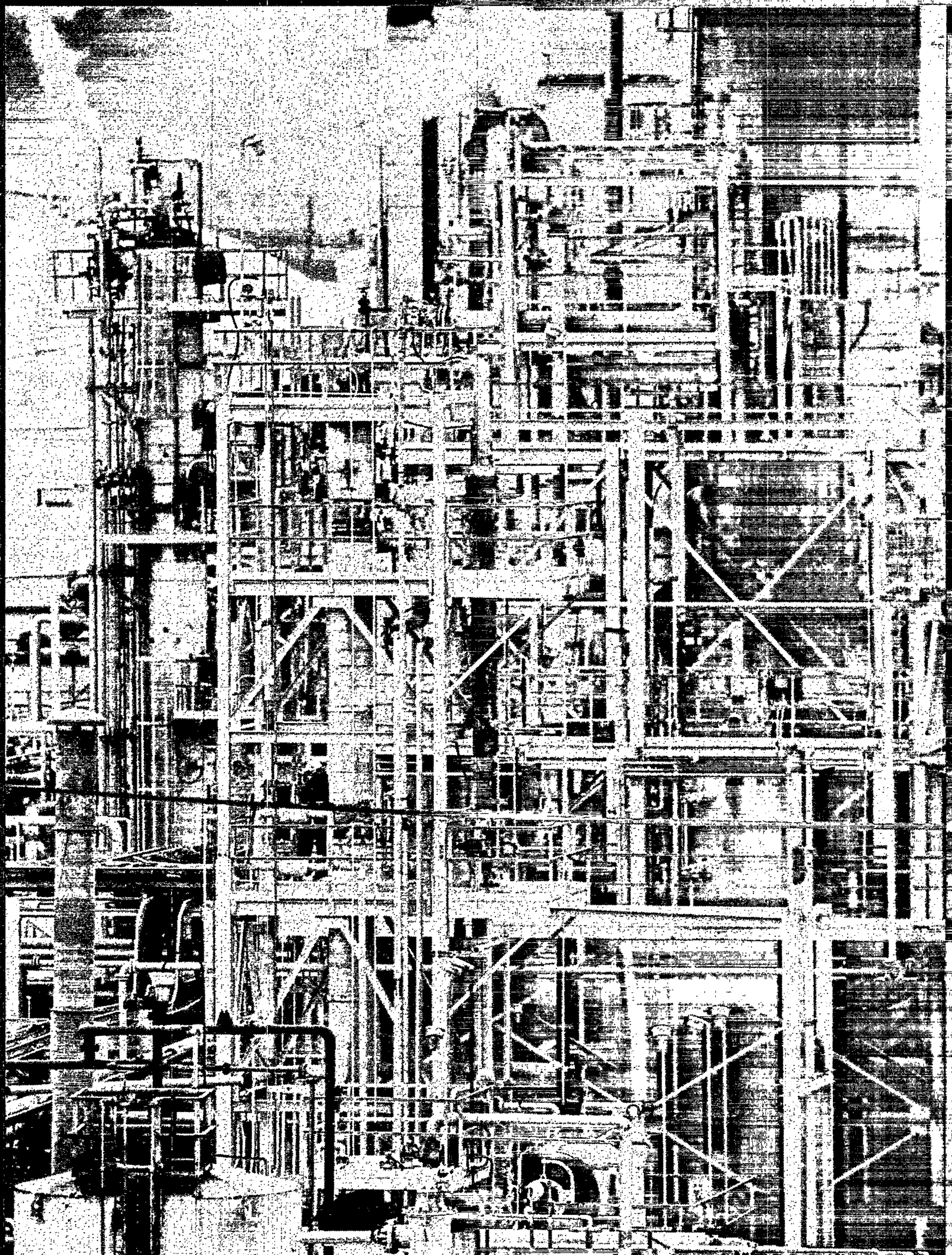
September 1995

EPA

Profile Of The Organic Chemicals Industry



SECTOR NOTEBOOKS

EPA Office Of Compliance Sector Notebook Project

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE ADMINISTRATOR

Message from the Administrator

Over the past 25 years, our nation has made tremendous progress in protecting public health and our environment while promoting economic prosperity. Businesses as large as iron and steel plants and businesses as small as the dry cleaner on the corner have worked with EPA to find ways to operate cleaner, cheaper, and smarter. As a result, we no longer have rivers catching on fire. Our skies are clearer. American environmental technology and expertise are in demand throughout the world.

The Clinton Administration recognizes that to continue this progress, we must move beyond the pollutant-by-pollutant approaches of the past to comprehensive, facility-wide approaches for the future. Industry by industry and community by community, we must build a new generation of environmental protection.

Within the past two years, the Environmental Protection Agency undertook its Sector Notebook Project to compile, for a number of key industries, information about environmental problems and solutions, case studies and tips about complying with regulations. We called on industry leaders, state regulators, and EPA staff with many years of experience in these industries and with their unique environmental issues. Together with notebooks for 17 other industries, the notebook you hold in your hand is the result.

These notebooks will help business managers to better understand their regulatory requirements, learn more about how others in their industry have undertaken regulatory compliance and the innovative methods some have found to prevent pollution in the first instance. These notebooks will give useful information to state regulatory agencies moving toward industry-based programs. Across EPA we will use this manual to better integrate our programs and improve our compliance assistance efforts.

I encourage you to use this notebook to evaluate and improve the way that together we achieve our important environmental protection goals. I am confident that these notebooks will help us to move forward in ensuring that -- in industry after industry, community after community -- environmental protection and economic prosperity go hand in hand.

Carol M. Browner

EPA/310-R-95-012

EPA Office of Compliance Sector Notebook Project

Profile of the Organic Chemical Industry

September 1995

Office of Compliance
Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency
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Washington, DC 20460

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This report is one in a series of volumes published by the U.S. Environmental Protection Agency (EPA) to provide information of general interest regarding environmental issues associated with specific industrial sectors. The documents were developed under contract by Abt Associates (Cambridge, MA), and Booz-Allen & Hamilton, Inc. (McLean, VA). This publication may be **purchased** from the Superintendent of Documents, U.S. Government Printing Office. A listing of available Sector Notebooks and document numbers is included at the end of this document.

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Complimentary volumes are available to certain groups or subscribers, such as public and academic libraries, Federal, State, local, and foreign governments, and the media. For further information, and for answers to questions pertaining to these documents, please refer to the contact names and numbers provided within this volume.

Electronic versions of all Sector Notebooks are available on the EPA Enviroene Bulletin Board and via the Internet on the Enviroene World Wide Web. Downloading procedures are described in Appendix A of this document.

Cover photograph by Steve Delaney, EPA. Photograph courtesy of Vista Chemicals, Baltimore, Maryland. Special thanks to Dave Mahler.

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EPA/310-R-95-003.	Wood Furniture and Fixtures Industry	Bob Marshall	564-7021
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EPA/310-R-95-006.	Lumber and Wood Products Industry	Seth Heminway	564-7017
EPA/310-R-95-007.	Fabricated Metal Products Industry	Scott Throwe	564-7013
EPA/310-R-95-008.	Metal Mining Industry	Keith Brown	564-7124
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Industry Sector Notebook Contents: Organic Chemicals

Exhibits Index

List of Acronyms

AFS -	AIRS Facility Subsystem (CAA database)
AIRS -	Aerometric Information Retrieval System (CAA database)
BIFs -	Boilers and Industrial Furnaces (RCRA)
BOD -	Biochemical Oxygen Demand
CAA -	Clean Air Act
CAAA -	Clean Air Act Amendments of 1990
CERCLA -	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS -	CERCLA Information System
CFCs -	Chlorofluorocarbons
CO -	Carbon Monoxide
COD -	Chemical Oxygen Demand
CSI -	Common Sense Initiative
CWA -	Clean Water Act
D&B -	Dun and Bradstreet Marketing Index
ELP -	Environmental Leadership Program
EPA -	United States Environmental Protection Agency
EPCRA -	Emergency Planning and Community Right-to-Know Act
FIFRA -	Federal Insecticide, Fungicide, and Rodenticide Act
FINDS -	Facility Indexing System
HAPs -	Hazardous Air Pollutants (CAA)
HSDB -	Hazardous Substances Data Bank
IDEA -	Integrated Data for Enforcement Analysis
LDR -	Land Disposal Restrictions (RCRA)
LEPCs -	Local Emergency Planning Committees
MACT -	Maximum Achievable Control Technology (CAA)
MCLGs -	Maximum Contaminant Level Goals
MCLs -	Maximum Contaminant Levels
MEK -	Methyl Ethyl Ketone
MSDSs -	Material Safety Data Sheets
NAAQS -	National Ambient Air Quality Standards (CAA)
NAFTA -	North American Free Trade Agreement
NCDB -	National Compliance Database (for TSCA, FIFRA, EPCRA)
NCP -	National Oil and Hazardous Substances Pollution Contingency Plan
NEIC -	National Enforcement Investigation Center
NESHAP -	National Emission Standards for Hazardous Air Pollutants
NO_2 -	Nitrogen Dioxide
NOV -	Notice of Violation
NO_x -	Nitrogen Oxides
NPDES -	National Pollution Discharge Elimination System (CWA)
NPL -	National Priorities List
NRC -	National Response Center

NSPS - New Source Performance Standards (CAA)
OAR - Office of Air and Radiation
OECA - Office of Enforcement and Compliance Assurance
OPA - Oil Pollution Act
OPPTS - Office of Prevention, Pesticides, and Toxic Substances
OSHA - Occupational Safety and Health Administration
OSW - Office of Solid Waste
OSWER - Office of Solid Waste and Emergency Response
OW - Office of Water
P2 - Pollution Prevention
PCS - Permit Compliance System (CWA Database)
POTW - Publicly Owned Treatments Works
RCRA - Resource Conservation and Recovery Act
RCRIS - RCRA Information System
SARA - Superfund Amendments and Reauthorization Act
SDWA - Safe Drinking Water Act
SEPs - Supplementary Environmental Projects
SERCs - State Emergency Response Commissions
SIC - Standard Industrial Classification
SO_2 - Sulfur Dioxide
SO_x - Sulfur Oxides
TOC - Total Organic Carbon
TRI - Toxic Release Inventory
TRIS - Toxic Release Inventory System
TCRIS - Toxic Chemical Release Inventory System
TSCA - Toxic Substances Control Act
TSS - Total Suspended Solids
UIC - Underground Injection Control (SDWA)
UST - Underground Storage Tanks (RCRA)
VOCs - Volatile Organic Compounds

I. INTRODUCTION TO THE SECTOR NOTEBOOK PROJECT

I.A. Summary of the Sector Notebook Project

Environmental policies based upon comprehensive analysis of air, water and land pollution are an inevitable and logical supplement to traditional single-media approaches to environmental protection. Environmental regulatory agencies are beginning to embrace comprehensive, multi-statute solutions to facility permitting, enforcement and compliance assurance, education/ outreach, research, and regulatory development issues. The central concepts driving the new policy direction are that pollutant releases to each environmental medium (air, water and land) affect each other, and that environmental strategies must actively identify and address these inter-relationships by designing policies for the "whole" facility. One way to achieve a whole facility focus is to design environmental policies for similar industrial facilities. By doing so, environmental concerns that are common to the manufacturing of similar products can be addressed in a comprehensive manner. Recognition of the need to develop the industrial "sector based" approach within the EPA Office of Compliance led to the creation of this document. Many of those who reviewed this notebook are listed as contacts in Section IX and may be sources of additional information. The individuals and groups on this list do not necessarily concur with all statements within this notebook.

The Sector Notebook Project was initiated by the Office of Compliance within the Office of Enforcement and Compliance Assurance (OECA) to provide its staff and managers with summary information for eighteen specific industrial sectors. As other EPA offices, states, the regulated community, environmental groups, and the public became interested in this project, the scope of the original project was expanded. The ability to design comprehensive, common sense environmental protection measures for specific industries is dependent on knowledge of several inter-related topics. For the purposes of this project, the key elements chosen for inclusion are: general industry information (economic and geographic); a description of industrial processes; pollution outputs; pollution prevention opportunities; Federal statutory and regulatory framework; compliance history; and a description of partnerships that have been formed between regulatory agencies, the regulated community and the public.

For any given industry, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue, and references if more in-depth information is available. The contents of each profile were researched from a variety of sources, and were usually condensed from more detailed sources. This approach allowed for a wide coverage of activities that can be further explored based upon the citations and references listed at the end of this profile. As a check on the information included, each notebook went through an external review process. The Office of Compliance appreciates the efforts of all those that participated in this process which enabled us to develop more complete, accurate and up-to-date summaries.

I.B. Additional Information

Providing Comments

OECA's Office of Compliance plans to periodically review and update the notebooks and will make these updates available both in hard copy and electronically. If you have any comments on the existing notebook, or if you would like to provide additional information, please send a hard copy and computer disk to the EPA Office of Compliance, Sector Notebook Project, 401 M St., SW (2223-A), Washington, DC 20460. Comments can also be uploaded to the Enviroene Bulletin Board or the Enviroene World Wide Web for general access to all users of the system. Follow instructions in Appendix A for accessing these data systems. Once you have logged in, procedures for uploading text are available from the on-line Enviroene Help System.

Adapting Notebooks to Particular Needs

The scope of the existing notebooks reflect an approximation of the relative national occurrence of facility types that occur within each sector. In many instances, industries within specific geographic regions or states may have unique characteristics that are not fully captured in these profiles. For this reason, the Office of Compliance encourages state and local environmental agencies and other groups to supplement or re-package the information included in this notebook to include more specific industrial and regulatory information that may be available. Additionally, interested states may want to supplement the "Summary of Applicable Federal Statutes and Regulations" section with state and local requirements. Compliance or technical assistance providers may also want to develop the "Pollution Prevention" section in more detail. Please contact the appropriate specialist listed on the opening page of this notebook if your office is interested in assisting us in the further development of the information or policies addressed within this volume.
If you are interested in assisting in the development of new notebooks for sectors not covered in the original eighteen, please contact the Office of Compliance at 202-564-2395.

II. INTRODUCTION TO THE ORGANIC CHEMICALS INDUSTRY

This section provides background information on the size, geographic distribution, employment, production, sales, and economic condition of the organic chemical industry. The type of facilities described within the document are also described in terms of their Standard Industrial Classification (SIC) codes. Additionally, this section contains a list of the largest companies in terms of sales.

II.A. Introduction, Background, and Scope of the Notebook

The industrial organic chemical sector produces organic chemicals (those containing carbon) used as either chemical intermediates or end-products. This categorization corresponds to Standard Industrial Classification (SIC) code 286 established by the Bureau of Census to track the flow of goods and services within the economy. The 286 category includes gum and wood chemicals (SIC 2861), cyclic organic crudes and intermediates, organic dyes and pigments (SIC 2865), and industrial organic chemicals not elsewhere classified (SIC 2869). By this definition, the industry does not include plastics, drugs, soaps and detergents, agricultural chemicals or paints, and allied products which are typical end-products manufactured from industrial organic chemicals. In 1993, there were 987 establishments in SIC 286 of which the largest 53 firms (by employment) accounted for more than 50 percent of the industry's value of shipments. The SIC 286 may include a small number of integrated firms that are also engaged in petroleum refining and manufacturing of other types of chemicals at the same site although firms primarily engaged in manufacturing coal tar crudes or petroleum refining are classified elsewhere.[a]

The industrial organic chemical market has two broadly defined categories, commodity and specialty. Commodity chemical manufacturers compete on price and produce large volumes of small sets of chemicals using dedicated equipment with continuous and efficient processing. Specialty chemical manufacturers cater to custom markets, manufacture a diverse set of chemicals, use two or three different reaction steps to produce a product, tend to use batch processes, compete on technological expertise and have a greater value added to their products. Commodity chemical manufacturers have lower labor requirements per volume and require less professional labor per volume.

[a] Variations in facility counts occur across data sources due to many factors including reporting and definitional differences. This notebook does not attempt to reconcile these differences, but rather reports the data as they are maintained by each source.

The *1992 Census of Manufactures for Industrial Organic Chemicals* reports employment of 124,800 and a 1992 value of shipments of $64.6 billion. This value of shipments does not include organic chemicals manufactured for captive use within a facility or the value of other non-industrial organic chemical products manufactured by the same facility. It does, however, include intra-company transfers which are significant in this industry. By comparison, the 1992 value of shipments for inorganic chemicals totaled $27.3 billion with employment of 103,400 people. The 1992 value of shipments for the entire chemical industry (SIC 28) was $292.3 billion and employment totaled 850,000. According to *Chemical and Engineering News*, the production of industrial organic chemicals has increased by three percent per year between 1983 and 1993 while employment has fallen by one percent per year over the same period indicating an overall increase in productivity for the sector. The same source reports the industry employed 153,000 people in 1993 while shipping products valued at $60.9 billion.

The Department of Commerce reported that output in the industrial organic chemical market grew five percent between 1992 and 1993 and is expected to continue to grow at the same rate partially on the strength of increased demand and production of methyl tert-butyl ether, a fuel oxygenate.

II.B. Characterization of the Organic Chemicals Industry

II.B.1. Industry size and geographic distribution

Industrial organic chemical facilities have an unusual distribution when compared to downstream manufacturing facilities. Most significantly, a small number of very large facilities account for the majority of the industry's value of shipments. The *1992 Census of Manufactures* (Exhibit 1) showed that only 113 of the 986 industrial organic chemical facilities (11 percent) had more than 250 employees. However, these facilities accounted for almost 70 percent of the value of shipments for the industry; the largest 16 plants (greater than 1,000 employees) accounted for about 25 percent of the total value of shipments.

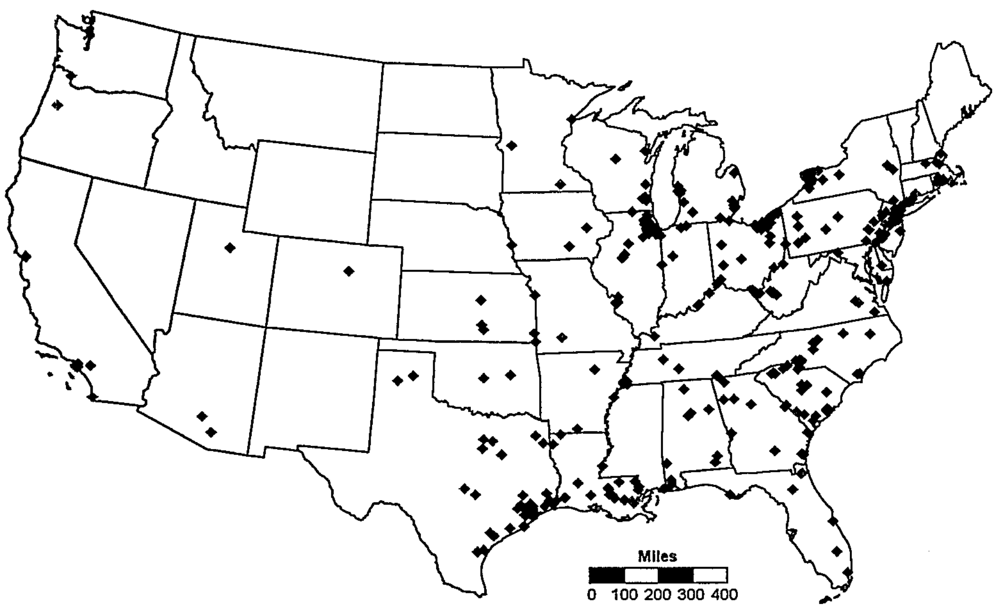
Exhibit 1: Small Number of Large Facilities Account for Majority of Shipments

Number of Employees	Number of Facilities	Percent of Facilities	Percent of Shipment Value
fewer than 10	259	26%	1%
10 to 49	301	30%	5%
50 to 249	313	32%	27%
250 to 499	60	6%	16%
500 to 999	37	4%	26%
1,000 or more	16	2%	25%
Total	986	100%	100%

Source: *1992 Census of Manufactures*

The industrial organic chemical sector is geographically diverse (Exhibit 2). Gum and wood chemical manufacture (SIC 2861) is concentrated in Missouri, Florida and Virginia. Cyclic crudes and intermediates (SIC 2865) and unclassified industrial organic chemicals (SIC 2869) are concentrated in Texas, Louisiana, New Jersey, Ohio, Illinois and West Virginia. Facility sites are typically chosen for their access to raw materials (petroleum and coal products for SICs 2865 and 2869 and wood for SIC 2861) and to transportation routes. In addition, because much of the market for industrial organic chemicals is the chemical industry, facilities tend to cluster near such end-users.

Exhibit 2: Organic Chemical Manufacturing Facilities (SIC 286)



(Source: U.S. EPA, Toxics Release Inventory Database, 1993)

Ward's Business Directory of U.S. Private and Public Companies, produced by Gale Research Inc., compiles financial data on U.S. companies including those operating within the organic chemical industry. Ward's ranks U.S. companies, whether they are a parent company, subsidiary or division, by sales volume within their assigned 4-digit SIC code. Readers should note that: (1) companies are assigned a 4-digit SIC that most closely resembles their principal industry; and (2) sales figures include total company sales, including subsidiaries and operations (not related to organic chemicals). Additional sources of company specific financial information include Standard & Poor's *Stock Report Services*, Dun & Bradstreet's *Million Dollar Directory,* Moody's Manuals, and annual reports.

Exhibit 3: Top U.S. Companies with Organic Chemical Operations

Rank[a]	Company[b]	1993 Sales (millions of dollars)
1	Exxon Corp., Exxon Chemical Co. - S. Darien, CT	9,591
2	Dow Chemical USA - Midland, MI	9,000
3	Miles, Inc. - Pittsburgh, PA	5,130
4	Union Carbide Corp. - Danbury, CT	4,877
5	Amoco Chemical Co. - Chicago, IL	4,031
6	Chevron Chemical Co. - San Ramon, CA	3,354
7	Quantum Chemical Corp. - New York, NY	2,532
8	Witco Corp. - New York, NY	1,631
9	Ethyl Corp. - Baton Rouge, LA	1,600
10	Texaco Chemical Co. - Houston, TX	1,600

Note: [a] When Ward's Business Directory lists both a parent and subsidiary in the top ten, only the parent company is presented above to avoid double counting. Not all sales can be attributed to the companies' organic chemical operations.
[b] Companies shown listed SIC 286 as primary activity.

Source: Ward's Business Directory of U.S. Private and Public Companies - 1993.

II.B.2. Product Characterization

The two-digit SIC code 28, Chemicals and Allied Products, includes facilities classified as industrial organic chemical manufacturers under the three-digit SIC code 286. This includes gum and wood chemicals, cyclic crudes and intermediates and industrial organic chemical not elsewhere classified. The last category is by far the largest and most diverse of the three; however, its size distribution and industry structure are similar to those of the cyclic crudes and intermediates because both use primarily petroleum and coal derived feedstocks. In addition to industrial organic chemicals, seven separate types of product establishments are identified under Chemicals and Allied Products (SIC 28). Many of the other industry sectors within the two-digit SIC code 28, such as plastics materials and synthetics (SIC 282), are downstream users of the products manufactured by the industrial organic chemical industry. Others, such as the inorganic chemical sector, utilize unrelated feedstocks.

The following list includes industrial organic chemicals (italicized) as well as other chemicals and allied product SIC codes included within SIC code 28.

SIC	Industry Sector	SIC	Industry Sector
281	Inorganic Chemicals	*2861*	*Gum and Wood Chemicals*
282	Plastics Materials and Synthetics	*2865*	*Cyclic Organic Chemicals*
283	Drugs	*2869*	*Industrial Organic Chemicals, n.e.c.*
284	Soaps, Cleaners, and Toilet Goods	287	Agricultural Chemicals
285	Paints and Allied Products	289	Miscellaneous Chemical Products

The industrial organic chemical industry uses feedstocks derived from petroleum and natural gas (about 90 percent) and from recovered coal tar condensates generated by coke production (about 10 percent). The chemical industry produces raw materials and intermediates, as well as a wide variety of finished products for industry, business and individual consumers. The important classes of products within SIC code 2861 are hardwood and softwood distillation products, wood and gum naval stores, charcoal, natural dyestuffs, and natural tanning materials.

The important classes of products within SIC code 2865 are: (1) derivatives of benzene, toluene, naphthalene, anthracene, pyridene, carbazole, and other cyclic chemical products, (2) synthetic organic dyes, (3) synthetic organic pigments, (4) cyclic (coal tar) crudes, such as light oils and light oil products; coal tar acids; and products of medium and heavy oil such as creosote oil, naphthalene, anthracene and their high homologues.

Important classes of chemicals produced by organic chemical industry facilities within SIC code 2869 include: (1) non-cyclic organic chemicals such as acetic, chloroacetic, adipic, formic, oxalic acids and their metallic salts, chloral, formaldehyde, and methylamine; (2) solvents such as amyl, butyl and ethyl alcohols; methanol; amyl, butyl, and ethyl acetates; ethyl ether, ethylene glycol ether and diethylene glycol ether; acetone, carbon disulfide, and chlorinated solvents such as carbon tetrachloride, tetrachloroethene, and trichloroethene; (3) polyhydric alcohols such as ethylene glycol, sorbitol, pentaerythritol, and synthetic glycerin; (4) synthetic perfumes and flavoring materials such as coumarin, methyl salicylate, saccharin, citral, citronellal, synthetic geraniol, ionone, terpineol, and synthetic vanillin; (5) rubber processing chemicals such as accelerators and antioxidants, both cyclic and acyclic; (6) plasticizers, both cyclic and acyclic, such as esters of phosphoric acid, phthalic anhydride, adipic acid, lauric acid, oleic acid, sebacic acid, and stearic acid; (7) synthetic tanning agents such as sulfonic acid condensates; and (8) esters and amines of polyhydric alcohols and fatty and other acids.

II.B.3. Economic trends

With organic chemicals as the single largest segment of chemical exports (accounting for nearly one-half of total chemical shipments to foreign markets), the industrial organic sector faces a market similar to the petrochemical industry. While the U.S. production is expected to continue to grow at two to four percent annually, there is increasing competition in the export market despite growing demand. World petrochemical demand is projected to increase from 320 million metric tons in 1992 to 575 million metric tons in 2010. The share accounted for by the United States, Western Europe and Japan is expected to drop from 71 to 63 percent. Products from the Gulf Cooperation Council and Pacific Rim countries, including China and Korea, will begin to compete with U.S. products in current export markets as new facilities are brought on-line. The U.S. is expected to maintain a positive trade balance in organic chemicals. Chemical imports of organic chemicals (some representing intra-company transfers) have been steady over the last five years. The reduced trade barriers due to the North American Free Trade Agreement (NAFTA) and the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) have increased competition. Firms are adapting to the increased competition by emphasizing specialty chemicals and higher value-added products.

III. INDUSTRIAL PROCESS DESCRIPTION

This section describes the major industrial processes within the organic chemical industry, including the materials and equipment used, and the processes employed. The section is designed for those interested in gaining a general understanding of the industry, and for those interested in the inter-relationship between the industrial process and the topics described in subsequent sections of this profile -- pollutant outputs, pollution prevention opportunities, and Federal regulations. This section does not attempt to replicate published engineering information that is available for this industry. Refer to Section IX for a list of reference documents that are available.

This section specifically contains a description of commonly used production processes, associated raw materials, the by-products produced or released, and the materials either recycled or transferred off-site. This discussion, coupled with schematic drawings of the identified processes, provides a concise description of where wastes may be produced in the process. This section also describes the potential fate (via air, water, and soil pathways) of these waste products.

III.A. Industrial Processes in the Organic Chemicals Industry

Industrial Organic Chemicals - Overview

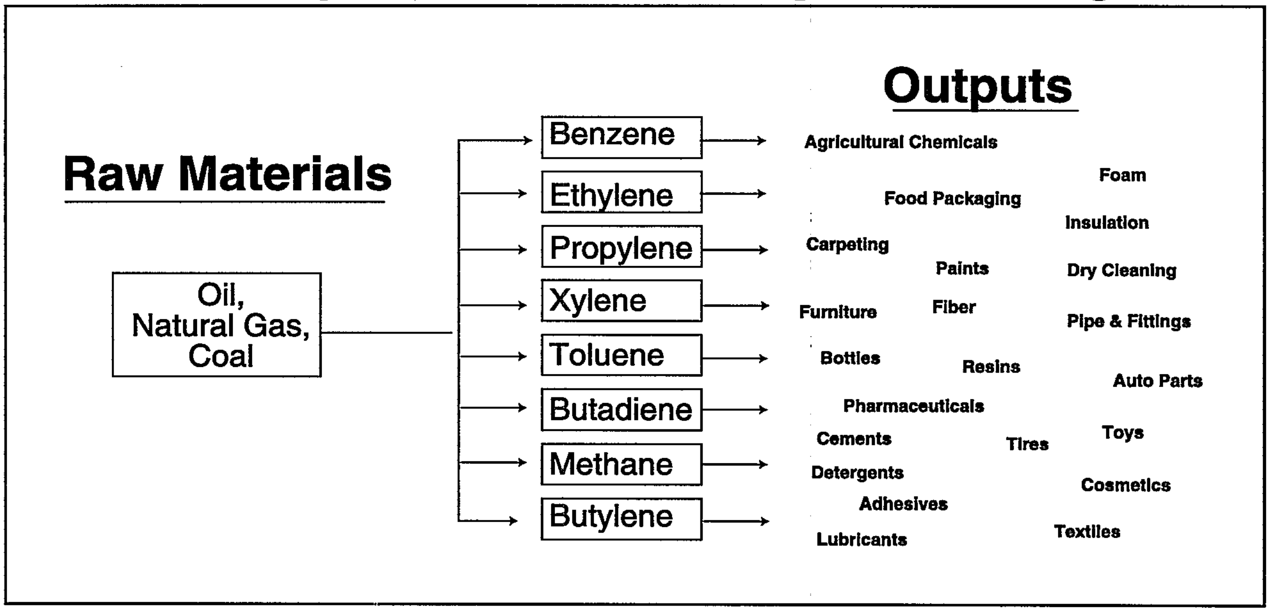
The industrial organic chemical sector includes thousands of chemicals and hundreds of processes. In general, a set of building blocks (feedstocks) is combined in a series of reaction steps to produce both intermediates and end-products. The chart and flow diagram below (Exhibits 4 and 5) show the primary organic chemical building blocks (generated principally from petroleum refining), a key subset of the large volume secondary building blocks and a set of large volume tertiary building blocks. The subsequent chart (Exhibit 6) shows the reaction types used to manufacture a sample of organic chemicals, and illustrates the large variety of processes used by the industry.

Exhibit 4: High Volume Organic Chemical Building Blocks

Primary Building Block	Secondary Building Block	Tertiary Building Block
Ethylene	Ethylene dichloride	Vinyl chloride
	Ethylene oxide	Ethylene glycol
	Ethylbenzene	Vinyl acetate
Propylene	Propylene oxide	
	Acrylonitrile	
	Isopropyl alcohol	Acetone
Benzene	Ethylbenzene	Styrene
	Cumene	Phenol
		Acetone
	Cyclohexane	Adipic acid
Methanol	Acetic acid	Vinyl acetate
	Formaldehyde	
	Methyl t-butyl ether	
Toluene		
Xylenes		
p-isomer	Terephthalic acid	
Butadiene		
Butylene		

Source: Szmant, *Organic Building Blocks of the Chemical Industry*

Exhibit 5: Organic Chemicals and Building Blocks Flow Diagram



The typical chemical synthesis process involves combining multiple feedstocks in a series of unit operations. The first unit operation is a chemical reaction. Commodity chemicals tend to be synthesized in a continuous reactor while specialty chemicals usually are produced in batches. Most reactions take place at high temperatures, involve metal catalysts, and include one or two additional reaction components. The yield of the reaction will partially determine the kind and quantity of by-products and releases. Many specialty chemicals require a series of two or three reaction steps. Once the reaction is complete, the desired product must be separated from the by-products by a second unit operation. A number of separation techniques such as settling, distillation or refrigeration may be used. The final product may be further processed, by spray drying or pelletizing for example, to produce the saleable item. Frequently by-products are also sold and their value may alter the process economics.

Exhibit 6: Reaction/Process Types by Chemical Category for a Sampling of Organic Chemicals

Generic Process	Ethers		Halocarbons			Hydrocarbons					Ketones	Nitrile
	Bis-1,2-Chloroisopropyl Ether	Ethylene Glycol Monomethyl Ether	Epichlorohydrin	Methyl Bromide	1,1,1-Trichloroethane	Butadiene	Hexane	Isoamylene	Styrene	Xylenes	Acetone	Acetonitrile
Alkoxylation		●										
Condensation	●											
Halogenation			●		●							
Oxidation												
Polymerization												
Hydrolysis												
Hydrogenation												
Esterification												
Pyrolysis								●		●	●	
Alkylation									●			
Dehydrogenation						●			●			
Amination (Ammonolysis)												
Nitration												
Sulfonation												
Ammoxidation												●
Carbonylation												
Hydrohalogenation				●								
Dehydration												
Dehydrohalogenation			●									
Oxyhalogenation					●							
Catalytic Cracking							●					
Hydrodealkylation										●		
Phosgenation												
Extraction						●		●				
Distillation						●		●				
Other											●	
Hydration												

Exhibit 6 (cont.): Reaction/Process Types by Chemical Category for a Sampling of Organic Chemicals

Generic Process	Nitro-Carbon	Phenol	Salt	Misc.		Acid	Alcohols		Alde-hyde	Amine	Amide	Anhy-drides	Ester
	Nitrobenzene	p-Aminophenol	Sodium Benzoate	Dichlorodiphenyl Sulfone	Methylene Diphenyl Diisocyanate	Sulfonic Acid	n-Butanol	1,6-Hexanediol	Benzaldehyde	Hydroxylamine	Formamide	Tetrachloroprophthalic Anhydride	Dimethyl Terephthalate
Alkoxylation													
Condensation					●								
Halogenation												●	
Oxidation			●					●	●			●	●
Polymerization													
Hydrolysis										●			
Hydrogenation		●					●	●					
Esterification								●					●
Pyrolysis													
Alkylation													
Dehydrogenation													
Amination (Ammonolysis)											●		
Nitration	●												
Sulfonation				●									
Ammoxidation													
Carbonylation						●			●				
Hydrohalogenation													
Dehydration												●	
Dehydrohalogenation													
Oxyhalogenation													
Catalytic Cracking													
Hydrodealkylation													
Phosgenation					●								
Extraction													
Distillation													
Other			●	●									
Hydration							●						

Source: U.S. Development Document for Effluent Limitations, Guidelines and Standards for the Organic Chemicals, Plastics and Synthetic Fibers Point Source Category

The separation technology employed depends on many factors including the phases of the substances being separated, the number of components in the mixture, and whether recovery of by-products is important. Numerous techniques such as distillation, extraction, filtration, and settling can be used singly or in combination to accomplish separations and are summarized in publications such as *Perry's Chemical Engineers' Handbook* or basic texts on chemical plant design.

Relatively few organic chemical manufacturing facilities are single product/process plants. Additionally, many process units are designed so that production levels of related products can be varied over wide ranges. This flexibility is required to accommodate variations in feedstock and product prices which can change the production rate and processes used, even on a short-term (less than a year) basis. A 1983 survey showed that 59 percent of industrial organic plants had more than one product or process and that seven percent had more than 20 (USEPA Development Document for Effluent Limitations Guidelines and Standards for the Organic Chemicals, Plastics and Synthetic Fibers Point Source Category).

The type of reaction process used to manufacture chemicals depends on the intended product; however, several types of reactions are common: polymerization, oxidation, and addition. Polymerization is a chemical reaction usually carried out with a catalyst, heat or light (often under high pressure) in which a large number of relatively simple molecules combine to form a chain-like macromolecule. Oxidation, in the strict sense, means combining oxygen chemically with another substance although this name is also applied to reactions where electrons are transferred. Addition covers a wide range of reactions where a double or triple bond is broken and a component added to the structure. Alkylation can be considered an addition, as can some oxidation reactions. The following charts list the reactions used to produce a subset of organic chemical products.

Four Specific Industrial Organic Chemicals

This profile examines the reactions of four high-volume chemicals (ethylene, propylene, benzene and vinyl chloride) chosen to illustrate the use of typical chemical feedstocks based on several factors, including the quantity of chemical produced, and the health and environmental impacts of the chemical. Ethylene, propylene, and benzene are all primary building blocks and their reaction products are used to produce still other chemicals. Vinyl chloride is an important tertiary building block.

The four chemicals described below illustrate several key points. First, primary building blocks are typically used in more reactions than the building blocks further down the chain. Second, most feedstocks can participate in more than one reaction and third, there is typically more than one reaction route to an end-product. The end-products of all of these chemicals can be used in numerous commercial applications; *Riegel's Handbook of Industrial Chemistry,* listed in the reference section, describes many uses.

Ethylene

The major uses for ethylene are in the synthesis of polymers (polyethylene) and in ethylene dichloride, a precursor to vinyl chloride. Other important products are ethylene oxide (a precursor to ethylene glycol) and ethylbenzene (a precursor to styrene). While ethylene itself is not generally considered a health threat, several of its derivatives, such as ethylene oxide and vinyl chloride, have been shown to cause cancer. The distribution of uses is shown below.

The manufacturing processes that use ethylene as a feedstock are summarized in the table below along with reaction conditions and components. In 1993, 18.8 million metric tons of ethylene were produced in the United States making ethylene the fourth largest production volume organic chemical in the United States. Ethylene dichloride, ethylbenzene, and ethylene oxide (products of ethylene reactions) are all among the top 50 high production volume organic chemicals in the United States (*Chemical and Engineering News*).

Exhibit 7: Distribution of Uses for Ethylene

Product	**Percent of Ethylene Use**
Polyethylene	54
Ethylene dichloride	16
Ethylbenzene-styrene	7
Ethylene oxide-glycol	13
Ethanol	1
Linear olefins-alcohol	3
Vinyl acetate	2
Other	4

Source: *Kirk-Othmer Encyclopedia of Chemical Technology*

Exhibit 8: Manufacturing Processes Using Ethylene

Process	Target Product	Process Conditions			Reaction Components	Other Characteristics
		Pressure (MPa)	Temperature (°C)	Catalyst		
Polymerization	Low Density Polyethylene (LDPE)	60 - 350	350		Oxygen or Peroxide	
	High Density Polyethylene	0.1 - 20	50 - 300	Molybdenum Chromium oxide		
	Polyethylene	Low		Aluminum alkyls Titanium oxide		
Oxidation	Ethylene Oxide	1 - 2	250 - 300	Silver	1,2-Dichloro-ethane, Oxygen	60% is converted to ethylene glycol using an acid catalyst
	Acetaldehyde	0.3	120 - 130	Copper chloride/ palladium chloride	Oxygen	Vapor phase
	Vinyl acetate	0.4 - 1	170 - 200	Palladium	Acetic acid	
Addition Halogenation\ hydrohalogenation	Ethylene dichloride		60	Iron, aluminum, copper, or antimony chlorides	Chlorine	Feedstock for vinyl chloride and trichloroethylene and tetrachloroethylene
	Ethyl chloride	0.3 - 0.5		Aluminum or iron chlorides	HCl	Precursor of styrene
Alkylation	Ethylbenzene			Aluminum, iron, and boron chlorides	Benzene	
Hydroformation	Propionaldehyde	4 - 35	60 - 200	Cobalt	Synthesis gas (carbon monoxide and hydrogen)	

Source: *Kirk-Othmer Encyclopedia of Chemical Technology*

Propylene

Over half of the U.S. propylene supplies (10.2 million metric tons produced in 1993) are used in the production of chemicals. The primary products are polypropylene, acrylonitrile, propylene oxide, and isopropyl alcohol. Of these, propylene, acrylonitrile and propylene oxide are among the top fifty high-volume chemicals produced in the United States. Acrylonitrile and propylene oxide have both been shown to cause cancer, while propylene itself is not generally considered a health threat. The table below shows the use distribution of propylene.

Exhibit 9: Distribution of Propylene Use

Product	Percent of Propylene Use
Polypropylene	36
Acrylonitrile	16
Propylene oxide	11
Cumene	9
Butyraldehydes	7
Oligomers	6
Isopropyl alcohol	6
Other	9

Source: Szmant, *Organic Building Blocks of the Chemical Industry*

The important propylene reactions are shown below. The products of the reactions are the feedstocks for numerous additional products.

Process	Target Product	Process Conditions			Reaction Components	Other Characteristics
		Pressure (MPa)	Temperature	Catalyst		
Polymerization	Polypropylene			Aluminum alkyls/Titanium oxide		
Oxidation	Acrylonitrile		400	Phosphomolybdate	Ammonia Oxygen	Commercially valuable by-products are acetonitrile and hydrogen cyanide
	Propylene oxide				Oxygen Ethylbenzene	Commercially valuable by-product is *tert*-butyl alcohol
Addition Chlorohydrination	Propylene oxide	25	37	Tungsten	Hypochlorous acid	
Hydrolysis	Isopropyl alcohol		267		Water	

Exhibit 10: Manufacturing Processes Using Propylene

Source: *Kirk-Othmer Encyclopedia of Chemical Technology*

Benzene

Benzene is an important intermediate in the manufacture of industrial chemicals and over 5.5 million metric tons were produced in the U.S. in 1993 (*Chemical and Engineering News*). Over 95 percent of U.S. consumption of benzene is for the preparation of ethylbenzene, cumene, cyclohexane, nitrobenzene, and various chlorobenzenes as shown in the table below.

Exhibit 11: Distribution of Benzene Use

Product	Percent of Benzene Use
Ethylbenzene	52
Cumene	22
Cyclohexane	14
Nitrobenzene	5
Chlorobenzenes	2
Linear detergent alkylate	2
Other	3

Source: *Kirk-Othmer Encyclopedia of Chemical Technology*

The following table summarizes the primary benzene reactions. The products are frequently feedstocks in the synthesis of additional chemicals. Benzene is considered a human carcinogen by the Agency.

Exhibit 12: Manufacturing Processes Using Benzene

Process	Target product	Process Conditions			Reaction components	Other characteristics
		Pressure (MPa)	Temperature (°C)	Catalyst		
Oxidation	Phenol	0.6	90-100		Cumene, Oxygen	Most important phenol synthesis
	Maleic anhydride	0.1-0.2	350-400	Vanadium oxide	Butane Oxygen	
	Styrene	0.1	580-590	Iron oxide	Ethylene benzene	
Addition Alkylation	Ethylbenzene	0.2-0.4	125-140	Aluminum chloride	Benzene, Ethylene	Precursor to styrene
	Ethylbenzene	2.0	420-430	Zeolite	Benzene, Ethylene	Precursor to styrene
	Cumene	0.3-1.0	250-350	Phosphoric acid/silicate	Benzene, Propylene	
	2,6-Xylenol	0.1-0.2	300-400	Aluminum oxide	Phenol, Methanol	
Hydrogenation	Cyclohexanone	0.1	140-170	Palladium	Phenol, Hydrogen	
	Cyclohexanol	1.0-2.0	120-200	Nickel/silicon oxide and aluminum oxide	Phenol Hydrogen	
	Cyclohexane	2.0-5.0	150-200	Nickel	Benzene, Hydrogen	
	Aniline	.18	270	Copper	Nitrobenzene, Hydrogen	
Nitration	Nitrobenzene	0.1	60		Benzene, sulfuric acid, nitric acid	
Sulfonation	Surfactants	0.1	40-50		Alkylbenezenes/ Sulfur trioxide	
Chlorination	Chlorobenzene	0.1	30-40	Aluminum chloride/ Iron chloride	Benzene, Chlorine	
Condensation	Biphenol A	0.1	50-90	HCl	Phenol, Acetone	

Source: *Franck and Stadelhofer, "Industrial Aromatic Chemistry"*

Vinyl Chloride

Vinyl chloride is one of the largest commodity chemicals in the U.S. with over 6.25 million metric tons produced in 1993. It is also considered a human carcinogen by the EPA. Vinyl chloride polymers are the primary end use but various vinyl ethers, esters, and halogen products can also be made as shown in the table below.

Exhibit 13: Manufacturing Processes Using Vinyl Chloride

Process	Target Product	Process Conditions			Reaction components	Other characteristics
		Pressure (MPa)	Temperature (°C)	Catalyst		
Polymerization	Polyvinylchloride		50	Peroxides		
Substitution at the Carbon-Chlorine Bond	Vinyl acetates, alcholates, vinyl esters and vinyl ethers			Palladium	Alkyl halides	
Addition	Various halogen addition products					

Source: *Kirk-Othmer Encyclopedia of Chemical Technology*

III.B. Raw Material Inputs and Pollution Outputs

Industrial organic chemical manufacturers use and generate both large numbers and quantities of chemicals. The industry emits chemicals to all media including air (through both fugitive and direct emissions), water (direct discharge and runoff) and land. The types of pollutants a single facility will release depend on the feedstocks, processes, equipment in use and maintenance practices. These can vary from hour to hour and can also vary with the part of the process that is underway. For example, for batch reactions in a closed vessel, the chemicals are more likely to be emitted at the beginning and end of a reaction step (associated with vessel loading and product transfer operations), than during the reaction. The potential sources of pollutant outputs by media are shown below.

Exhibit 14: Potential Releases During Organic Chemical Manufacturing

Media	Potential Sources of Emissions
Air	Point source emissions: stack, vent (e.g. laboratory hood, distillation unit, reactor, storage tank vent), material loading/unloading operations (including rail cars, tank trucks, and marine vessels) Fugitive emissions: pumps, valves, flanges, sample collection, mechanical seals, relief devices, tanks Secondary emissions: waste and wastewater treatment units, cooling tower, process sewer, sump, spill/leak areas
Liquid wastes (Organic or Aqueous)	Equipment wash solvent/water, lab samples, surplus chemicals, product washes/purifications, seal flushes, scrubber blowdown, cooling water, steam jets, vacuum pumps, leaks, spills, spent/used solvents, housekeeping (pad washdown), waste oils/lubricants from maintenance
Solid Wastes	Spent catalysts, spent filters, sludges, wastewater treatment biological sludge, contaminated soil, old equipment/insulation, packaging material, reaction by-products, spent carbon/resins, drying aids
Ground Water Contamination	Unlined ditches, process trenches, sumps, pumps/valves/fittings, wastewater treatment ponds, product storage areas, tanks and tank farms, aboveground and underground piping, loading/unloading areas/racks, manufacturing maintenance facilities

Source: *Designing Pollution Prevention into the Process- Research, Development and Engineering*

III.C. Management of Chemicals in the Production Process

The Pollution Prevention Act of 1990 (PPA) requires facilities to report information about the management of TRI chemicals in waste and efforts made to eliminate or reduce those quantities. These data have been collected annually in Section 8 of the TRI reporting Form R beginning with the 1991 reporting year. The data summarized below cover the years 1992 through 1995 and is meant to provide a basic understanding of the quantities of waste handled by the industry, the methods typically used to manage this waste, and recent trends in these methods. TRI waste management data can be used to assess trends in source reduction within individual industries and facilities, and for specific TRI chemicals. This information could then be used as a tool in identifying opportunities for pollution prevention compliance assistance activities.

From the yearly data presented below it is apparent that the portion of TRI wastes reported as recycled on-site has remained reasonably constant between 1992 and 1995 (projected). While the quantities reported for 1992 and 1993 are estimates of quantities already managed, the quantities reported for 1994 and 1995 are projections only. The PPA requires these projections to encourage facilities to consider future waste generation and source reduction of those quantities as well as movement up the waste management hierarchy. Future-year estimates are not commitments that facilities reporting under TRI are required to meet.

Exhibit 15 shows that the organic chemical industry managed about 6.3 trillion pounds of production-related waste (total quantity of TRI chemicals in the waste from routine production operations) in 1993 (column B). Column C reveals that of this production-related waste, seven percent was either transferred off-site or released to the environment. Column C is calculated by dividing the total TRI transfers and releases by the total quantity of production-related waste. In other words, about 90 percent of the industry's TRI wastes were managed on-site through recycling, energy recovery, or treatment as shown in columns E, F and G, respectively. The majority of waste that is released or transferred off-site can be divided into portions that are recycled off-site, recovered for energy off-site, or treated off-site as shown in columns H, I and J, respectively. The remaining portion of the production related wastes (three percent), shown in column D, is either released to the environment through direct discharges to air, land, water, and underground injection, or it is disposed off-site.

Exhibit 15: Source Reduction and Recycling Activity for the Organic Chemical Industry (SIC 286) as Reported within TRI

A	B	C	D	On-Site			Off-Site		
				E	F	G	H	I	J
Year	Quantity of Production-Related Waste (10^6 lbs.)[a]	% Released and Transferred[b]	% Released and Disposed[c] Off-site	% Recycled	% Energy Recovery	% Treated	% Recycled	% Energy Recovery	% Treated
1992	6,313	7%	3%	71%	7%	15%	2%	1%	2%
1993	6,325	7%	3%	71%	7%	15%	2%	1%	1%
1994	6,712	---	2%	71%	8%	15%	2%	1%	1%
1995	6,645	---	2%	72%	7%	15%	2%	1%	<1%

[a] Within this industry sector, non-production related waste < 1% of production related wastes for 1993.
[b] Total TRI transfers and releases as reported in Section 5 and 6 of Form R as a percentage of production related wastes.
[c] Percentage of production related waste released to the environment and transferred off-site for disposal.

IV. CHEMICAL RELEASE AND TRANSFER PROFILE

The following is a synopsis of current scientific toxicity and fate information for the top chemicals (by weight) that facilities within this sector self-reported as released to the environment based upon 1993 TRI data. Because this section is based upon self-reported release data, it does not attempt to provide information on management practices employed by the sector to reduce the release of these chemicals. Information regarding pollutant release reductions over time may be available from EPA's TRI and 33/50 programs, or directly from the industrial trade associations that are listed in Section IX of this document. Since these descriptions are cursory, please consult the sources referenced below for a more detailed description of both the chemicals described in this section and the chemicals that appear on the full list of TRI chemicals appearing in Section IV.A.

This section is designed to provide background information on the pollutant releases that are reported by this industry. The best source of comparative pollutant release information is the Toxic Release Inventory System (TRI). Pursuant to the Emergency Planning and Community Right-to-Know Act, TRI includes self-reported facility release and transfer data for over 600 toxic chemicals. Facilities within SIC Codes 20 through 39 (manufacturing industries) that have more than 10 employees, and that are above weight-based reporting thresholds are required to report TRI on-site releases and off-site transfers. The information presented within the sector notebooks is derived from the most recently available (1993) TRI reporting year (which then included 316 chemicals), and focuses primarily on the on-site releases reported by each sector. Because TRI requires consistent reporting regardless of sector, it is an excellent tool for drawing comparisons across industries. TRI data provide the type, amount and media receptor of each chemical released or transferred.

Although this sector notebook does not present historical information regarding TRI chemical releases over time, please note that in general, toxic chemical releases have been declining. In fact, according to the 1993 Toxic Release Inventory Data Book, reported releases dropped by 43 percent between 1988 and 1993. Although on-site releases have decreased, the total amount of reported toxic waste has not declined because the amount of toxic chemicals transferred off-site has increased. Transfers have increased from 3.7 billion pounds in 1991 to 4.7 billion pounds in 1993. Better management practices have led to increases in off-site transfers of toxic chemicals for recycling. More detailed information can be obtained from EPA's annual Toxics Release Inventory Public Data Release book (which is available through the EPCRA Hotlines at 800-535-0202), or directly from the Toxic Release Inventory System database (for user support call 202-260-1531).

Wherever possible, the sector notebooks present TRI data as the primary indicator of chemical release within each industrial category. TRI data provide the type, amount and media receptor of each chemical released or transferred. When other sources of pollutant release data have been obtained, these data have been included to augment the TRI information.

TRI Data Limitations

The reader should keep in mind the following limitations regarding TRI data. Within some sectors, the majority of facilities are not subject to TRI reporting because they are not considered manufacturing industries, or because they are below TRI reporting thresholds. Examples are the mining, dry cleaning, printing, and transportation equipment cleaning sectors. For these sectors, release information from other sources has been included.

The reader should also be aware that TRI "pounds released" data presented within the notebooks is not equivalent to a "risk" ranking for each industry. Weighting each pound of release equally does not factor in the relative toxicity of each chemical that is released. The Agency is in the process of developing an approach to assign toxicological weightings to each chemical released so that one can differentiate between pollutants with significant differences in toxicity. As a preliminary indicator of the environmental impact of the industry's most commonly released chemicals, this notebook briefly summarizes the toxicological properties of the top five chemicals (by weight) reported by the organic chemical industry.

Definitions Associated with Section IV Data Tables

General Definitions

SIC Code -- is the Standard Industrial Classification (SIC) is a statistical classification standard used for all establishment-based Federal economic statistics. The SIC codes facilitate comparisons between facility and industry data.

TRI Facilities -- are manufacturing facilities that have 10 or more full-time employees and are above established chemical throughput thresholds. Manufacturing facilities are defined as facilities in Standard Industrial Classification primary codes 20 through 39. Facilities must submit estimates for all chemicals that are on the EPA's defined list and are above throughput thresholds.

Data Table Column Heading Definitions

The following definitions are based upon standard definitions developed by EPA's Toxic Release Inventory Program. The categories below represent the possible pollutant destinations that can be reported.

RELEASES -- are an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, releases at the facility to land, as well as contained disposal into underground injection wells.

Releases to Air (Point and Fugitive Air Emissions) -- Include all air emissions from industry activity. Point emissions occur through confined air streams as found in stacks, ducts, or pipes. Fugitive emissions include losses from equipment leaks, or evaporative losses from impoundments, spills, or leaks.

Releases to Water (Surface Water Discharges) -- encompass any releases going directly to streams, rivers, lakes, oceans, or other bodies of water. Any estimates for storm water runoff and non-point losses must also be included.

Releases to Land -- includes disposal of toxic chemicals in waste to on-site landfills, land treated or incorporation into soil, surface impoundments, spills, leaks, or waste piles. These activities must occur within the facility's boundaries for inclusion in this category.

Underground Injection -- is a contained release of a fluid into a subsurface well for the purpose of waste disposal.

TRANSFERS -- is a transfer of toxic chemicals in wastes to a facility that is geographically or physically separate from the facility reporting under TRI. The quantities reported represent a movement of the chemical away from the reporting facility. Except for off-site transfers for disposal, these quantities do not necessarily represent entry of the chemical into the environment.

Transfers to POTWs -- are waste waters transferred through pipes or sewers to a publicly owned treatments works (POTW). Treatment and chemical removal depend on the chemical's nature and treatment methods used. Chemicals not treated or destroyed by the POTW are generally released to surface waters or land filled within the sludge.

Transfers to Recycling -- are sent off-site for the purposes of regenerating or recovering still valuable materials. Once these chemicals have been recycled, they may be returned to the originating facility or sold commercially.

Transfers to Energy Recovery -- are wastes combusted off-site in industrial furnaces for energy recovery. Treatment of a chemical by incineration is not considered to be energy recovery.

Transfers to Treatment -- are wastes moved off-site for either neutralization, incineration, biological destruction, or physical separation. In some cases, the chemicals are not destroyed but prepared for further waste management.

Transfers to Disposal -- are wastes taken to another facility for disposal generally as a release to land or as an injection underground.

IV.A. EPA Toxic Release Inventory for the Organic Chemicals Industry

According to the Toxics Release Inventory (TRI) data, 417 organic chemical facilities released (to the air, water or land) and transferred (shipped off-site or discharged to sewers) a total of 438 million pounds of toxic chemicals during calendar year 1993. That represents approximately 18 percent of the 2.5 billion pounds of releases and transfers from the chemical industry as a whole (SIC 28) and about six percent of the releases and transfers for all manufacturers reporting to TRI that year. By comparison, the inorganic chemical industry's releases and transfers in 1993 totaled 249.7 million pounds, or sixty percent of the releases and transfers of the industrial organic chemical sector.

The chemical industry's <u>releases</u> have been declining in recent years. Between 1988 and 1992 TRI emissions from chemical companies (all those categorized within SIC 28, not just organic chemical manufacturers) to air, land, and water were reduced 44 percent, which is average for all manufacturing sectors reporting to TRI.

Because the chemical industry (SIC 28) has historically released more TRI chemicals than any other industry, the EPA has worked to improve environmental performance within this sector. This has been done through a combination of enforcement actions, regulatory requirements, pollution prevention projects, and voluntary programs (e.g. EPA's 33/50 program). In addition, the chemical industry has focused on reducing pollutant releases. For example, the Chemical Manufacturer's Association's (CMA's) Responsible Care® initiative is intended to reduce or eliminate chemical manufacturers' wastes. All 185 members of the CMA, firms that account for the majority of U.S. chemical industry sales and earnings, are required to participate in the program as a condition of CMA membership. Participation involves demonstrating a commitment to the program's mandate of continuous improvement of the environment, health, and safety. In June of 1994, the CMA approved the use of a third-party verification of management plans to meet these objectives. State-level toxics use reduction requirements, public disclosure of release and transfer information contained in TRI, and voluntary programs such as EPA's 33/50 Program have also been given as reasons for release reductions.

Exhibit 16 presents the number and volumes of chemicals released by organic chemical facilities. The quantity of the basic feedstocks released reflects their volume of usage. The inorganic chemicals among the top ten released (ammonia, nitric acid, ammonium sulfate, and sulfuric acid) are also large volume reaction feedstocks. Inorganic chemicals contained in wastes injected underground on-site account for 58 percent of the industry's releases; ammonia makes up the vast majority of TRI chemicals disposed of via underground injection. Air releases account for 40 percent (61 million pounds), and the remaining approximately 1.5 percent (2.4 million pounds) is discharged directly to water or land disposed.

Exhibit 17 presents the number and volumes of chemicals transferred by organic chemical facilities. Off-site transfers account for the largest amount, 65 percent, of the organic chemical industry's total releases and transfers as reported in TRI. Three chemicals (sulfuric acid, methanol and *tert*-butyl alcohol) account for over one-half of the 287 million pounds transferred off-site. The 49 million pounds of POTW discharges (primarily methanol and ammonia) account for 17 percent of releases and transfers.

The frequency with which chemicals are reported by facilities within a sector is one indication of the diversity of operations and processes. Many chemicals are released or transferred by a small number of facilities, which indicates a wide diversity of production processes, particularly for specialty organic chemicals -- over one half of the 204 chemicals reported are released by fewer than 10 facilities. However, the organic chemical industry is also characterized by one of the largest numbers of chemicals reported by any manufacturing sector. Of the over 300 chemicals currently listed on TRI, 204 are reported as released or transferred by at least one organic chemical facility.

Exhibit 16: 1993 Releases for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Releases reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	WATER DISCHARGES	UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASE PER FACILITY
SULFURIC ACID	216	38,135	84,847	50	5,590,786	6,367	5,720,185	26,482
METHANOL	194	3,872,663	5,125,135	60,131	5,944,874	6,212	15,009,015	77,366
HYDROCHLORIC ACID	144	389,413	1,153,510	29,028	82,677	974	1,655,602	11,497
AMMONIA	116	1,111,918	2,572,704	726,248	28,145,563	235,994	32,792,427	282,693
TOLUENE	109	851,359	957,684	154	194,937	1,019	2,005,153	18,396
XYLENE (MIXED ISOMERS)	89	730,696	207,630	334	161,156	313	1,100,129	12,361
ETHYLENE GLYCOL	86	204,427	3,272,040	28,445	5,867,002	63,735	9,435,649	109,717
CHLORINE	85	130,761	157,695	2,236	780	0	291,472	3,429
ACETONE	84	5,159,656	1,348,278	4,040	1,264,031	7,195	7,783,200	92,657
FORMALDEHYDE	78	280,006	382,300	4,610	75,086	1,205	743,207	9,528
BENZENE	72	850,106	803,898	494	231,093	308	1,885,899	26,193
GLYCOL ETHERS	67	136,339	22,304	23,684	88	8,197	190,612	2,845
PHOSPHORIC ACID	67	11,835	1,378	15	0	5	13,233	198
PHENOL	62	434,770	268,529	3,620	2,011,015	1,134	2,719,068	43,856
N-BUTYL ALCOHOL	56	256,456	236,442	15,550	1,363,944	1,303	1,873,695	33,459
STYRENE	47	210,666	277,926	283	132,575	851	622,301	13,240
ZINC COMPOUNDS	46	9,364	15,103	8,011	9,254	36,160	77,892	1,693
COPPER COMPOUNDS	44	1,274	1,363	6,454	147,134	33,141	189,366	4,304
NAPHTHALENE	44	305,328	337,758	45	63,265	12,131	718,527	16,330
ETHYLBENZENE	42	230,216	138,969	60	333,489	102	702,836	16,734
ETHYLENE	38	2,649,664	4,027,122	0	0	0	6,676,786	175,705
MALEIC ANHYDRIDE	38	17,956	20,838	15	0	0	38,809	1,021
DICHLOROMETHANE	36	65,419	191,239	600	0	0	257,258	7,146
PROPYLENE	35	2,353,950	602,285	0	0	0	2,956,235	84,464
ACRYLIC ACID	31	269,020	108,887	14	160,000	0	537,921	17,352
BIPHENYL	28	51,616	10,857	10	44,266	6,138	112,887	4,032
CYCLOHEXANE	28	232,868	812,798	17,370	258,817	169	1,322,022	47,215
DIETHANOLAMINE	28	33,271	1,035	22,766	0	53,663	110,735	3,955
BARIUM COMPOUNDS	27	6,838	4,156	6,900	1,600	22	19,516	723
METHYL ETHYL KETONE	27	166,230	215,714	290	246,072	0	628,306	23,271
NITRIC ACID	27	3,949	26,784	2,000	16,097,146	2,490	16,132,369	597,495
PHTHALIC ANHYDRIDE	27	33,350	13,593	0	0	0	46,943	1,739
ANILINE	26	73,410	54,142	2,073	430,763	20	560,408	21,554
CHLOROMETHANE	25	263,303	719,728	570	0	0	983,601	39,344
CUMENE	25	299,630	436,635	40	17,000	200	753,505	30,140
CHROMIUM COMPOUNDS	24	725	1,239	1,365	3,269	6,184	12,782	533
ETHYLENE OXIDE	24	130,124	70,116	2,359	28,000	895	231,494	9,646
PROPYLENE OXIDE	23	175,006	129,503	5,472	5,151	6,125	321,257	13,968
1,3-BUTADIENE	23	496,952	196,341	1,321	0	284	694,898	30,213
1,2,4-TRIMETHYLBENZENE	22	12,418	6,232	286	304	25	19,265	876
ACETALDEHYDE	20	150,111	1,131,895	1,436	1,346,120	16	2,629,578	131,479
METHYL ISOBUTYL KETONE	19	1,632,377	298,258	6,119	0	5	1,936,759	101,935
NICKEL COMPOUNDS	19	758	2,294	2,251	100,816	4,113	110,232	5,802
ACRYLONITRILE	18	27,146	38,612	17	629,590	10	695,375	38,632
CHLOROETHANE	18	32,455	54,124	2,179	0	0	88,758	4,931
ANTHRACENE	17	6,817	9,620	10	0	5,119	21,566	1,269
CHLOROBENZENE	16	47,007	23,124	272	51,000	293	121,696	7,606
1,1,1-TRICHLOROETHANE	16	26,046	12,350	0	0	0	38,396	2,400
CRESOL (MIXED ISOMERS)	15	72,079	17,910	35	793,402	120	883,546	58,903
DICHLORODIFLUOROMETHANE	15	389,258	73,271	10	1	100	462,640	30,843
TERT-BUTYL ALCOHOL	15	1,068,315	234,114	158,120	302,943	180	1,763,672	117,578
AMMONIUM SULFATE	14	10	6,810	122	5,746,409	420,001	6,173,352	440,954

Exhibit 16 (cont.): 1993 Releases for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Releases reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	WATER DISCHARGES	UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASES PER FACILITY
DIMETHYL SULFATE	14	1,310	644	0	0	5	1,959	140
TETRACHLOROETHYLENE	14	29,594	17,654	29	0	0	47,277	3,377
CREOSOTE	13	55,110	74,595	5	0	585	130,295	10,023
BUTYL ACRYLATE	12	81,815	45,684	306	0	0	127,805	10,650
CARBON DISULFIDE	12	43,576	10,221	251	0	0	54,048	4,504
EPICHLOROHYDRIN	12	17,289	2,296	292	0	0	19,877	1,656
O-XYLENE	12	102,254	160,275	141	0	0	262,670	21,889
1,2-DICHLOROETHANE	12	220,032	968,026	70	0	0	1,188,128	99,011
BENZOYL CHLORIDE	11	6,087	1,819	0	0	5	7,911	719
BUTYRALDEHYDE	11	34,477	31,689	7	189,447	0	255,620	23,238
CHLOROFORM	11	12,764	62,055	693	74	200	75,786	6,890
COBALT COMPOUNDS	11	0	4,592	80,304	0	18,696	103,592	9,417
DIBENZOFURAN	11	10,880	10,059	10	0	910	21,859	1,987
DIETHYL SULFATE	11	616	17	0	0	5	638	58
ETHYL ACRYLATE	11	46,571	35,631	410	2,400	0	85,012	7,728
HYDROQUINONE	11	188	5	30	190,000	117	190,340	17,304
MANGANESE COMPOUNDS	11	1,760	28,017	131,505	0	61,000	222,282	20,207
METHYL ACRYLATE	11	51,940	49,500	5	0	0	101,445	9,222
METHYL METHACRYLATE	11	76,114	119,538	750	0	250	196,652	17,877
METHYL TERT-BUTYL ETHER	11	143,917	70,795	85	8,772	0	223,569	20,324
TRICHLOROETHYLENE	11	42,619	936	5	0	0	43,560	3,960
VINYL ACETATE	11	166,157	744,939	0	892,698	0	1,803,794	163,981
BENZYL CHLORIDE	10	2,297	432	0	0	58	2,787	279
HYDROGEN CYANIDE	10	10,539	298,141	0	651,815	12	960,507	96,051
M-CRESOL	10	20,937	2,442	406	520,000	0	543,785	54,379
QUINOLINE	10	3,327	17,900	40	63,000	190	84,457	8,446
SEC-BUTYL ALCOHOL	10	15,241	8,310	2,440	0	5	25,996	2,600
ACETONITRILE	9	79,850	64,366	217	3,969,793	13	4,114,239	457,138
ACRYLAMIDE	9	16,503	1,597	0	930,000	160	948,260	105,362
CARBON TETRACHLORIDE	9	55,191	55,130	234	63	0	110,618	12,291
FREON 113	9	23,242	84,780	44	4	406	108,476	12,053
HYDRAZINE	9	7,195	1,551	0	0	0	8,746	972
TRICHLOROFLUOROMETHAN	9	103,857	74,459	50	11	750	179,127	19,903
ALLYL ALCOHOL	8	36,773	6,928	5,100	192,966	0	241,767	30,221
CHLOROACETIC ACID	8	3,786	413	5	0	0	4,204	526
COPPER	8	0	170	1,329	0	4,880	6,379	797
CUMENE HYDROPEROXIDE	8	11,380	5,404	190	380,000	3	396,977	49,622
CYANIDE COMPOUNDS	8	26,142	1,543	7,391	426,890	2,846	464,812	58,102
ISOBUTYRALDEHYDE	8	37,012	16,187	255	34,783	0	88,237	11,030
O-TOLUIDINE	8	8,370	155	5	9,600	7	18,137	2,267
P-CRESOL	8	13,522	2,197	273	260,000	0	275,992	34,499
PROPIONALDEHYDE	8	20,845	13,991	5	31,995	0	66,836	8,355
2-METHOXYETHANOL	8	27,431	3,436	430	0	0	31,297	3,912
4,4'-	8	67,835	8,979	337	43,000	250	120,401	15,050
DI(2-ETHYLHEXYL)	7	270	255	0	0	0	525	75
DIBUTYL PHTHALATE	7	271	505	23	0	0	799	114
DIMETHYL PHTHALATE	7	5,424	1,461	12	1,300	5	8,202	1,172
HYDROGEN FLUORIDE	7	3,894	4,627	0	1	0	8,522	1,217
NICKEL	7	6	250	5	0	113	374	53
PHOSGENE	7	265	293	0	0	0	558	80
PYRIDINE	7	11,229	2,339	0	220,000	0	233,568	33,367
ACROLEIN	6	5,170	10,129	0	82	0	15,381	2,564

Exhibit 16 (cont.): 1993 Releases for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Releases reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	WATER DISCHARGES	UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASES PER FACILITY
ANTIMONY COMPOUNDS	6	20	257	125	759	10	1,171	195
BIS(2-ETHYLHEXYL) ADIPATE	6	23	257	0	0	0	280	47
LEAD COMPOUNDS	6	304	256	1	0	0	561	94
M-XYLENE	6	90,153	51,519	0	0	0	141,672	23,612
N,N-DIMETHYLANILINE	6	906	2,745	250	0	0	3,901	650
P-XYLENE	6	240,522	2,362,739	1	0	1	2,603,263	433,877
1,2,4-TRICHLOROBENZENE	6	2,536	38,272	10	0	0	40,818	6,803
AMMONIUM NITRATE (SOLUTION)	5	0	750	8,500	0	0	9,250	1,850
CADMIUM COMPOUNDS	5	1,895	1,005	0	0	0	2,900	580
DIETHYL PHTHALATE	5	510	10	0	0	250	770	154
MOLYBDENUM TRIOXIDE	5	0	7,100	0	55,000	99	62,199	12,440
O-ANISIDINE	5	405	11	81	0	116	613	123
P-CRESIDINE	5	285	125	5	0	85	500	100
VINYL CHLORIDE	5	31,082	3,504	0	0	0	34,586	6,917
ALLYL CHLORIDE	4	2,702	294	0	0	0	2,996	749
BENZOYL PEROXIDE	4	250	977	0	0	0	1,227	307
BUTYL BENZYL PHTHALATE	4	18	0	0	83	7	108	27
CHROMIUM	4	0	0	250	0	1	251	63
METHYLENEBIS (PHENYLISOCYANATE)	4	3,053	256	0	0	5	3,314	829
O-CRESOL	4	8,804	1,087	95	560,000	0	569,986	142,497
1,1,2-TRICHLOROETHANE	4	2,672	90	3	0	0	2,765	691
1,2-DICHLOROETHYLENE	4	224	50	0	0	0	274	69
1,4-DIOXANE	4	15,613	2,414	21,715	0	2,100	41,842	10,461
2-ETHOXYETHANOL	4	26,298	10,122	1,932	0	0	38,352	9,588
3,3'-DICHLOROBENZIDINE	4	0	0	0	0	0	0	0
4,6-DINITRO-O-CRESOL	4	6	37	10	0	0	53	13
ASBESTOS (FRIABLE)	3	0	0	0	0	0	0	0
DIAMINOTOLUENE (MIXED	3	1,205	19	500	0	10	1,734	578
DICHLOROTETRAFLUOROETHANE	3	7,967	23,440	0	0	0	31,407	10,469
ISOPROPYL ALCOHOL	3	157	34	0	0	0	191	64
NITROBENZENE	3	11,255	1,030	0	0	0	12,285	4,095
PICRIC ACID	3	2	2	1	38,294	1	38,300	12,767
SILVER	3	0	9	62	210	0	281	94
SILVER COMPOUNDS	3	3,743	0	0	0	0	3,743	1,248
STYRENE OXIDE	3	298	38	0	0	0	336	112
VINYLIDENE CHLORIDE	3	162	158	0	0	0	320	107
1,1,2,2-TETRACHLOROETHANE	3	141	10	0	0	0	151	50
1,2-DICHLOROBENZENE	3	7,605	8,412	1	0	0	16,018	5,339
2-NITROPHENOL	3	5	10	5	0	0	20	7
2,4-DIAMINOTOLUENE	3	13	0	0	0	0	13	4
ANTIMONY	2	260	33	0	0	0	293	147
BROMOMETHANE	2	2,300	618,500	0	0	0	620,800	310,400
C.I. BASIC GREEN 4	2	0	0	0	0	0	0	0
C.I.FOOD RED 15	2	0	1	0	0	0	1	1
CHLOROPRENE	2	6	13	0	0	0	19	10
DICHLOROBENZENE (MIXED	2	219	13	0	1	0	233	117
HEXACHLORO-1,3-BUTADIENE	2	1	0	0	0	0	1	1
HEXACHLOROBENZENE	2	0	0	0	0	0	0	0

Exhibit 16 (cont.): 1993 Releases for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Releases reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	WATER DISCHARGES	UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASES PER FACILITY
TOLUENEDIISOCYANATE	2	5	5	0	0	250	260	13,059
(MIXED ISOMERS)	0			0	0	0		
1,2-BUTYLENE OXIDE	2	289	0	0	0	0	289	145
2,4-DIMETHYLPHENOL	0	3,400	160	80	0	0	58,640	29,320
2,3-DINITROPHENOL	2	1	2	110	0	0	117	59
3,3'-DIMETHOXYBENZIDINE	0	0	0	4	0	0	4	2
4,4'-METHYLENEDIANILINE	(1)	2,404	5	0	150	0	2,559	1,280
ACETAMIDE	0	2	8	0	89,000	0	89,010	89,010
ALPHA-NAPHTHYLAMINE	0	0	0	0	0	0	0	0
ALUMINUM (FUME OR DUST)	1	115	0	219	0	0	334	334
BENZIOIC TRICHLORIDE	1	1,318	5	0	0	0	1,323	1,323
BIS(2-CHLOROETHYL) ETHER	1	22	0	0	0	0	22	22
BROMOCHLORODIFLUOROMETHANE	1	0	0	0	0	0	0	0
C.I. BASIC RED 1	1	0	0	0	0	0	0	0
C.I. DISPERSE YELLOW 3	1	399	0	28	0	9,199	9,626	9,626
C.I. SOLVENT YELLOW 3	1	0	0	0	0	0	0	0
CADMIUM	1	0	0	0	0	0	0	0
CHLORDANE	1	51	0	15	0	0	66	66
COBALT	1	0	1,800	460	0	1,600	3,860	3,860
CUPFERRON	1	2	23	0	0	0	25	25
ETHYL CHLOROFORMATE	1	250	5	0	0	0	255	255
ETHYLENE THIOUREA	1	5	5	0	0	0	10	10
ETHYLENEIMINE	1	0	0	0	0	0	0	0
HEPTACHLOR	1	31	0	2	0	0	33	33
HEXACHLOROCYCLOPENTADIENE	1	1,342	861	0	0	0	2,203	2,203
HEXACHLOROETHANE	1	1	0	0	0	0	1	1
HYDRAZINE SULFATE	1	0	0	0	0	0	0	0
LEAD	1	5	5	0	0	0	10	10
M-DINITROBENZINE	1	49	7	0	0	0	56	56
METHYL IODIDE	1	6,800	92	0	0	0	6,892	6,892
METHYL ISOCYANATE	1	0	0	0	0	0	0	0
METHYLENE BROMIDE	1	3	13	0	0	0	16	16
O-DINITROBENZENE	1	1	1	0	0	0	2	2
OXY-ALKYLATED ALCOHOL	1	250	5	0	0	0	255	255
P-PHENYLENEDIAMINE	1	1	1	0	0	0	4	4
PHENYL MIXTURE	1	2,600	200	0	0	0	2,800	2,800
PHOSPHORUS (YELLOW OR WHITE)	1	0	0	0	0	0	0	0
SACCHARIN (MANUFACTURING)	1	50	1	0	0	0	51	51
TITANIUM TETRACHLORIDE	1	0	0	0	0	0	0	0
ZINC (FUME OR DUST)	1	0	290	0	0	0	290	290
1,3-DICHLOROBENZENE	1	0	0	0	0	0	0	0
1,3-DICHLOROPROPYLENE	1	3	22	0	0	0	25	25
1,4-DICHLOROBENZENE	1	32	95	0	0	0	127	127
2-NITROPROPANE	1	0	0	0	0	0	0	0
2,4-DIAMINOANISOLE	1	0	13	0	0	0	13	13
2,4-DINITROTOLUENE	1	1	2	0	0	0	3	3
2,6-SYLIDINE	1	53	2	0	0	0	55	55
4-NITROPHENOL	1	290	21	0	0	0	311	311
5-NITRO-O-ANISIDINE	1	5	5	0	0	0	10	10
TOTAL	417	28,256,560	33,222,806	1,415,674	87,698,609	1,027,734	151,621,383	363,600

Exhibit 17: 1993 Transfers for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW DISCHARGES	DISPOSAL	RECYCLING	TREATMENT	ENERGY RECOVERY	TOTAL TRANSFERS	AVG. TRANSFERS PER FACILITY
SULFURIC ACID	216	60,857	1,460,275	84,722,700	3,530,520	0	86,596,884	400,912
METHANOL	194	210,007,643	298,453	5,596,077	4,597,065	11,815,643	43,307,981	223,237
HYDROCHLORIC ACID	144	742,576	770,703	7,415	2,680,884	182	4,202,346	29,183
AMMONIA	116	8,351,095	1,263,566	162,738	83,271	930	9,861,610	85,014
TOLUENE	109	13,790	267,107	7,155,414	999,051	9,256,100	17,691,462	162,307
XYLENE (MIXED ISOMERS)	89	19,513	248,470	303,172	205,720	4,912,122	5,688,997	63,921
ETHYLENE GLYCOL	86	2,630,290	291,143	122,260	2,504,914	4,915,874	10,464,481	121,680
CHLORINE	85	30,671	22	0	115,400	2,687	148,780	1,750
ACETONE	84	2,452,706	27,530	182,320	859,366	3,893,746	7,415,668	88,282
FORMALDEHYDE	78	264,163	403	173	102,654	1,055	368,448	4,724
BENZENE	72	596	31,498	705,846	225,803	174,445	1,138,188	158,808
GLYCOL ETHERS	67	2,469,069	82,646	10,170	173,874	254,182	2,989,941	44,626
PHOSPHORIC ACID	67	36,422	11,680	0	2,166	15	50,283	750
PHENOL	62	559,856	96,193	3,300	247,644	466,822	1,373,815	22,158
N-BUTYL ALCOHOL	56	235,678	193,040	210	335,171	2,024,030	2,788,129	49,788
STYRENE	47	9,772	12,738	9,935	714,896	250,703	998,044	21,235
ZINC COMPOUNDS	46	53,120	1,078,844	173,261	62,751	16,914	1,384,890	30,106
COPPER COMPOUNDS	44	46,957	242,892	1,458,665	187,352	0	193,866	43,997
NAPHTHALENE	44	3,853	156,104	56,080	218,493	220,473	655,003	14,886
ETHYLBENZENE	42	331	28,706	4,765	12,484	448,357	494,643	11,777
ETHYLENE	38	0	68	0	0	0	68	2
MALEIC ANHYDRIDE	38	155	7,797	0	2,563	0	10,515	277
DICHLOROMETHANE	36	533	814	539,664	278,008	420,139	1,239,158	34,421
PROPYLENE	35	0	0	0	380,000	0	380,000	10,857
ACRYLIC ACID	31	29,470	26,822	0	73,140	7,855,500	7,984,932	257,578
BIPHENYL	28	265,741	9,922	14,409	92,951	75,951	458,974	16,392
CYCLOHEXANE	28	3,083	1,420	1,034,820	196,873	406,927	1,643,123	58,683
DIETHANOLAMINE	28	123,941	46,624	0	1,428	6,839	178,832	6,387
BARIUM COMPOUNDS	27	80,991	251,349	1,039	22,895	32,435	388,709	14,397
METHYL ETHYL KETONE	27	88,200	14,967	7,402	34,173	1,703,103	1,847,845	68,439
NITRIC ACID	27	355	232,000	0	7,160	0	239,515	8,871
PHTHALIC ANHYDRIDE	27	3,956	46,965	0	34,579	1,774,375	1,859,875	68,884
ANILINE	26	1,309,605	390,621	0	28,201	166,308	1,894,735	72,874
CHLOROMETHANE	25	788	6	0	91,521	47,285	139,600	5,584
CUMENE	25	20,017	5,761	4,511	8,372	68,031	106,692	4,268
CHROMIUM COMPOUNDS	24	4,982	44,909	561,231	110,976	190	722,288	30,095
ETHYLENE OXIDE	24	18,441	1,989	0	0	1	20,431	851
PROPYLENE OXIDE	23	9,409	9,564	0	7	2,660	21,640	941
1,3-BUTADIENE	23	250	550	0	21	81	902	39
1,2,4-TRIMETHYLBENZENE	22	49,994	5,068	4,511	451	60,471	120,495	5,477
ACETALDEHYDE	20	80,071	0	0	264	0	80,335	4,019
METHYL ISOBUTYL KETONE	19	50,988	642	25	856	289,105	341,616	17,980
NICKEL COMPOUNDS	19	5,504	43,454	747,998	211,744	0	1,008,700	53,089
ACRYLONITRILE	18	35,489	0	0	349,878	585,483	970,850	53,936
CHLOROETHANE	18	5	0	151,000	388,895	0	539,900	29,994
ANTHRACENE	17	256	28,683	8,909	2,600	53,834	94,282	5,546
CHLOROBENZENE	16	1,076	915	157	17,904	15,591	35,643	2,228
1,1,1-TRICHLOROETHANE	16	12	0	16,461	620,387	1,591	638,451	39,903
CRESOL (MIXED ISOMERS)	15	250	4,113	6,500	26,725	447	38,035	2,536
DICHLORODIFLUOROMETHANE	15	8	8	0	0	0	16	1
TERT-BUTYL ALCOHOL	15	862,730	255,223	5,324	328,262	29,383,823	30,835,362	2,055,691
AMMONIUM SULFATE	14	5,178,324	250	0	211,000	0	5,389,574	384,970

Exhibit 17(cont.): 1993 Transfers for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW DISCHARGES	DISPOSAL	RECYCLING	TREATMENT	ENERGY RECOVERY	TOTAL TRANSFERS	AVG. TRANSFERS PER FACILITY
DIMETHYL SULFATE	14	255	0	39,542	0	0	39,797	2,843
TETRACHLOROETHYLENE	14	447	79	1,126	282,805	11,855	296,312	21,165
CREOSOTE	13	0	700,472	273,000	300	29,220	1,002,992	77,153
BUTYL ACRYLATE	12	279	725	0	7,541	0	8,545	712
CARBON DISULFIDE	12	7,289	279	4,413	7,925	125,206	145,112	12,093
EPICHLOROHYDRIN	12	255	0	0	185	0	440	37
O-XYLENE	12	28	28,557	5,414	10,341	861,637	905,977	75,498
1,2-DICHLOROETHANE	12	731	54,402	1,700,000	402,888	406	2,158,427	179,869
BENZOYL CHLORIDE	11	0	250	0	0	0	250	23
BUTYRALDEHYDE	11	0	1,700	450	0	1,700	3,850	350
CHLOROFORM	11	264	0	3,100	131,685	19,297	154,346	14,031
COBALT COMPOUNDS	11	14	184,500	148,400	7	0	332,921	30,266
DIBENZOFURAN	11	250	25,701	3,609	0	19,988	49,548	4,504
DIETHYL SULFATE	11	10	0	5,370,000	0	0	53,701,010	488,183
ETHYL ACRYLATE	11	500	6,950	0	187,311	1,378,573	1,573,334	143,030
HYDROQUINONE	11	1,210	32,261	0	338	0	33,809	3,074
MANGANESE COMPOUNDS	11	5,019	819,758	11,600	0	0	836,377	76,034
METHYL ACRYLATE	11	2,110	250	0	5,765	10,508	18,633	1,694
METHYL METHACRYLATE	11	563	750	71,000	226,520	10,410	309,243	28,113
METHYL TERT-BUTYL ETHER	11	31	133,320	0	0	237,779	371,130	33,739
TRICHLOROETHYLENE	11	7	0	1,143	310,803	0	311,953	28,359
VINYL ACETATE	11	95,453	390	0	9,341	561,083	666,267	60,570
BENZYL CHLORIDE	10	250	0	0	14	30,980	31,244	3,124
HYDROGEN CYANIDE	10	250	2,053	0	74	250	2,627	263
M-CRESOL	10	9,649	13,336	270,000	51,118	2,923	347,026	34,703
QUINOLINE	10	250	5,482	3,609	2	5,354	14,397	1,470
SEC-BUTYL ALCOHOL	10	2,046	145,000	0	1,682	4,082,657	4,231,385	423,139
ACETONITRILE	9	255	1,601	0	410	263,316	265,582	29,509
ACRYLAMIDE	9	79,559	500	0	20,470	44,330	154,859	17,207
CARBON TETRACHLORIDE	9	1,604	1,366	1,750	136,570	0	141,290	15,699
FREON 113	9	0	12	13,215	64,636	0	77,863	8,651
HYDRAZINE	9	1,400	3,617	0	0	0	5,017	557
TRICHLOROFLUOROMETHANE	9	349	0	750	2,433	0	3,532	392
ALLYL ALCOHOL	8	27,663	4,271	0	28,172	139,592	199,698	24,962
CHLOROACETIC ACID	8	0	250	0	1,026	150	1,426	178
COPPER	8	0	30,937	35,708	21,000	0	86,756	10,845
CUMENE HYDROPEROXIDE	8	0	415	0	3,566	0	3,981	498
CYANIDE COMPOUNDS	8	3,005	3,231	0	3,292	0	9,528	1,191
ISOBUTYRALDEHYDE	8	0	0	200	32,000	655,579	687,779	85,972
O-TOLUIDINE	8	5,819	42	0	0	220	6,081	760
P-CRESOL	8	866,495	7,086	160,000	10,886	41,466	1,085,933	135,742
PROPIONALDEHYDE	8	0	3,167	0	0	0	3,167	396
2-METHOXYETHANOL	8	46,000	16,300	70	0	91,736	154,106	19,263
4,4'-ISOPROPYLIDENEDIPHENOL	8	255	30,767	0	1,231	5,447	37,700	4,713
DI(2-ETHYLHEXYL)	7	10	250	0	250	1,424	1,934	276
DIBUTYL PHTHALATE	7	256	296	0	658	5,659	6,869	981
DIMETHYL PHTHALATE	7	119,565	825	0	3,967	618	124,975	17,854
HYDROGEN FLUORIDE	7	0	1	0	3,603	0	3,604	515
NICKEL	7	748	3,413	192,295	0	0	196,456	28,065
PHOSGENE	7	0	0	0	0	0	0	0
PYRIDINE	7	24,344	606	3,609	12,457	0	41,016	5,859
ACROLEIN	6	0	0	0	8	5,873	5,881	980

Exhibit 17(cont.): 1993 Transfers for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW DISCHARGES	DISPOSAL	RECYCLING	TREATMENT	ENERGY RECOVERY	TOTAL TRANSFERS	AVG. TRANSFER PER FACILITY
ANTIMONY COMPOUNDS	6	124	2,152	0	2,450	22,055	27,031	4,505
BIS(2-ETHYLHEXYL) ADIPATE	6	250	746	0	5	308	1,309	218
LEAD COMPOUNDS	6	2	53,692	0	213	0	53,907	8,985
M-XYLENE	6	0	237	17,143	794	884	19,058	3,176
N,N-DIMETHYLANILINE	6	52,126	0	0	1,500	120,000	173,626	28,938
P-XYLENE	6	0	1,058	0	5,260	1,402	7,720	1,287
1,2,4-TRICHLOROBENZENE	6	503	3,255	520	5,428	4,400	14,106	2,351
AMMONIUM NITRATE (SOLUTION)	5	28,800	2,530,000	0	0	0	2,558,800	511,760
CADMIUM COMPOUNDS	5	29	21,776	0	3,738	1,128	26,671	5,334
DIETHYL PHTHALATE	5	255	94	0	500	250	1,099	220
MOLYBDENUM TRIOXIDE	5	0	1,897	17,000	19,000	0	37,897	7,579
O-ANISIDINE	5	0	0	0	0	0	0	0
P-CRESIDINE	5	28,223	0	0	1,400	0	29,623	5,925
VINYL CHLORIDE	5	0	1	53,000	1,329	0	54,330	10,866
ALLYL CHLORIDE	4	0	0	0	0	0	0	0
BENZOYL PEROXIDE	4	9,980	0	0	4,620	0	14,600	3,650
BUTYL BENZYL PHTHALATE	4	158	43	0	12,943	0	13,144	3,286
CHROMIUM	4	0	0	0	21,505	0	21,505	5,376
METHYLENEBIS	4	0	0	0	13,270	0	13,270	3,318
(PHENYLISOCYANATE)					11,109	1,301	59,061	14,765
O-CRESOL	4	40,541	6,110	0				
1,1,2-TRICHLOROETHANE	4	0	70	57,000	236,101	0	293,171	73,298
1,2-DICHLOROETHYLENE	4	0	0	2,100	10	0	21,110	528
1,4-DIOXANE	4	0	0	8	0	0	8	2
2-ETHOXYETHANOL	4	390,022	0	328,374	11,783	150,875	881,054	220,264
3,3'-DICHLOROBENZIDINE	4	10	5	0	250	0	265	66
4,6-DINITRO-O-CRESOL	4	0	6,630	0	4,422	1,376	12,428	3,107
ASBESTOS (FRIABLE)	3	0	28,894	0	0	0	28,894	9,631
DIAMINOTOLUENE (MIXED ISOMERS)	3	550	0	0	172	1,100	1,822	607
DICHLOROTETRAFLUOROETHANE	3	0	15	0	51	0	66	22
ISOPROPYL ALCOHOL	3	0	0	50	81,000	72,700	153,750	51,250
NITROBENZENE	3	108	420	0	8,620	5,440	14,588	4,863
PICRIC ACID	3	0	0	0	0	0	0	0
SILVER	3	0	590	35,000	0	0	35,590	11,863
SILVER COMPOUNDS	3	0	0	48,230	0	0	48,230	16,077
STYRENE OXIDE	3	0	0	0	0	0	0	0
VINYLIDENE CHLORIDE	3	169	0	0	10,519	0	40,688	13,563
1,1,2,2-TETRACHLOROETHANE	3	0	17	1	10	0	28	9
1,2-DICHLOROBENZENE	3	0	0	860	1,477	12,830	15,167	5,056
2-NITROPHENOL	3	0	0	0	4,216	4,592	8,808	2,936
2,4-DIAMINOTOLUENE	3	0	0	0	882	0	882	294
ANTIMONY	2	8,355	7,657	58,716	0	0	74,728	37,364
BROMOMETHANE	2	0	0	0	0	0	0	0
C.I. BASIC GREEN 4	2	83	0	0	0	0	83	42
C.I.FOOD RED 15	2	1,100	0	0	0	0	1,100	550
CHLOROPRENE	2	0	0	134,800	570	0	135,370	67,685
DICHLOROBENZENE (MIXED ISOMERS)	2	0	0	0	0	128	128	64
HEXACHLORO-1,3-BUTADIENE	2	0	0	0	13,750	0	13,750	6,875
HEXACHLOROBENZENE	2	0	0	1	2,503	0	2,504	1,252
MONOCHLOROPENTAFLUOROEHTANE	2	0	0	0	0	0	0	0
P-ANISIDINE	2	2	0	0	0	0	2	1
PERACETIC ACID	2	0	0	0	0	0	0	0

Exhibit 17(cont.): 1993 Transfers for Organic Chemical Manufacturing Facilities in TRI, by Number of Facilities Reporting (Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW DISCHARGES	DISPOSAL	RECYCLING	TREATMENT	ENERGY RECOVERY	TOTAL TRANSFERS	AVG. TRANSFER PER FACILITY
TOLUENEDIISOCYANATE (MIXED ISOMERS)	2	0	0	0	9,050	2,700	11,750	5,875
1,2-BUTYLENE OXIDE	2	0	0	0	0	373,200	373,200	186,600
2,4-DIMETHYLPHENOL	2	0	0	0	13,000	0	17,244	8,622
2,3-DINITROPHENOL	2	0	0	0	9,000	0	9,020	4,510
3,3'-DIMETHOXYBENZIDINE	2	0	635	3,609	0	0	0	0
4,4'-METHYLENEDIANILINE	2	960	20	0	0	2,530	3,490	1,745
ACETAMIDE	1	0	0	0	98	0	98	98
ALPHA-NAPHTHYLAMINE	1	0	0	0	0	0	0	0
ALUMINUM (FUME OR DUST)	1	0	0	0	0	0	0	0
BENZIOIC TRICHLORIDE	1	0	0	0	0	0	0	0
BIS(2-CHLOROETHYL) ETHER	1	0	0	0	0	0	0	0
BROMOCHLORODIFLUOROMETHANE	1	0	0	0	0	0	0	0
C.I. BASIC RED 1	1	24	0	0	0	0	24	24
C.I. DISPERSE YELLOW 3	1	0	1,658	0	0	0	1,658	1,658
C.I. SOLVENT YELLOW 3	1	0	0	0	0	0	0	0
CADMIUM	1	0	0	0	0	0	0	0
CHLORDANE	1	51	0	0	11	0	62	62
COBALT	1	0	21	0	0	0	21	21
CUPFERRON	1	0	0	0	2,300	0	2,300	2,300
ETHYL CHLOROFORMATE	1	0	0	0	0	0	0	0
ETHYLENE THIOUREA	1	0	250	0	0	0	250	250
ETHYLENEIMINE	1	0	0	0	0	0	0	0
HEPTACHLOR	1	42	0	0	77,287	0	77,329	77,329
HEXACHLOROCYCLOPENTADIENE	1	636	0	0	4,810	0	5,446	5,446
HEXACHLOROETHANE	1	0	0	0	0	0	0	0
HYDRAZINE SULFATE	1	0	0	0	0	0	0	0
LEAD	1	0	0	0	0	0	0	0
M-DINITROBENZINE	1	0	0	0	0	0	0	0
METHYL IODIDE	1	0	27	0	230	350	607	607
METHYL ISOCYANATE	1	0	0	0	0	0	0	0
METHYLENE BROMIDE	1	0	0	0	0	0	0	0
O-DINITROBENZENE	1	0	0	0	0	0	0	0
OXY-ALKYLATED ALCOHOL	1	5	0	0	0	0	5	5
P-PHENYLENEDIAMINE	1	0	0	0	0	0	0	0
PHENYL MIXTURE	1	0	0	0	0	11,525	11,525	11,525
PHOSPHORUS (YELLOW OR WHITE)	1	0	0	0	0	0	0	0
SACCHARIN (MANUFACTURING)	1	7	840	0	0	0	847	847
TITANIUM TETRACHLORIDE	1	0	0	0	0	0	0	0
ZINC (FUME OR DUST)	1	0	0	0	0	0	0	0
1,3-DICHLOROBENZENE	1	0	0	860	570	0	1,430	1,430
1,3-DICHLOROPROPYLENE	1	0	0	0	0	0	0	0
1,4-DICHLOROBENZENE	1	0	0	0	4	0	4	4
2-NITROPROPANE	1	0	0	0	12,180	0	12,180	12,180
2,4-DIAMINOANISOLE	1	0	0	0	0	0	0	0
2,4-DINITROTOLUENE	1	0	0	0	0	300	300	300
2,6-SYLIDINE	1	0	0	0	0	0	0	0
4-NITROPHENOL	1	0	0	0	1	0	5	5
5-NITRO-O-ANISIDINE	1	5	0	0	0	0	5	5
TOTAL	417	49,074,289	12,926,499	112,849,737	20,826,187	91,051,060	286,728,608	687,599

The TRI database contains a detailed compilation of self-reported, facility-specific chemical releases. The top reporting facilities for this sector are listed below (Exhibit 18). Facilities that have reported only the SIC codes covered under this notebook appear on the first list. Exhibit 19 contains additional facilities that have reported the SIC code covered within this report, and one or more SIC codes that are not within the scope of this notebook. Therefore, the second list includes facilities that conduct multiple operations -- some that are under the scope of this notebook, and some that are not. Currently, the facility-level data do not allow pollutant releases to be broken apart by industrial process.

Exhibit 18: Top 10 TRI Releasing Organic Chemical Manufacturing Facilities[b]

Rank	Facility	Total TRI Releases in Pounds
1	Du Pont Victoria Plant - Victoria, TX	22,471,672
2	BP Chemicals Inc. Green Lake - Port Lavaca, TX	20,650,979
3	Zeneca Specialties Mount Pleasant Plant - Mt. Pleasant, TN	13,429,259
4	Hoechst-Celanese Chemical Group Inc. Clear Lake Plant - Pasadena, TX	10,354,443
5	Du Pont Sabine River Works - Orange, TX	9,731,302
6	Merichem Co. - Houston, TX	3,832,980
7	Hoechst-Celanese Chemical Group Inc. - Bay City, TX	3,454,971
8	Union Carbide C & P CO. Institute WV Plant Ops. - Institute, WV	3,082,932
9	Aqualon - Hopewell, VA	3,007,010
10	Aristech Chemical Corp. - Haverhill, OH	2,858,009

Source: U.S. EPA, Toxics Release Inventory Database, 1993

[b] Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

Exhibit 19: Top 10 TRI Releasing Facilities Reporting Organic Chemical Manufacturing SIC Codes to TRI[c]

Rank	SIC Codes Reported in TRI	Facility	Total TRI Releases in Pounds
1	2819, 2869	Cytec Inc. Inc. Fortier Plant - Westwego, LA	120,149,724
2	2869, 2819, 2841, 2879	Monsanto Co. - Alvin, TX	40,517,095
3	2822, 2865, 2869, 2873	Du Pont Beaumont Plant - Beaumont, TX	36,817,348
4	2823, 2821, 2869, 2824	Tennessee Eastman Division - Kingsport, TN	29,339,677
5	2869, 2865, 2819	Sterling Chemicals Inc. - Texas City, TX	24,709,135
6	2869	Du Pont Victoria Plant - Victoria, TX	22,471,672
7	2869	BP Chemicals Inc. Green Lake - Port Lavaca, TX	20,650,979
8	2821, 2869, 2873	BP Chemicals - Lima, OH	20,620,680
9	2812, 2869, 2813	Vulcan Chemicals - Cheyenne, WY	17,406,218
10	2813, 2819, 2869, 2873	Coastal Chemicals Inc. - Cheyenne, WY	15,334,423

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

[c] Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

IV.B. Summary of Selected Chemicals Released

The brief descriptions provided below were taken from the *1993 Toxics Release Inventory Public Data Release* (EPA, 1994), the Hazardous Substances Data Bank (HSDB), and the Integrated Risk Information System (IRIS), both accessed via TOXNET.[d]

Ammonia[e] (CAS: 7664-41-7)

Toxicity. Anhydrous ammonia is irritating to the skin, eyes, nose, throat, and upper respiratory system.

Ecologically, ammonia is a source of nitrogen (an essential element for aquatic plant growth), and may therefore contribute to eutrophication of standing or slow-moving surface water, particularly in nitrogen-limited waters such as the Chesapeake Bay. In addition, aqueous ammonia is moderately toxic to aquatic organisms.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Ammonia combines with sulfate ions in the atmosphere and is washed out by rainfall, resulting in rapid return of ammonia to the soil and surface waters.

Ammonia is a central compound in the environmental cycling of nitrogen. Ammonia in lakes, rivers, and streams is converted to nitrate.

Physical Properties. Ammonia is a corrosive and severely irritating gas with a pungent odor.

[d] TOXNET is a computer system run by the National Library of Medicine that includes a number of toxicological databases managed by EPA, National Cancer Institute, and the National Institute for Occupational Safety and Health. For more information on TOXNET, contact the TOXNET help line at 800-231-3766. Databases included in TOXNET are: CCRIS (Chemical Carcinogenesis Research Information System), DART (Developmental and Reproductive Toxicity Database), DBIR (Directory of Biotechnology Information Resources), EMICBACK (Environmental Mutagen Information Center Backfile), GENE-TOX (Genetic Toxicology), HSDB (Hazardous Substances Data Bank), IRIS (Integrated Risk Information System), RTECS (Registry of Toxic Effects of Chemical Substances), and TRI (Toxic Chemical Release Inventory). HSDB contains chemical-specific information on manufacturing and use, chemical and physical properties, safety and handling, toxicity and biomedical effects, pharmacology, environmental fate and exposure potential, exposure standards and regulations, monitoring and analysis methods, and additional references.

[e] The reporting standards for ammonia were changed in 1995. Ammonium sulfate is deleted from the list and threshold and release determinations for aqueous ammonia are limited to 10 percent of the total ammonia present in solution. This change will reduce the amount of ammonia reported to TRI. Complete details of the revisions can be found in 40 CFR Part 372.

Nitric Acid (CAS: 7697-37-2)

Toxicity. The toxicity of nitric acid is related to its potent corrosivity as an acid, with ulceration of all membranes and tissues with which it comes in contact. Concentrated nitric acid causes immediate opacification and blindness of the cornea when it comes in contact with the eye. Inhalation of concentrated nitric acid causes severe, sometimes fatal, corrosion of the respiratory tract. Ingestion of nitric acid leads to gastric hemorrhaging, nausea, and vomiting. Circulatory shock is often the immediate cause of death due to nitric acid exposure. Damage to the respiratory system may be delayed for months, and even years. Populations at increased risk from nitric acid exposure include people with pre-existing skin, eye, or cardiopulmonary disorders.

Ecologically, gaseous nitric acid is a component of acid rain. Acid rain causes serious and cumulative damage to surface waters and aquatic and terrestrial organisms by decreasing water and soil pH levels. Nitric acid in rainwater acts as a topical source of nitrogen, preventing "hardening off" of evergreen foliage and increasing frost damage to perennial plants in temperate regions. Nitric acid also acts as an available nitrogen source in surface water, stimulating plankton and aquatic weed growth.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Nitric acid is mainly transported in the atmosphere as nitric acid vapors and in water as dissociated nitrate and hydrogen ions. In soil, nitric acid reacts with minerals such as calcium and magnesium, becoming neutralized, and at the same time decreasing soil "buffering capacity" against changes in pH levels.

Nitric acid leaches readily to groundwater, where it decreases the pH of the affected groundwater. In the winter, gaseous nitric acid is incorporated into snow, causing surges of acid during spring snow melt. Forested areas are strong sinks for nitric acid, incorporating the nitrate ions into plant tissues.

Methanol (CAS: 67-56-1)

Toxicity. Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses. In the body, methanol is converted into formaldehyde and formic acid. Methanol is excreted as formic acid. Observed toxic effects at high dose levels generally include central nervous system damage and blindness. Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in animals.

Ecologically, methanol is expected to have low toxicity to aquatic organisms. Concentrations lethal to half the organisms of a test population are expected to exceed one mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Liquid methanol is likely to evaporate when left exposed. Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants. In the atmosphere it can react with other atmospheric chemicals or be washed out by rain. Methanol is readily degraded by microorganisms in soils and surface waters.

Physical Properties. Methanol is highly flammable

Ethylene Glycol (CAS: 74-85-1)

Sources. Ethylene glycol is used as an antifreeze, heat transfer agent and solvent in industrial organic chemical facilities. The large quantity of ethylene glycol released is due to its ubiquitous use as an antifreeze and because in 1993 it had the 29th largest chemical production volume in the United States (*Chemical and Engineering News*). While the largest volume is released through underground injection, a substantial release also occurs from air point sources.

Toxicity. Long-term inhalation exposure to low levels of ethylene glycol may cause throat irritation, mild headache and backache. Exposure to higher concentrations may lead to unconsciousness. Liquid ethylene glycol is irritating to the eyes and skin.

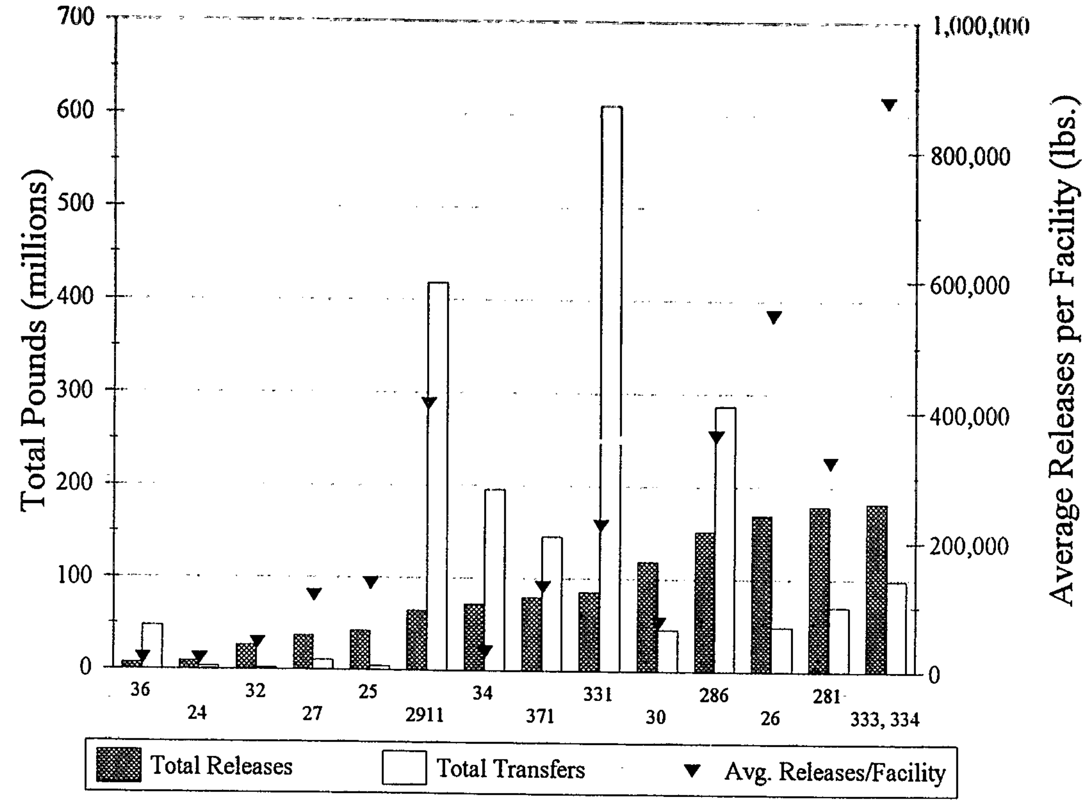
Toxic effects from ingestion of ethylene glycol include damage to the central nervous system and kidneys, intoxication, conjunctivitis, nausea and vomiting, abdominal pain, weakness, low blood oxygen, tremors, convulsions, respiratory failure, and coma. Renal failure due to ethylene glycol poisoning can lead to death.

Environmental Fate. Ethylene glycol readily biodegrades in water. No data are available that report its fate in soils; however, biodegradation is probably the dominant removal mechanism. Should ethylene glycol leach into the groundwater, biodegradation may occur.

regarding the total release and transfer amounts that are reported to TRI. Similar information is available within the annual TRI Public Data Release Book.

Exhibit 21 is a graphical representation of a summary of the 1993 TRI data for the organic chemical industry and the other sectors profiled in separate notebooks. The bar graph presents the total TRI releases and total transfers on the left axis and the triangle points show the average releases per facility on the right axis. Industry sectors are presented in the order of increasing total TRI releases. The graph is based on the data shown in Exhibit 22 and is meant to facilitate comparisons between the relative amounts of releases, transfers, and releases per facility both within and between these sectors. The reader should note, however, that differences in the proportion of facilities captured by TRI exist between industry sectors. This can be a factor of poor SIC matching and relative differences in the number of facilities reporting to TRI from the various sectors. In the case of the organic chemical industry, the 1993 TRI data presented here covers 417 facilities. Only those facilities listing SIC Codes falling within SIC 286 were used.

Exhibit 16: Summary of 1993 TRI Data: Releases and Transfers by Industry



SIC Range	Industry Sector	SIC Range	Industry Sector	SIC Range	Industry Sector
36	Electronic Equipment and Components	2911	Petroleum Refining	286	Organic Chemical Mfg.
24	Lumber and Wood Products	34	Fabricated Metals	26	Pulp and Paper
32	Stone, Clay, and Concrete	371	Motor Vehicles, Bodies, Parts, and Accessories	281	Inorganic Chemical Mfg.
27	Printing	331	Iron and Steel	333, 334	Nonferrous Metals
25	Wood Furniture and Fixtures	30	Rubber and Misc. Plastics		

Exhibit 22: Toxics Release Inventory Data for Selected Industries

Industry Sector	SIC Range	# TRI Facilities	1993 TRI Releases: Total Releases (million lbs.)	1993 TRI Releases: Average Releases per Facility (pounds)	1993 TRI Transfers: Total Transfers (million lbs.)	1993 TRI Transfers: Average Transfers per Facility (pounds)	Total Releases + Transfers (million lbs.)	Average Releases + Transfers per Facility (pounds)
Stone, Clay, and Concrete	32	634	26.6	42,000	2.2	4,000	28.8	46,000
Lumber and Wood Products	24	491	8.4	17,000	3.5	7,000	11.9	24,000
Furniture and Fixtures	25	313	42.2	135,000	4.2	13,000	46.4	148,000
Printing	2711-2789	318	36.5	115,000	10.2	32,000	46.7	147,000
Electronic Equip. and Components	36	406	6.7	17,000	47.1	116,000	53.7	133,000
Rubber and Misc. Plastics	30	1,579	118.4	75,000	45	29,000	163.4	104,000
Motor Vehicles, Bodies, Parts, and Accessories	371	609	79.3	130,000	145.5	239,000	224.8	369,000
Pulp and Paper	2611-2631	309	169.7	549,000	48.4	157,000	218.1	706,000
Inorganic Chem. Mfg.	2812-2819	555	179.6	324,000	70	126,000	249.7	450,000
Petroleum Refining	2911	156	64.3	412,000	417.5	2,676,000	481.9	3,088,000
Fabricated Metals	34	2,363	72	30,000	195.7	83,000	267.7	123,000
Iron and Steel	331	381	85.8	225,000	609.5	1,600,000	695.3	1,825,000
Nonferrous Metals	333, 334	208	182.5	877,000	98.2	472,000	280.7	1,349,000
Organic Chemical Mfg.	**2861-2869**	**417**	**151.6**	**364,000**	**286.7**	**688,000**	**438.4**	**1,052,000**
Metal Mining	10	Industry sector not subject to TRI reporting.						
Nonmetal Mining	14	Industry sector not subject to TRI reporting.						
Dry Cleaning	7216	Industry sector not subject to TRI reporting.						

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

V. POLLUTION PREVENTION OPPORTUNITIES

The best way to reduce pollution is to prevent it in the first place. Some companies have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and substituting benign chemicals for toxic ones. Some smaller facilities are able to actually get below regulatory thresholds just by reducing pollutant releases through aggressive pollution prevention policies.

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the organic chemical industry. While the list is not exhaustive, it does provide core information that can be used as the starting point for facilities interested in beginning their own pollution prevention projects. When possible, this section provides information from real activities that can, or are being implemented by this sector -- including a discussion of associated costs, time frames, and expected rates of return. This section provides summary information from activities that may be, or are being implemented by this sector. When possible, information is provided that gives the context in which the technique can be effectively used. Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector. Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects air, land and water pollutant releases.

The leaders in the organic chemical industry, similar to those in the chemical industry as a whole, have been promoting pollution prevention through various means. The most visible of these efforts is the Responsible Care® initiative of the Chemical Manufacturer's Association (CMA). Responsible Care is mandatory for CMA members who must commit to act as stewards for products through use and ultimate reuse or disposal. One of the guiding principles of this initiative is the inclusion of waste and release prevention objectives in research and in design of new or modified facilities, processes and products. The Synthetic Organic Chemical Manufactures Association (SOCMA) also requires its members to implement the Responsible Care® Guiding Principles as a condition of membership. SOCMA is instituting the Responsible Care® management practice codes on a phased-in basis to assist its approximately 110-non CMA members, which are primarily small and batch chemical manufacturers, in successfully implementing their programs.

Using pollution prevention techniques which prevent the release or generation of pollution in the first place have several advantages over end-of-pipe waste treatment technologies. The table below lists the direct and indirect benefits that could result.

Exhibit 23: Pollution Prevention Activities Can Reduce Costs

Direct Benefits

- Reduced waste treatment costs
  - Reduced capital and operating costs for waste treatment facilities
  - Reduced off-site treatment and disposal costs
- Reduced manufacturing costs due to improved yields
- Income or savings from sale or reuse of wastes
- Reduced environmental compliance costs (e.g., fines, shutdowns)
- Reduced or eliminated inventories or spills
- Reduced secondary emissions from waste treatment facilities
- Retained sales (production threatened by poor environmental performance or sales)

Indirect Benefits

- Reduced likelihood of future costs from:
  - Remediation
  - Legal liabilities
  - Complying with future regulations
- Use of emission offsets (internal and external)
- Improved community relations
- Increase environmental awareness by plant personnel and management
- Reduced societal costs
- Improved public health

Source: Chemical Manufacturer's Association *Designing Pollution Prevention into the Process*

These incentives may encourage organic chemical manufacturers to undertake pollution prevention activities voluntarily, but a number of barriers still exist in achieving widespread adoption of pollution prevention. The U.S. Office of Technology Assessment has identified and characterized a number of these barriers in its report titled *Industry, Technology, and the Environment.*

Pollution prevention can be carried out at any stage of the development of a process. In general, changes made at the research and development stage will have the greatest impact; however, changes in the process design and operating practices can also yield significant results.

In the research and development stage, all possible reaction pathways for producing the desired product can be examined. These can then be evaluated in light of yield, undesirable by-products, and their health and environmental impacts. The area of "green synthesis" is the focus of considerable research funded jointly by the Agency and by the National Science Foundation. Several alternative syntheses have already been developed that could reduce wastes. For example, Joseph M. Desimone of the University of North

Carolina, Chapel Hill, has used supercritical carbon dioxide as a medium for carrying out dispersion polymerizations. He uses a specially engineered free-radical initiator to start the reaction and a polymeric stabilizer to affect the polymerization of methyl methacrylate. Because the carbon dioxide can easily be separated from the reaction mixture, this reaction offers the possibility of reduced hazardous waste generation, particularly of aqueous streams contaminated with residual monomer and initiator.

Because of the large investment in current technology, and the lifetime of capital equipment, pollution prevention at the earliest stages is unlikely unless a company undertakes the design of a new production line or facility. There are, however, more numerous pollution prevention opportunities that can be realized by modifying current processes and equipment.

Exhibit 24: Process/Product Modifications Create Pollution Prevention Opportunities

Area	Potential Problem	Possible Approach
By-products Co-products		
Quantity and Quality	▪ Process inefficiencies result in the generation of undesired by-products and co-products. Inefficiencies will require larger volumes of raw materials and result in additional secondary products. Inefficiencies can also increase fugitive emissions and wastes generated through material handling.	▪ Increase product yield to reduce by-product and co-product generation and raw material requirements.
Uses and Outlets	▪ By-products and co-products are not fully utilized, generating material or waste that must be managed.	▪ Identify uses and develop a sales outlet. Collect information necessary to firm up a purchase commitment such as minimum quality criteria, maximum impurity levels that can be tolerated, and performance criteria.
Catalysts		
Composition	▪ The presence of heavy metals in catalysts can result in contaminated process wastewater from catalyst handling and separation. These wastes may require special treatment and disposal procedures or facilities. Heavy metals can be inhibitory or toxic to biological wastewater treatment units. Sludge from wastewater treatment units may be classified as hazardous due to heavy metals content. Heavy metals generally exhibit low toxicity thresholds in aquatic environments and may bioaccumulate.	▪ Catalysts comprised of noble metals, because of their cost, are generally recycled by both onsite and offsite reclaimers.
Preparation and Handling	▪ Emissions or effluents are generated with catalyst activation or regeneration.	▪ Obtain catalyst in the active form. ▪ Provide insitu activation with appropriate processing/activation facilities.
	▪ Catalyst attrition and carryover into product requires de-ashing facilities which are a likely source of wastewater and solid waste.	▪ Develop a more robust catalyst or support.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
Catalysts (cont.)		
Preparation and Handling (cont.)	▪ Catalyst is spent and needs to be replaced.	▪ In situ regeneration eliminates unloading/loading emissions and effluents versus offsite regeneration or disposal.
	▪ Pyrophoric catalyst needs to be kept wet, resulting in liquid contaminated with metals.	▪ Use a nonpryrophoric catalyst. Minimize amount of water required to handle and store safely.
	▪ Short catalyst life.	▪ Study and identify catalyst deactivitation mechanisms. Avoid conditions which promote thermal or chemical deactivation. By extending catalyst life, emissions and effluents associated with catalyst handling and regeneration can be reduced.
Effectiveness	▪ Catalyzed reaction has by-product formation, incomplete conversion and less-than-perfect yield.	▪ Reduce catalyst consumption with a more active form. A higher concentration of active ingredient or increased surface area can reduce catalyst loadings.
		▪ Use a more selective catalyst which will reduce the yield of undesired by-products.
		▪ Improve reactor mixing/contacting to increase catalyst effectiveness.
	▪ Catalyzed reaction has by-product formation, incomplete conversion and less-than perfect yield.	▪ Develop a thorough understanding of reaction to allow optimization of reactor design. Include in the optimization, catalyst consumption and by-product yield.
Intermediate Products		
Quantity and Quality	▪ Intermediate reaction products or chemical species, including trace levels of toxic constituents, may contribute to process waste under both normal and upset conditions.	▪ Modify reaction sequence to reduce amount or change composition of intermediates.
	▪ Intermediates may contain toxic constituents or have characteristics that are harmful to the environment.	▪ Modify reaction sequence to change intermediate properties.
		▪ Use equipment design and process control to reduce releases.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
Process Conditions/ Configuration		
Temperature	▪ High heat exchange tube temperatures cause thermal cracking/decomposition of many chemicals. These lower molecular weight by-products are a source of "light ends" and fugitive emissions. High localized temperature gives rise to polymerization of reactive monomers, resulting in "heavies" or "tars." such materials can foul heat exchange equipment or plug fixed-bed reactors, thereby requiring costly equipment cleaning and production outage.	▪ Select operating temperatures at or near ambient temperature whenever possible. ▪ Use lower pressure steam to lower temperatures. ▪ Use intermediate exchangers to avoid contact with furnace tubes and walls. ▪ Use staged heating to minimize product degradation and unwanted side reactions. ▪ Use superheat of high-pressure steam in place of furnace. ▪ Monitor exchanger fouling to correlate process conditions which increase fouling, avoid conditions which rapidly foul exchangers. ▪ Use online tube cleaning technologies to keep tube surfaces clean to increase heat transfer. ▪ Use scraped wall exchangers in viscous service. ▪ Use falling film reboiler, pumped recirculation reboiler or high-flux tubes.
	▪ Higher operating temperatures imply "heat input" usually via combustion which generates emissions.	▪ Explore heat integration opportunities (e.g., use waste heat to preheat materials and reduce the amount of combustion required.) ▪ Use thermocompressor to upgrade low-pressure steam to avoid the need for additional boilers and furnaces.
	▪ Heat sources such as furnaces and boilers are a source of combustion emissions.	▪ If possible, cool materials before sending to storage.
	▪ Vapor pressure increases with increasing temperature. Loading/ unloading, tankage and fugitive emissions generally increase with increasing vapor pressure.	▪ Use hot process streams to reheat feeds.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
Process Conditions/ Configuration (cont.)		
Temperature (cont.)		■ Add vent condensers to recover vapors in storage tanks or process.
		■ Add closed dome loading with vapor recovery condensers.
	■ Water solubility of most chemicals increases with increasing temperature.	■ Use lower temperature (vacuum processing).
Pressure	■ Fugitive emissions from equipment.	■ Equipment operating in vacuum service is not a source of fugitives; however, leaks into the process require control when system is degassed.
	■ Seal leakage potential due to pressure differential.	■ Minimize operating pressure.
	■ Gas solubility increases with higher pressures.	■ Determine whether gases can be recovered, compressed, and reused or require controls.
Corrosive Environment	■ Material contamination occurs from corrosion products. Equipment failures result in spills, leaks and increased maintenance costs.	■ Improve metallurgy or provide coating or lining.
		■ Neutralize corrosivity of materials contacting equipment.
		■ Use corrosion inhibitors.
	■ Increased waste generation due to addition of corrosion inhibitors or neutralization.	■ Improve metallurgy or provide coating or lining or operate in a less corrosive environment.
Batch vs. Continuous Operations	■ Vent gas lost during batch fill.	■Equalize reactor and storage tank vent lines.
		■Recover vapors through condenser, adsorber, etc.
	■ Waste generated by cleaning/purging of process equipment between production batches.	■ Use materials with low viscosity. Minimize equipment roughness.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
Process Conditions/ Configuration (cont.) *Batch vs. Continuous Operations (cont.)*		■ Optimize product manufacturing sequence to minimize washing operations and cross-contamination of subsequent batches.
	■ Process inefficiencies lower yield and increase emissions.	■ Sequence addition of reactants and reagents to optimize yields and lower emissions.
	■ Continuous process fugitive emissions and waste increase over time due to equipment failure through a lack of maintenance between turnarounds.	■Design facility to readily allow maintenance so as to avoid unexpected equipment failure and resultant release.
Process Operation/Design	■ Numerous processing steps create wastes and opportunities for errors.	■ Keep it simple. Make sure all operations are necessary. More operations and complexity only tend to increase potential emission and waste sources.
	■ Nonreactant materials (solvents, absorbants, etc.) create wastes. Each chemical (including water) employed within the process introduces additional potential waste sources; the composition of generated wastes also tends to become more complex.	■ Evaluate unit operation or technologies (e.g., separation) that do not require the addition of solvents or other nonreactant chemicals.
	■ High conversion with low yield results in wastes.	■ Recycle operations generally improve overall use of raw materials and chemicals, thereby both increasing the yield of desired products while at the same time reducing the generation of wastes. A case-in-point is to operate at a lower conversion per reaction cycle by reducing catalyst consumption, temperature, or residence time. Many times, this can result in a higher selectivity to desired products. The net effect upon recycle of unreacted reagents is an increase in product yield, while at the same time reducing the quantities of spent catalyst and less desirable by-products.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities

Area	Potential Problem	Possible Approach
Process Conditions/ Configuration (cont.)		
Process Operation/Design	■ Non-regenerative treatment systems result in increased waste versus regenerative systems.	■ Regenerative fixed bed treating or desiccant operation (e.g., aluminum oxide, silica, activated carbon, molecular sieves, etc.) will generate less quantities of solid or liquid waste than nonregenerative units (e.g., calcium chloride or activated clay). With regenerative units though, emissions during bed activation and regeneration can be significant. Further, side reactions during activation/regeneration can give rise to problematic pollutants.
Product		
Process Chemistry	■ Insufficient R&D into alternative reaction pathways may miss pollution opportunities such as waste reduction or eliminating a hazardous constituent.	■ R&D during process conception and laboratory studies should thoroughly investigate alternatives in process chemistry that affect pollution prevention.
Product Formulation	■ Product based on end-use performance may have undesirable environmental impacts or use raw materials or components that generate excessive or hazardous wastes.	■ Reformulate products by substituting different material or using a mixture of individual chemicals that meet end-use performance specifications.
Raw Materials		
Purity	■ Impurities may produce unwanted by-products and waste. Toxic impurities, even in trace amounts, can make a waste hazardous and therefore subject to strict and costly regulation.	■ Use higher purity materials. ■ Purify materials before use and reuse if practical. ■ Use inhibitors to prevent side reactions.
	■ Excessive impurities may require more processing and equipment to meet product specifications, increasing costs and potential for fugitive emissions, leaks, and spills.	■ Achieve balance between feed purity, processing steps, product quality and waste generation.
	■ Specifying a purity greater than needed by the process increases costs and can result in more waste generation by the supplier.	■ Specify a purity no greater than what the process needs.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities

Area	Potential Problem	Possible Approach
Raw Materials (cont.)		
Purity (cont.)	■ Impurities in clean air can increase inert purges.	■Use pure oxygen.
	■ Impurities may poison catalyst prematurely resulting in increased wastes due to yield loss and more frequent catalyst replacement.	■Install guard beds to protect catalysts.
Vapor Pressure	■ Higher vapor pressures increase fugitive emissions in material handling and storage.	■ Use material with lower vapor pressure.
	■ High vapor pressure with low odor threshold materials can cause nuisance odors.	■ Use materials with lower vapor pressure and higher odor threshold.
Water Solubility	■ Toxic or nonbiodegradable materials that are water soluble may affect wastewater treatment operation, efficiency, and cost.	■ Use less toxic or more biodegradable materials.
	■ Higher solubility may increase potential for surface and groundwater contamination and may require more careful spill prevention, containment, and cleanup (SPCC) plans.	■ Use less soluble materials.
	■ Higher solubility may increase potential for storm water contamination in open areas.	■ Use less soluble materials. ■ Prevent direct contact with storm water by diking or covering areas.
	■ Process wastewater associated with water washing or hydrocarbon/water phase separation will be impacted by containment solubility in water. Appropriate wastewater treatment will be impacted.	■ Minimize water usage. ■ Reuse wash water. ■ Determine optimum process conditions for phase separation. ■ Evaluate alternative separation technologies (coalescers, membranes, distillation, etc.)

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities

Area	Potential Problem	Possible Approach
Raw Materials (cont.)		
Toxicity	▪ Community and worker safety and health concerns result from routine and nonroutine emissions. Emissions sources include vents, equipment leaks, wastewater emissions, emergency pressure relief, etc.	▪ Use less toxic materials. ▪ Reduce exposure through equipment design and process control. Use systems which are passive for emergency containment of toxic releases.
	▪ Surges or higher than normal continuous levels of toxic materials can shock or miss wastewater biological treatment systems resulting in possible fines and possible toxicity in the receiving water.	▪ Use less toxic material. ▪ Reduce spills, leaks, and upset conditions through equipment and process control. ▪ Consider effect of chemicals on biological treatment; provide unit pretreatment or diversion capacity to remove toxicity. ▪ Install surge capacity for flow and concentration equalization.
Regulatory	▪ Hazardous or toxic materials are stringently regulated. They may require enhanced control and monitoring; increased compliance issues and paperwork for permits and record keeping; stricter control for handling, shipping, and disposal; higher sampling and analytical costs; and increased health and safety costs.	▪ Use materials which are less toxic or hazardous. ▪ Use better equipment and process design to minimize or control releases; in some cases, meeting certain regulatory criteria will exempt a system from permitting or other regulatory requirements.
Form of Supply	▪ Small containers increase shipping frequency which increases chances of material releases and waste residues from shipping containers (including wash waters).	▪ Use bulk supply, ship by pipeline, or use "jumbo" drums or sacks. ▪ In some cases, product may be shipped out in the same containers the material supply was shipped in without washing.
	▪ Nonreturnable containers may increase waste.	▪ Use returnable shipping containers or drums.
Handling and Storage	▪ Physical state (solid, liquid, gaseous) may raise unique environmental, safety, and health issues with unloading operations and transfer to process equipment.	▪ Use equipment and controls appropriate to the type of materials to control releases.

Exhibit 24 (cont.): Process/Product Modifications Create Pollution Prevention Opportunities		
Area	**Potential Problem**	**Possible Approach**
Raw Materials (cont.)		
Handling and Storage (cont.)	▪ Large inventories can lead to spills, inherent safety issues and material expiration.	▪ Minimize inventory by utilizing just-in-time delivery.
Waste Streams		
Quantity and Quality	▪ Characteristics and sources of waste streams are unknown.	▪ Document sources and quantities of waste streams prior to pollution prevention assessment.
	▪ Wastes are generated as part of the process.	▪ Determine what changes in process conditions would lower waste generation of toxicity.
		▪ Determine if wastes can be recycled back into the process.
Composition	▪ Hazardous or toxic constituents are found in waste streams. Examples are: sulfides, heavy metals, halogenated hydrocarbons, and polynuclear aromatics.	▪ Evaluate whether different process conditions, routes, or reagent chemicals (e.g., solvent catalysts) can be substituted or changed to reduce or eliminate hazardous or toxic compounds.
Properties	▪ Environmental fate and waste properties are not known or understood.	▪ Evaluate waste characteristics using the following type properties: corrosivity, ignitability, reactivity, BTU content (energy recovery), biodegradability, aquatic toxicity, and bioaccumulation potential of the waste and of its degradable products, and whether it is a solid, liquid, or gas.
Disposal	▪ Ability to treat and manage hazardous and toxic waste unknown or limited.	▪ Consider and evaluate all onsite and offsite recycle, reuse, treatment, and disposal options available. Determine availability of facilities to treat or manage wastes generated.

Source: Chemical Manufacturer's Association. *Designing Pollution Prevention into the Process, Research, Development and Engineering.*

Exhibit 25: Modifications to Equipment Can Also Prevent Pollution

Equipment	Potential Environment Problem	Possible Approach	
		Design Related	Operational Related
Compressors, blowers, fans	■ Shaft seal leaks, piston rod seal leaks, and vent streams	■ Seal-less designs (diaphragmatic, hermetic or magnetic) ■ Design for low emissions (internal balancing, double inlet, gland eductors) ■ Shaft seal designs (carbon rings, double mechanical seals, buffered seals) ■ Double seal with barrier fluid vented to control device	■ Preventive maintenance program
Concrete pads, floors, sumps	■ Leaks to groundwater	■ Water stops ■ Embedded metal plates ■ Epoxy sealing ■ Other impervious sealing	■ Reduce unnecessary purges, transfers, and sampling ■ Use drip pans where necessary
Controls	■ Shutdowns and start-ups generate waste and releases	■ Improve on-line controls ■ On-line instrumentation ■ Automatic start-up and shutdown ■ On-line vibration analysis ■ Use "consensus" systems (e.g., shutdown trip requires 2 out of 3 affirmative responses)	■ Continuous versus batch ■ Optimize on-line run time ■ Optimize shutdown interlock inspection frequency ■ Identify safety and environment critical instruments and equipment
Distillation	■ Impurities remain in process streams	■ Increase reflux ratio ■ Add section to column ■ Column intervals ■ Change feed tray	■ Change column operating conditions - reflux ratio - feed tray - temperature - pressure - etc.

Exhibit 25 (cont.): Modifications to Equipment Can Also Prevent Pollution			
		Possible Approach	
Equipment	Potential Environment Problem	Design Related	Operational Related
Distillation (cont.)	▪ Impurities remain in process streams (cont.)	▪ Insulate to prevent heat loss ▪ Preheat column feed ▪ Increase vapor line size to lower pressure drop	▪ Clean column to reduce fouling
	▪ Large amounts of contaminated water condensate from stream stripping	▪ Use reboilers or inert gas stripping agents	▪ Use higher temperature steam
General manufacturing equipment areas	▪ Contaminated rainwater	▪ Provide roof over process facilities ▪ Segregate process sewer from storm sewer (diking) ▪ Hard-pipe process streams to process sewer	▪ Return samples to process ▪ Monitor stormwater discharge
	▪ Contaminated sprinkler and fire water	▪ Seal floors ▪ Drain to sump ▪ Route to waste treatment	
	▪ Leaks and emissions during cleaning	▪ Design for cleaning ▪ Design for minimum rinsing ▪ Design for minimum sludge ▪ Provide vapor enclosure ▪ Drain to process	▪ Use drip pans for maintenance activities ▪ Rinse to sump ▪ Reuse cleaning solutions
Heat exchangers	▪ Increased waste due to high localized temperatures	▪ Use intermediate exchangers to avoid contact with furnace tubes and walls ▪ Use staged heating to minimize product degradation and unwanted side reactions. (waste heat >>low pressure steam >>high pressure steam)	▪ Select operating temperatures at or near ambient temperature when-ever possible. These are generally most desirable from a pollution prevention standpoint ▪ Use lower pressure steam to lower temperatures

Exhibit 25 (cont.): Modifications to Equipment Can Also Prevent Pollution			
		Possible Approach	
Equipment	Potential Environment Problem	Design Related	Operational Related
Heat exchangers (cont.)	■ Increased waste due to high localized temperatures (cont.)	■ Use scraped wall exchangers in viscous service ■ Using falling film reboiler, piped recirculation reboiler or high-flux tubes ■ Use lowest pressure steam possible	■ Monitor exchanger fouling to correlate process conditions which increase fouling, avoid conditions which rapidly foul exchangers ■ Use on-line tube cleaning techniques to keep tube surfaces clean
	■ Contaminated materials due to tubes leaking at tube sheets	■ Use welded tubes or double tube sheets with inert purge. Mount vertically	■ Monitor for leaks
	■ Furnace emissions	■ Use superheat of high-pressure steam in place of a furnace	
Piping	■ Leaks to groundwater; fugitive emissions	■ Design equipment layout so as to minimize pipe run length ■ Eliminate underground piping or design for cathodic protection if necessary to install piping underground ■ Welded fittings ■ Reduce number of flanges and valves ■ All welded pipe ■ Secondary containment ■ Spiral-wound gaskets ■ Use plugs and double valves for open end lines ■ Change metallurgy ■ Use lined pipe	■ Monitor for corrosion and erosion ■ Paint to prevent external corrosion

Exhibit 25 (cont.): Modifications to Equipment Can Also Prevent Pollution			
		Possible Approach	
Equipment	Potential Environment Problem	Design Related	Operational Related
Piping (cont.)	■ Releases when cleaning or purging lines	■ Use "pigs" for cleaning ■ Slope to low point drain ■ Use heat tracing and insulation to prevent freezing ■ Install equalizer lines	■ Flush to product storage tank
Pumps	■ Fugitive emissions from shaft seal leaks	■ Mechanical seal in lieu of packing ■ Double mechanical seal with inert barrier fluid ■ Double machined seal with barrier fluid vented to control device ■ Seal-less pump (canned motor magnetic drive) ■ Vertical pump	■ Seal installation practices ■ Monitor for leaks
	■ Fugitive emissions from shaft seal leaks	■ Use pressure transfer to eliminate pump	
	■ Residual "heel" of liquid during pump maintenance	■ Low point drain on pump casing	■ Flush casing to process sewer for treatment ■ Increase the mean time between pump failures by: - selecting proper seal material; - good alignment; - reduce pipe-induced stress - Maintaining seal lubrication
	■ Injection of seal flush fluid into process stream	■ Use double mechanical seal with inert barrier fluid where practical	
Reactors	■ Poor conversion or performance due to inadequate mixing	■ Static mixing ■ Add baffles ■ Change impellers	■ Add ingredients with optimum sequence

Exhibit 25 (cont.): Modifications to Equipment Can Also Prevent Pollution

Equipment	Potential Environment Problem	Possible Approach: Design Related	Possible Approach: Operational Related
Reactors (cont.)	▪ Poor conversion (cont.)	▪ Add horsepower ▪ Add distributor	▪ Allow proper head space in reactor to enhance vortex effect
	▪ Waste by-product formation	▪ Provide separate reactor for converting recycle streams to usable products	▪ Optimize reaction conditions (temperature, pressure, etc.)
Relief Valve	▪ Leaks	▪ Provide upstream rupture disc	
	▪ Fugitive emissions	▪ Vent to control or recovery device	▪ Monitor for leaks and for control efficiency
	▪ Discharge to environment from over pressure	▪ Pump discharges to suction of pump ▪ Thermal relief to tanks ▪ Avoid discharge to roof areas to prevent contamination of rainwater	▪ Monitor for leaks
	▪ Frequent relief	▪ Use pilot operated relief valve ▪ Increase margin between design and operating pressure	▪ Reduce operating pressure ▪ Review system performance
Sampling	▪ Waste generation due to sampling (disposal, containers, leaks, fugitives, etc.)	▪ In-line insitu analyzers ▪ System for return to process ▪ Closed loop ▪ Drain to sump	▪ Reduce number and size of samples required ▪ Sample at the lowest possible temperature ▪ Cool before sampling
Tanks	▪ Tank breathing and working losses	▪ Cool materials before storage ▪ Insulate tanks ▪ Vent to control device (flare, condenser, etc.) ▪ Vapor balancing ▪ Floating roof	▪ Optimize storage conditions to reduce losses

Exhibit 25 (cont.): Modifications to Equipment Can Also Prevent Pollution

Equipment	Potential Environment Problem	Possible Approach: Design Related	Possible Approach: Operational Related
Tanks (cont.)	▪ Tank breathing and working losses (cont.)	▪ Floating roof ▪ Higher design pressure	
	▪ Leak to groundwater	▪ All aboveground (situated so bottom can routinely be checked for leaks) ▪ Secondary containment ▪ Improve corrosion resistance	▪ Monitor for leaks and corrosion
	▪ Large waste heel	▪ Design for 100% de-inventory	▪ Recycle to process if practical
Vacuum Systems	▪ Waste discharge from jets	▪ Substitute mechanical vacuum pump ▪ Evaluate using process fluid for powering jet	▪ Monitor for air leaks ▪ Recycle condensate to process
Valves	▪ Fugitive emissions from leaks	▪ Bellow seals ▪ Reduce number where practical ▪ Special packing sets	▪ Stringent adherence to packing procedures
Vents	▪ Release to environment	▪ Route to control or recovery device	▪ Monitor performance

Source: Chemical Manufacturer's Association. *Designing Pollution Prevention into the Process, Research, Development and Engineering.*

It is critical to emphasize that pollution prevention in the chemical industry is process specific and oftentimes constrained by site-specific considerations. As such, it is difficult to generalize about the relative merits of different pollution prevention strategies. The age, size, and purpose of the plant will influence the choice of the most effective pollution prevention strategy. Commodity chemical manufacturers redesign their processes infrequently so that redesign of the reaction process or equipment is unlikely in the short term. Here operational changes are the most feasible response. Specialty chemical manufacturers are making a greater variety of chemicals and have more process and design flexibility. Incorporating changes at the earlier research and development phases may be possible for them.

Changes in operational practices may yield the most immediate gains with the least investment. For example, the majority of the waste generated by the chemical processing industry is contaminated water: Borden Chemical Company has collected and isolated its waste water in a trench coming from the phenol rail car unloading area and reused the water in resin batches. This eliminated the entire waste stream with a capital investment of $3,000 and annual savings of $1,500 a year in treatment costs. Rhone-Poulenc, in New Brunswick, New Jersey, is now sending all quality control and raw material samples back to be reused in the production process saving $20,000 per year and reducing waste volume by 3,000 pounds.

Another area that can yield significant benefits is improved process control so that less off-specification product is produced (that must be discarded) and the process is run more optimally (fewer by-products). Exxon Chemical Americas of Linden, New Jersey, used continuous process optimization to reduce the generation of acid coke, a process residue, thus saving $340,000 annually in treatment costs. New in-line process controls are under development (a fertile area of research being pursued by the Center for Process Analytic Chemistry at the University of Washington) that may allow better process optimization through tighter process control.

Chemical substitution, particularly of water for non-aqueous solvents, can also prevent pollution. For example, Du Pont at the Chamber Works in New Jersey is using a high-pressure water-jet system to clean polymer reaction vessels. This replaces organic solvent cleaning that annually produced 40,000 pounds of solvent waste. Installing the new cleaning system cost $125,000 but it will save $270,000 annually.

Improved separations design also offers a pollution prevention opportunity since separations account for about 20 percent of energy use in the chemical process industry. In one case, a solvent was replaced by an excess of a reaction component, thus eliminating the need to separate the solvent from the waste stream while reducing separation costs.

VI. SUMMARY OF APPLICABLE FEDERAL STATUTES AND REGULATIONS

This section discusses the Federal regulations that may apply to this sector. The purpose of this section is to highlight and briefly describe the applicable Federal requirements, and to provide citations for more detailed information. The three following sections are included:

- Section VI.A contains a general overview of major statutes
- Section VI.B contains a list of regulations specific to this industry
- Section VI.C contains a list of pending and proposed regulations

The descriptions within Section VI are intended solely for general information. Depending upon the nature or scope of the activities at a particular facility, these summaries may or may not necessarily describe all applicable environmental requirements. Moreover, they do not constitute formal interpretations or clarifications of the statutes and regulations. For further information readers should consult the Code of Federal Regulations and other state or local regulatory agencies. EPA Hotline contacts are also provided for each major statute.

VI.A. General Description of Major Statutes

Resource Conservation And Recovery Act (RCRA)

RCRA of 1976, which amended the Solid Waste Disposal Act, addresses solid (Subtitle D) and hazardous (Subtitle C) waste management activities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 strengthened RCRA's waste management provisions and added Subtitle I, which governs underground storage tanks (USTs).

Regulations promulgated pursuant to Subtitle C of RCRA (40 CFR Parts 260-299) establish a "cradle-to-grave" system governing hazardous waste from the point of generation to disposal. RCRA hazardous wastes include the specific materials listed in the regulations (commercial chemical products, designated with the code "P" or "U"; hazardous wastes from specific industries/sources, designated with the code "K"; or hazardous wastes from non-specific sources, designated with the code "F") or materials which exhibit a hazardous waste characteristic (ignitibility, corrosivity, reactivity, or toxicity and designated with the code "D").

Regulated entities that generate hazardous waste are subject to waste accumulation, manifesting, and record keeping standards. Facilities that treat, store, or dispose of hazardous waste must obtain a permit, either from EPA or from a State agency which EPA has authorized to implement the permitting program. Subtitle C permits contain general facility standards such as contingency plans, emergency procedures, record keeping and reporting requirements, financial assurance mechanisms, and unit-specific standards. RCRA also contains provisions (40 CFR Part 264 Subpart S and §264.10) for conducting corrective actions which govern the cleanup of releases of hazardous waste or constituents from solid waste management units at RCRA-regulated facilities.

Although RCRA is a Federal statute, many States implement the RCRA program. Currently, EPA has delegated its authority to implement various provisions of RCRA to 46 of the 50 States.

Most RCRA requirements are not industry specific but apply to any company that transports, treats, stores, or disposes of hazardous waste. Here are some important RCRA regulatory requirements:

- **Identification of Solid and Hazardous Wastes** (40 CFR Part 261) lays out the procedure every generator should follow to determine whether the material created is considered a hazardous waste, solid waste, or is exempted from regulation.

- **Standards for Generators of Hazardous Waste** (40 CFR Part 262) establishes the responsibilities of hazardous waste generators including obtaining an ID number, preparing a manifest, ensuring proper packaging and labeling, meeting standards for waste accumulation units, and record keeping and reporting requirements. Generators can accumulate hazardous waste for up to 90 days (or 180 days depending on the amount of waste generated) without obtaining a permit.

- **Land Disposal Restrictions** (LDRs) are regulations prohibiting the disposal of hazardous waste on land without prior treatment. Under the LDRs (40 CFR 268), materials must meet land disposal restriction (LDR) treatment standards prior to placement in a RCRA land disposal unit (landfill, land treatment unit, waste pile, or surface impoundment). Wastes subject to the LDRs include solvents, electroplating wastes, heavy metals, and acids. Generators of waste subject to the LDRs must provide notification of such to the designated TSD facility to ensure proper treatment prior to disposal.

- **Used Oil** storage and disposal regulations (40 CFR Part 279) do not define **Used Oil Management Standards** impose management requirements affecting the storage, transportation, burning, processing, and re-refining of the used oil. For parties that merely generate used oil, regulations establish storage standards. For a party considered a used oil marketer (one who generates and sells off-specification used oil directly to a used oil burner), additional tracking and paperwork requirements must be satisfied.

- **Tanks and Containers** used to store hazardous waste with a high volatile organic concentration must meet emission standards under RCRA. Regulations (40 CFR Part 264-265, Subpart CC) require generators to test the waste to determine the concentration of the waste, to satisfy tank and container emissions standards, and to inspect and monitor regulated units. These regulations apply to all facilities who store such waste, including generators operating under the 90-day accumulation rule.

- **Underground Storage Tanks** (USTs) containing petroleum and hazardous substance are regulated under Subtitle I of RCRA. Subtitle I regulations (40 CFR Part 280) contain tank design and release detection requirements, as well as financial responsibility and corrective action standards for USTs. The UST program also establishes increasingly stringent standards, including upgrade requirements for existing tanks, that must be met by 1998.

- **Boilers and Industrial Furnaces** (BIFs) that use or burn fuel containing hazardous waste must comply with strict design and operating standards. BIF regulations (40 CFR Part 266, Subpart H) address unit design, provide performance standards, require emissions monitoring, and restrict the type of waste that may be burned.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, responds to questions and distributes guidance regarding all RCRA regulations. The RCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Comprehensive Environmental Response, Compensation, And Liability Act (CERCLA)

CERCLA, a 1980 law commonly known as Superfund, authorizes EPA to respond to releases, or threatened releases, of hazardous substances that may endanger public health, welfare, or the environment. CERCLA also enables EPA to force parties responsible for environmental contamination to clean it up or to reimburse the Superfund for response costs incurred by EPA. The Superfund Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for Superfund, and created a free-standing law, SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The CERCLA **hazardous substance release reporting regulations** (40 CFR Part 302) direct the person in charge of a facility to report to the National Response Center (NRC) any environmental release of a hazardous substance which exceeds a reportable quantity. Reportable quantities are defined and listed in 40 CFR §302.4. A release report may trigger a response by EPA, or by one or more Federal or State emergency response authorities.

EPA implements **hazardous substance responses** according to procedures outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as "removals." EPA generally takes remedial actions only at sites on the

National Priorities List (NPL), which currently includes approximately 1300 sites. Both EPA and states can act at other sites; however, EPA provides responsible parties the opportunity to conduct removal and remedial actions and encourages community involvement throughout the Superfund response process.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, answers questions and references guidance pertaining to the Superfund program. The CERCLA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Emergency Planning And Community Right-To-Know Act (EPCRA)

The Superfund Amendments and Reauthorization Act (SARA) of 1986 created EPCRA, also known as SARA Title III, a statute designed to improve community access to information about chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA required the establishment of State emergency response commissions (SERCs), responsible for coordinating certain emergency response activities and for appointing local emergency planning committees (LEPCs).

EPCRA and the EPCRA regulations (40 CFR Parts 350-372) establish four types of reporting obligations for facilities which store or manage specified chemicals:

- **EPCRA §302** requires facilities to notify the SERC and LEPC of the presence of any "extremely hazardous substance" (the list of such substances is in 40 CFR Part 355, Appendices A and B) if it has such substance in excess of the substance's threshold planning quantity, and directs the facility to appoint an emergency response coordinator.

- **EPCRA §304** requires the facility to notify the SERC and the LEPC in the event of a release exceeding the reportable quantity of a CERCLA hazardous substance or an EPCRA extremely hazardous substance.

- **EPCRA §311 and §312** require a facility at which a hazardous chemical, as defined by the Occupational Safety and Health Act, is present in an amount exceeding a specified threshold to submit to the SERC, LEPC and local fire department material safety data sheets (MSDSs) or lists of MSDS's and hazardous chemical inventory forms (also known as Tier I and II forms). This information helps the local government respond in the event of a spill or release of the chemical.

- **EPCRA §313** requires manufacturing facilities included in SIC codes 20 through 39, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report. This report, commonly known as the Form R, covers releases and transfers of toxic chemicals to various facilities and environmental media, and allows EPA to compile the national Toxic Release Inventory (TRI) database.

All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

EPA's EPCRA Hotline, at (800) 535-0202, answers questions and distributes guidance regarding the emergency planning and community right-to-know regulations. The EPCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Clean Water Act (CWA)

The primary objective of the Federal Water Pollution Control Act, commonly referred to as the CWA, is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the CWA include "priority" pollutants and various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants which are pollutants not identified as either conventional or priority.

The CWA regulates both direct and indirect discharges. The **National Pollutant Discharge Elimination System (NPDES)** program (CWA §402) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits, issued by either EPA or an authorized State (EPA has authorized approximately forty States to administer the NPDES program), contain industry-specific, technology-based and/or water quality-based limits, and establish pollutant monitoring requirements. A facility that intends to discharge into the nation's waters must obtain a permit prior to initiating its discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set forth the conditions and effluent limitations under which a facility may make a discharge.

A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs. Water quality criteria and standards vary from state to state, and site to site, depending on the use classification of the receiving body of water. Most states follow EPA guidelines, which propose aquatic life and human health criteria for many of the 126 priority pollutants.

Storm Water Discharges

In 1987 the CWA was amended to require EPA to establish a program to address **storm water discharges**. In response, EPA promulgated the NPDES storm water permit application regulations. Storm water discharge associated with industrial activity means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw material storage areas at an industrial plant (40 CFR 122.26 (b)(14)). These regulations require that facilities with the following storm water discharges apply for an NPDES permit: (1) a discharge associated with industrial activity; (2) a discharge from a large or medium municipal storm sewer system; or (3) a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

The term "storm water discharge associated with industrial activity" means a storm water discharge from one of 11 categories of industrial activity defined at 40 CFR 122.26. Six of the categories are defined by SIC codes while the other five are identified through narrative descriptions of the regulated industrial activity. If the primary SIC code of the facility is one of those identified in the regulations, the facility is subject to the storm water permit application requirements. If any activity at a facility is covered by one of the five narrative categories, storm water discharges from those areas where the activities occur are subject to storm water discharge permit application requirements.

Those facilities/activities that are subject to storm water discharge permit application requirements are identified below. To determine whether a particular facility falls within one of these categories, the regulation should be consulted.

Category i: Facilities subject to storm water effluent guidelines, new source performance standards, or toxic pollutant effluent standards.

Category ii: Facilities classified as SIC 24-lumber and wood products (except wood kitchen cabinets); SIC 26-paper and allied products (except paperboard containers and products); SIC 28-chemicals and allied products (except drugs and paints); SIC 291-petroleum refining; and SIC 311-leather tanning and finishing.

Category iii: Facilities classified as SIC 10-metal mining; SIC 12-coal mining; SIC 13-oil and gas extraction; and SIC 14-nonmetallic mineral mining.

Category iv: Hazardous waste treatment, storage, or disposal facilities.

Category v: Landfills, land application sites, and open dumps that receive or have received industrial wastes.

Category vi: Facilities classified as SIC 5015-used motor vehicle parts; and SIC 5093-automotive scrap and waste material recycling facilities.

Category vii: Steam electric power generating facilities.

Category viii: Facilities classified as SIC 40-railroad transportation; SIC 41-local passenger transportation; SIC 42-trucking and warehousing (except public warehousing and storage); SIC 43-U.S. Postal Service; SIC 44-water transportation; SIC 45-transportation by air; and SIC 5171-petroleum bulk storage stations and terminals.

Category ix: Sewage treatment works.

Category x: Construction activities except operations that result in the disturbance of less than five acres of total land area.

Category xi: Facilities classified as SIC 20-food and kindred products; SIC 21-tobacco products; SIC 22-textile mill products; SIC 23-apparel related products; SIC 2434-wood kitchen cabinets manufacturing; SIC 25-furniture and fixtures; SIC 265-paperboard containers and boxes; SIC 267-converted paper and paperboard products; SIC 27-printing, publishing, and allied industries; SIC 283-drugs; SIC 285-paints, varnishes, lacquer, enamels, and allied products; SIC 30-rubber and plastics; SIC 31-leather and leather products (except leather and tanning and finishing); SIC 323-glass products; SIC 34-fabricated metal products (except fabricated structural metal); SIC 35-industrial and commercial machinery and computer equipment; SIC 36-electronic and other electrical equipment and components; SIC 37-transportation equipment (except ship and boat building and repairing); SIC 38-measuring, analyzing, and controlling instruments; SIC 39-miscellaneous manufacturing industries; and SIC 4221-4225-public warehousing and storage.

Pretreatment Program

Another type of discharge that is regulated by the CWA is one that goes to a publicly-owned treatment works (POTWs). The national **pretreatment program** (CWA §307(b)) controls the indirect discharge of pollutants to POTWs by "industrial users." Facilities regulated under §307(b) must meet certain pretreatment standards. The goal of the pretreatment program is to protect municipal wastewater treatment plants from damage that may occur when hazardous, toxic, or other wastes are discharged into a sewer system and to protect the quality of sludge generated by these plants. Discharges to a POTW are regulated primarily by the POTW itself, rather than the State or EPA.

EPA has developed technology-based standards for industrial users of POTWs. Different standards apply to existing and new sources within each category. "Categorical" pretreatment standards applicable to an industry on a nationwide basis are developed by EPA. In addition, another kind of pretreatment standard, "local limits," are developed by the POTW in order to assist the POTW in achieving the effluent limitations in its NPDES permit.

Regardless of whether a State is authorized to implement either the NPDES or the pretreatment program, if it develops its own program, it may enforce requirements more stringent than Federal standards.

EPA's Office of Water, at (202) 260-5700, will direct callers with questions about the CWA to the appropriate EPA office. EPA also maintains a bibliographic database of Office of Water publications which can be accessed through the Ground Water and Drinking Water resource center, at (202) 260-7786.

Safe Drinking Water Act (SDWA)

The SDWA mandates that EPA establish regulations to protect human health from contaminants in drinking water. The law authorizes EPA to develop national drinking water standards and to create a joint Federal-State system to ensure compliance with these standards. The SDWA also directs EPA to protect underground sources of drinking water through the control of underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its SDWA authority. EPA and authorized states enforce the primary drinking water standards, which are, contaminant-specific concentration limits that apply to certain public drinking water supplies. Primary drinking water standards consist of maximum contaminant level goals (MCLGs), which are non-enforceable health-based goals, and maximum contaminant levels (MCLs), which are enforceable limits set as close to MCLGs as possible, considering cost and feasibility of attainment.

The SDWA **Underground Injection Control** (UIC) program (40 CFR Parts 144-148) is a permit program which protects underground sources of drinking water by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA land disposal restrictions standards. The UIC permit program is primarily state-enforced, since EPA has authorized all but a few states to administer the program.

The SDWA also provides for a Federally-implemented Sole Source Aquifer program, which prohibits Federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area, and for a State-implemented Wellhead Protection program, designed to protect drinking water wells and drinking water recharge areas.

EPA's Safe Drinking Water Hotline, at (800) 426-4791, answers questions and distributes guidance pertaining to SDWA standards. The Hotline operates from 9:00 a.m. through 5:30 p.m., ET, excluding Federal holidays.

Toxic Substances Control Act (TSCA)

TSCA granted EPA authority to create a regulatory framework to collect data on chemicals in order to evaluate, assess, mitigate, and control risks which may be posed by their manufacture, processing, and use. TSCA provides a variety of control methods to prevent chemicals from posing unreasonable risk.

TSCA standards may apply at any point during a chemical's life cycle. Under TSCA §5, EPA has established an inventory of chemical substances. If a chemical is not already on the inventory, and has not been excluded by TSCA, a premanufacture notice (PMN) must be submitted to EPA prior to manufacture or import. The PMN must identify the chemical and provide available information on health and environmental effects. If available data are not sufficient to evaluate the chemicals effects, EPA can impose restrictions pending the development of information on its health and environmental effects. EPA can also restrict significant new uses of chemicals based upon factors such as the projected volume and use of the chemical.

Under TSCA §6, EPA can ban the manufacture or distribution in commerce, limit the use, require labeling, or place other restrictions on chemicals that pose unreasonable risks. Among the chemicals EPA regulates under §6 authority are asbestos, chlorofluorocarbons (CFCs), and polychlorinated biphenyls (PCBs).

EPA's TSCA Assistance Information Service, at (202) 554-1404, answers questions and distributes guidance pertaining to Toxic Substances Control Act standards. The Service operates from 8:30 a.m. through 4:30 p.m., ET, excluding Federal holidays.

Clean Air Act (CAA)

The CAA and its amendments, including the Clean Air Act Amendments (CAAA) of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50-99.

Pursuant to Title I of the CAA, EPA has established national ambient air quality standards (NAAQSs) to limit levels of "criteria pollutants," including carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide. Geographic areas that meet NAAQSs for a given pollutant are classified as attainment areas; those that do not meet NAAQSs are classified as non-attainment areas. Under §110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards.

Title I also authorizes EPA to establish New Source Performance Standards (NSPSs), which are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPSs are based on the pollution control technology available to that category of industrial source but allow the affected industries the flexibility to devise a cost-effective means of reducing emissions.

Under Title I, EPA establishes and enforces National Emission Standards for Hazardous Air Pollutants (NESHAPs), nationally uniform standards oriented towards controlling particular hazardous air pollutants (HAPs). Title III of the CAAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date, EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards will be developed for both new and existing sources based on "maximum achievable control technology (MACT)." The MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors.

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapor recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV establishes a sulfur dioxide emissions program designed to reduce the formation of acid rain. Reduction of sulfur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which, beginning in 1995, will be set below previous levels of sulfur dioxide releases.

Title V of the CAAA of 1990 created a permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing the permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State.

Title VI is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restrict their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs), will be phased out entirely by the year 2000, while certain hydrochlorofluorocarbons (HCFCs) will be phased out by 2030.

EPA's Control Technology Center, at (919) 541-0800, provides general assistance and information on CAA standards. The Stratospheric Ozone Information Hotline, at (800) 296-1996, provides general information about regulations promulgated under Title VI of the CAA, and EPA's EPCRA Hotline, at (800) 535-0202, answers questions about accidental release prevention under CAA §112(r). In addition, the Technology Transfer Network Bulletin Board System (modem access (919) 541-5742)) includes recent CAA rules, EPA guidance documents, and updates of EPA activities.

VI.B. Industry Specific Requirements

The organic chemical industry is affected by nearly all federal environmental statutes. In addition, the industry is subject to numerous laws and regulations from state and local governments designed to protect and improve the nation's health, safety, and environment. A summary of the major federal regulations affecting the chemical industry follows. The Synthetic Organic Chemical Manufacturer's Association is undertaking a year-long study to identify the environmental regulations that apply to their members. The study should be available in early 1996.

Federal Statutes

Toxic Substances Control Act (TSCA)

TSCA gives the Environmental Protection Agency comprehensive authority to regulate any chemical substance whose manufacture, processing, distribution in commerce, use or disposal may present an unreasonable risk of injury to health or the environment. Three sections are of primary importance to the organic chemical industry. TSCA §5 mandates that chemical companies submit pre-manufacture notices that provide information on health and environmental effects for each new product and test existing products for these effects (40 CFR Part 720). TSCA §4 authorizes the EPA to require testing of certain substances (40 CFR Part 790). TSCA §6 gives the EPA authority to prohibit, limit or ban the manufacture, process and use of chemicals (40 CFR Part 750). To date over 20,000 premanufacturing notices have been filed.

Clean Air Act

The original CAA authorized EPA to set limits on chemical plant emissions. Many of these new source performance standards (NSPS) apply to organic chemical manufacturers including those for flares (40 CFR Part 60 Subpart A), storage vessels (40 CFR Part 60 Subpart K), synthetic organic chemical manufacturers equipment leaks (40 CFR Part 60 Subpart VV), synthetic organic chemicals manufacturers using air oxidation processes (40 CFR Part 60 Subpart III), distillation operations (40 CFR Part 60 Subpart NNN), reactor processes (40 CFR Part 60 Subpart RRR), and wastewater (40 CFR Part 60 Subpart YYY).

The Clean Air Act Amendments of 1990 set control standards by industrial sources for 41 pollutants to be met by 1995 and for 148 other pollutants to be reached by 2003. Several provisions affect the organic chemical industry. Under the air toxics provisions of the CAAA, more sources are covered including small businesses. In April 1994, the EPA proposed regulations to reduce air toxics emissions at chemical plants. The Hazardous Organic National Emissions Standard for Hazardous Air Pollutants, also known as HON, covers hundreds of chemical plants and thousands of chemical process units (40 CFR Part 63 Subparts F, G, H, I, J, K). The HON also includes innovative provisions such as emissions trading, that offer industry flexibility in complying with the rule's emissions goals. Subsets of the industry are regulated under other National Emission Standards for Hazardous Air Pollutants (NESHAP). These include vinyl chloride manufacturers (40 CFR Part 61 Subpart F), benzene emission from ethylbenzene/styrene manufacturers (40 CFR Part 61 Subpart I), benzene equipment leaks (40 CFR Part 61 Subpart J), emissions from storage tanks (40 CFR Part 61 Subpart K), benzene emissions from benzene transfer operations (40 CFR Part 61 Subpart BB), and benzene waste operations (40 CFR Part 61 Subpart FF). Another NESHAP that may affect organic chemical manufacturers is that for treatment, storage, and disposal facilities (TSDF) (40 Part CFR 63 Subpart AA). CAAA provisions on oxygenated additives for reformulated gasoline have also affected the chemical industry by encouraging production of the oxygenates methyl *tert*-butyl ether and ethyl *tert*-butyl ether.

Title V of the CAA introduces a new permit system that will require all major sources to obtain operating permits to cover all applicable control requirements. States were required to develop and implement the program in 1993 and the first permits were to be issued in 1995.

Clean Water Act

The Clean Water Act, first passed in 1972 and amended in 1977 and 1987, gives EPA the authority to regulate effluents from sewage treatment works, chemical plants, and other industrial sources into waters. The act sets "best available" technology standards for treatment of wastes for both direct and indirect (to a Publicly Owned Treatment Works) discharges. In 1987, EPA proposed final effluent guidelines for the organic, polymer and synthetic fiber industry. The majority of this rule was upheld by the federal courts. A final proposal for the remaining portions of the rule was issued in August 1993. The implementation of the guidelines is left to the states who issue National Pollutant Discharge Elimination System (NPDES) permits for each facility.

The Storm Water Rule (40 CFR §122.26(b)(14) Subparts (i, ii)) requires the capture and treatment of stormwater at facilities producing chemicals and allied products, including industrial organic chemical manufacture. Required treatment will remove from stormwater flows a large fraction of both conventional pollutants, such as suspended solids and biological oxygen demand (BOD), as well as toxic pollutants, such as certain metals and organic compounds.

Superfund

The Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) provide the basic legal framework for the federal "Superfund" program to clean up abandoned hazardous waste sites (40 CFR Part 305). The 1986 SARA legislation extended those taxes for five years and adopted a new broad-based corporate environmental tax. In 1990, Congress passed a simple reauthorization that did not substantially change the law but extended the program authority until 1994 and the taxing authority until 1995. The chemical industry (all SIC codes) pays about $300 million a year in Superfund chemical feedstock taxes. A comprehensive reauthorization was considered in 1994. The industry believes several serious concerns need to be addressed including the liability standard which threatens Potentially Responsible Parties (PRPs) with the entire cost of clean-up at sites even though they may be responsible for only a tiny fraction of the waste; clean-up requirements, which are often unaffordable, unattainable, and unjustified by the risks presented by the sites; and the punitive, adversarial nature of the enforcement program.

Title III of the 1986 SARA amendments (also known as Emergency Response and Community Right-to-Know Act, EPCRA) requires all manufacturing facilities, including chemical facilities, to report annual information to the public about stored toxic substances as well as release of these substances into the environment (42 U.S.C. 9601). This is known as the Toxic Release Inventory (TRI). Between 1988 and 1993 TRI emissions by chemical companies to air, land, and water were reduced 44 percent. EPCRA also establishes requirements for federal, state, and local governments regarding emergency planning. In 1994, over 300 more chemicals were added to the list of chemicals for which reporting is required.

VI.C. Pending and Proposed Regulatory Requirements

Chemical Inventory Update Rule

Every four years chemical manufacturers must report to EPA on their manufacture, importation, and, in 1994, use of chemicals on the Toxic Substances Control Act inventory.

VII. COMPLIANCE AND ENFORCEMENT PROFILE

Background

To date, EPA has focused much of its attention on measuring compliance with specific environmental statutes. This approach allows the Agency to track compliance with the Clean Air Act, the Resource Conservation and Recovery Act, the Clean Water Act, and other environmental statutes. Within the last several years, the Agency has begun to supplement single-media compliance indicators with facility-specific, multimedia indicators of compliance. In doing so, EPA is in a better position to track compliance with all statutes at the facility level, and within specific industrial sectors.

A major step in building the capacity to compile multimedia data for industrial sectors was the creation of EPA's Integrated Data for Enforcement Analysis (IDEA) system. IDEA has the capacity to "read into" the Agency's single-media databases, extract compliance records, and match the records to individual facilities. The IDEA system can match Air, Water, Waste, Toxics/Pesticides/EPCRA, TRI, and Enforcement Docket records for a given facility, and generate a list of historical permit, inspection, and enforcement activity. IDEA also has the capability to analyze data by geographic area and corporate holder. As the capacity to generate multimedia compliance data improves, EPA will make available more in-depth compliance and enforcement information. Additionally, sector-specific measures of success for compliance assistance efforts are under development.

Compliance and Enforcement Profile Description

Using inspection, violation, and enforcement data from the IDEA system, this section provides information regarding the historical compliance and enforcement activity of this sector. In order to mirror the facility universe reported in the Toxic Chemical Profile, the data reported within this section consists of records only from the TRI reporting universe. With this decision, the selection criteria are consistent across sectors with certain exceptions. For the sectors that do not normally report to the TRI program, data have been provided from EPA's Facility Indexing System (FINDS) which tracks facilities in all media databases. Please note, in this section, EPA does not attempt to define the actual number of facilities that fall within each sector. Instead, the section portrays the records of a subset of facilities within the sector that are well defined within EPA databases.

As a check on the relative size of the full sector universe, most notebooks contain an estimated number of facilities within the sector according to the Bureau of Census (See Section II). With sectors dominated by small businesses, such as metal finishers and printers, the reporting universe within the EPA databases may be small in comparison to Census data. However, the group selected for inclusion in this data analysis section should be consistent with this sector's general makeup.

Following this introduction is a list defining each data column presented within this section. These values represent a retrospective summary of inspections and enforcement actions, and solely reflect EPA, State, and local compliance assurance activities that have been entered into EPA databases. To identify any changes in trends, the EPA ran two data queries, one for the five calendar years August 10, 1990 to August 9, 1995, and the other for the most recent twelve-month period, August 10, 1994 to August 9, 1995. The five-year analysis gives an average level of activity for that period for comparison to the more recent activity.

Because most inspections focus on single-media requirements, the data queries presented in this section are taken from single media databases. These databases do not provide data on whether inspections are state/local or EPA-led. However, the table breaking down the universe of violations does give the reader a crude measurement of the EPA's and states' efforts within each media program. The presented data illustrate the variations across regions for certain sectors.[f] This variation may be attributable to state/local data entry variations, specific geographic concentrations, proximity to population centers, sensitive ecosystems, highly toxic chemicals used in production, or historical noncompliance. Hence, the exhibited data do not rank regional performance or necessarily reflect which regions may have the most compliance problems.

Compliance and Enforcement Data Definitions

General Definitions

Facility Indexing System (FINDS) -- this system assigns a common facility number to EPA single-media permit records. The FINDS identification number allows EPA to compile and review all permit, compliance, enforcement, and pollutant release data for any given regulated facility.

Integrated Data for Enforcement Analysis (IDEA) -- is a data integration system that can retrieve information from the major EPA program office databases. IDEA uses the FINDS identification number to "glue together" separate data records from EPA's databases. This is done to create a "master list" of data records for any given facility. Some of the data systems accessible through IDEA are: AIRS (Air Facility Indexing and Retrieval System, Office of Air and Radiation), PCS (Permit Compliance System, Office of Water), RCRIS (Resource Conservation and Recovery Information System, Office of Solid Waste), NCDB (National Compliance Data Base, Office of Prevention, Pesticides, and Toxic Substances), CERCLIS (Comprehensive Environmental and Liability Information System, Superfund),

[f] EPA Regions include the following states: I (CT, MA, ME, RI, NH, VT); II (NJ, NY, PR, VI); III (DC, DE, MD, PA, VA, WV); IV (AL, FL, GA, KY, MS, NC, SC, TN); V (IL, IN, MI, MN, OH, WI); VI (AR, LA, NM, OK, TX); VII (IA, KS, MO, NE); VIII (CO, MT, ND, SD, UT, WY); IX (AZ, CA, HI, NV, Pacific Trust Territories); X (AK, ID, OR, WA).

and TRIS (Toxic Release Inventory System). IDEA also contains information from outside sources such as Dun and Bradstreet and the Occupational Safety and Health Administration (OSHA). Most data queries displayed in notebook sections IV and VII were conducted using IDEA.

Data Table Column Heading Definitions

Facilities in Search -- are based on the universe of TRI reporters within the listed SIC code range. For industries not covered under TRI reporting requirements, the notebook uses the FINDS universe for executing data queries. The SIC code range selected for each search is defined by each notebook's selected SIC code coverage described in Section II.

Facilities Inspected -- indicates the level of EPA and state agency facility inspections for the facilities in this data search. These values show what percentage of the facility universe is inspected in a 12 or 60 month period. This column does not count non-inspectional compliance activities such as the review of facility-reported discharge reports.

Number of Inspections -- measures the total number of inspections conducted in this sector. An inspection event is counted each time it is entered into a single media database.

Average Time Between Inspections -- provides an average length of time, expressed in months, that a compliance inspection occurs at a facility within the defined universe.

Facilities with One or More Enforcement Actions -- expresses the number of facilities that were party to at least one enforcement action within the defined time period. This category is broken down further into federal and state actions. Data are obtained for administrative, civil/judicial, and criminal enforcement actions. Administrative actions include Notices of Violation (NOVs). A facility with multiple enforcement actions is only counted once in this column (a facility with three enforcement actions counts as one). All percentages that appear are referenced to the number of facilities inspected.

Total Enforcement Actions -- describes the total number of enforcement actions identified for an industrial sector across all environmental statutes. A facility with multiple enforcement actions is counted multiple times (a facility with three enforcement actions counts as three).

State Lead Actions -- shows what percentage of the total enforcement actions are taken by state and local environmental agencies. Varying levels of use of EPA data systems by states may limit the volume of actions accorded state enforcement activity. Some states extensively report enforcement activities into EPA data systems, while other states may use their own data systems.

Federal Lead Actions -- shows what percentage of the total enforcement actions are taken by the United States Environmental Protection Agency. This value includes referrals from state agencies. Many of these actions result from coordinated or joint state/federal efforts.

Enforcement to Inspection Rate -- expresses how often enforcement actions result from inspections. This value is a ratio of enforcement actions to inspections, and is presented for comparative purposes only. This measure is a rough indicator of the relationship between inspections and enforcement. This measure simply indicates historically how many enforcement actions can be attributed to inspection activity. Reported inspections and enforcement actions under the Clean Water Act (CWA), the Clean Air Act (CAA) and the Resource Conservation and Recovery Act (RCRA) are included in this ratio. Inspections and actions from the TSCA/FIFRA/EPCRA database are not factored into this ratio because most of the actions taken under these programs are not the result of facility inspections. This ratio does not account for enforcement actions arising from non-inspection compliance monitoring activities (e.g., self-reported water discharges) that can result in enforcement action within the CAA, CWA, and RCRA.

Facilities with One or More Violations Identified -- indicates the number and percentage of inspected facilities having a violation identified in one of the following data categories: In Violation or Significant Violation Status (CAA); Reportable Noncompliance, Current Year Noncompliance, Significant Noncompliance (CWA); Noncompliance and Significant Noncompliance (FIFRA, TSCA, and EPCRA); Unresolved Violation and Unresolved High Priority Violation (RCRA). The values presented for this column reflect the extent of noncompliance within the measured time frame, but do not distinguish between the severity of the noncompliance. Percentages within this column can exceed 100 percent because facilities can be in violation status without being inspected. Violation status may be a precursor to an enforcement action, but does not necessarily indicate that an enforcement action will occur.

Media Breakdown of Enforcement Actions and Inspections -- four columns identify the proportion of total inspections and enforcement actions within EPA Air, Water, Waste, and TSCA/FIFRA/EPCRA databases. Each column is a percentage of either the "Total Inspections," or the "Total Actions" column.

VII.A. Organic Chemicals Compliance History

Exhibit 26 provides an overview of the reported compliance and enforcement data for the organic chemical industry over the past five years (August 1990 to August 1995). These data are also broken out by EPA Region thereby permitting geographical comparisons. A few points evident from the data are listed below.

- About 77 percent of the organic chemical producing facilities identified in the IDEA search were inspected in the past five years. These facilities were inspected on average every six months.
- Those facilities with one or more enforcement actions had, on average, over the five year period, almost five enforcement actions brought against them.
- The complexity of reactions and diversity among and within facilities makes it difficult to generalize about the types of compliance problems facilities will face.

Exhibit 26: Five-Year Enforcement and Compliance Summary for Organic Chemicals

A	B	C	D	E	F	G	H	I	J
Region	Facilities in Search	Facilities Inspected	Number of Inspections	Average Months Between Inspections	Facilities with 1 or More Enforcement Actions	Total Enforcement Actions	Percent State Lead Actions	Percent Federal Lead Actions	Enforcement to Inspection Rate
I	14	8	39	22	1	5	0%	100%	0.13
II	63	50	640	6	26	131	78%	22%	0.20
III	35	30	383	5	12	55	93%	7%	0.14
IV	81	57	867	6	23	107	81%	19%	0.12
V	79	59	599	8	20	55	65%	35%	0.09
VI	110	89	1,206	5	66	356	55%	45%	0.30
VII	15	11	80	11	0	0	0%	0%	--
VIII	2	2	6	20	1	4	100%	0%	0.67
IX	11	8	32	21	1	1	0%	100%	0.03
X	2	2	12	10	2	12	33%	67%	1.0
TOTAL	412	316	3,864	6	152	726	66%	34%	0.19

VII.B. Comparison of Enforcement Activity Between Selected Industries

Exhibits 27 and 28 allow the compliance history of the organic chemical industry to be compared with the other industries covered by the industry sector notebooks. Comparisons between Exhibits 27 and 28 permit the identification of trends in compliance and enforcement records of the industry by comparing data covering the last five years to that of the past year. Some points evident from the data are listed below.

- The organic chemical industry has a relatively high frequency of inspections compared to the other sectors shown. On average, organic chemical facilities were inspected every six months.

- Over the last five years, the organic chemical industry has had a relatively high ratio of enforcement actions to inspections. This relatively high ratio has continued in the past year.

- Of the sectors shown, the organic chemical industry has one of the highest percentage of EPA led enforcement actions versus state led actions.

Exhibits 29 and 30 provide a more in-depth comparison between the organic chemical industry and other sectors by breaking out the compliance and enforcement data by environmental statute. As in Exhibits 29 and 30, the data cover the last five years (Exhibit 27) and the previous year (Exhibit 28) to facilitate the identification of recent trends. A few points evident from the data are listed below.

- Over the past five years, RCRA has accounted for the largest share of inspections and enforcement actions at organic chemical facilities. This trend has increased over the past year.

- The share of enforcement actions and inspections has decreased in the past year for the Clean Water Act and FIFRA/TSCA/EPCRA/Other and has increased for the Clean Air Act and RCRA in comparison to the previous five years.

Exhibit 27: Five-Year Enforcement and Compliance Summary for Selected Industries

A	B	C	D	E	F	G	H	I	J
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Average Months Between Inspections	Facilities with 1 or More Enforcement Actions	Total Enforcement Actions	Percent State Lead Actions	Percent Federal Lead Actions	Enforcement to Inspection Rate
Pulp and Paper	306	265	3,766	5	115	502	78%	22%	0.13
Printing	4,106	1,035	4,723	52	176	514	85%	15%	0.11
Inorganic Chemicals	548	298	3,034	11	99	402	76%	24%	0.13
Organic Chemicals	**412**	**316**	**3,864**	**6**	**152**	**726**	**66%**	**34%**	**0.19**
Petroleum Refining	156	145	3,257	3	110	797	66%	34%	0.25
Iron and Steel	374	275	3,555	6	115	499	72%	28%	0.14
Dry Cleaning	933	245	633	88	29	103	99%	1%	0.16
Metal Mining	873	339	1,519	34	67	155	47%	53%	0.10
Non-Metallic Mineral Mining	1,143	631	3,422	20	84	192	76%	24%	0.06
Lumber and Wood	464	301	1,891	15	78	232	79%	21%	0.12
Furniture	293	213	1,534	11	34	91	91%	9%	0.06
Rubber and Plastic	1,665	739	3,386	30	146	391	78%	22%	0.12
Stone, Clay, and Glass	468	268	2,475	11	73	301	70%	30%	0.12
Fabricated Metal	2,346	1,340	5,509	26	280	840	80%	20%	0.15
Nonferrous Metal	844	474	3,097	16	145	470	76%	24%	0.15
Electronics	405	222	777	31	68	212	79%	21%	0.27
Automobiles	598	390	2,216	16	81	240	80%	20%	0.11

Exhibit 28: One-Year Inspection and Enforcement Summary for Selected Industries

A	B	C	D	E		F		G	H
				Facilities with 1 or More Violations		Facilities with 1 or more Enforcement Actions			
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Number	Percent*	Number	Percent*	Total Enforcement Actions	Enforcement to Inspection Rate
Pulp and Paper	306	189	576	162	86%	28	15%	88	0.15
Printing	4,106	397	676	251	63%	25	6%	72	0.11
Inorganic Chemicals	548	158	427	167	106%	19	12%	49	0.12
Organic Chemicals	**412**	**195**	**545**	**197**	**101%**	**39**	**20%**	**118**	**0.22**
Petroleum Refining	156	109	437	109	100%	39	36%	114	0.26
Iron and Steel	374	167	488	165	99%	20	12%	46	0.09
Dry Cleaning	933	80	111	21	26%	5	6%	11	0.10
Metal Mining	873	114	194	82	72%	16	14%	24	0.13
Non-metallic Mineral Mining	1,143	253	425	75	30%	28	11%	54	0.13
Lumber and Wood	464	142	268	109	77%	18	13%	42	0.15
Furniture	293	160	113	66	41%	3	2%	5	0.04
Rubber and Plastic	1,665	271	435	289	107%	19	7%	59	0.14
Stone, Clay, and Glass	468	146	330	116	79%	20	14%	66	0.20
Nonferrous Metals	844	202	402	282	140%	22	11%	72	0.18
Fabricated Metal	2,346	477	746	525	110%	46	10%	114	0.15
Electronics	405	60	87	80	133%	8	13%	21	0.24
Automobiles	598	169	284	162	96%	14	8%	28	0.10

* Percentages in Columns E and F are based on the number of facilities inspected (Column C). Percentages can exceed 100% because violations and actions can occur without a facility inspection.

Exhibit 29: Five-Year Inspection and Enforcement Summary by Statute for Selected Industries

Industry Sector	Facilities Inspected	Total Inspections	Total Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/ EPCRA/Other	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Pulp and Paper	265	3,766	502	51%	48%	38%	30%	9%	18%	2%	3%
Printing	1,035	4,723	514	49%	31%	6%	3%	43%	62%	2%	4%
Inorganic Chemicals	298	3,034	402	29%	26%	29%	17%	39%	53%	3%	4%
Organic Chemicals	**316**	**3,864**	**726**	**33%**	**30%**	**16%**	**21%**	**46%**	**44%**	**5%**	**5%**
Petroleum Refining	145	3,237	797	44%	32%	19%	12%	35%	52%	2%	5%
Iron and Steel	275	3,555	499	32%	20%	30%	18%	37%	58%	2%	5%
Dry Cleaning	245	633	103	15%	1%	3%	4%	83%	93%	0%	1%
Metal Mining	339	1,519	155	35%	17%	57%	60%	6%	14%	1%	9%
Non-metallic Mineral Mining	631	3,422	192	65%	46%	31%	24%	3%	27%	0%	4%
Lumber and Wood	301	1,891	232	31%	21%	8%	7%	59%	67%	2%	5%
Furniture	213	1,534	91	52%	27%	1%	1%	45%	64%	1%	8%
Rubber and Plastic	739	3,386	391	39%	15%	13%	7%	44%	68%	3%	10%
Stone, Clay, and Glass	268	2,475	301	45%	39%	15%	5%	39%	51%	2%	5%
Nonferrous Metals	474	3,097	470	36%	22%	22%	13%	38%	54%	4%	10%
Fabricated Metal	1,340	5,509	840	25%	11%	15%	6%	56%	76%	4%	7%
Electronics	222	777	212	16%	2%	14%	3%	66%	90%	3%	5%
Automobiles	390	2,216	240	35%	15%	9%	4%	54%	75%	2%	6%

Exhibit 30: One-Year Inspection and Enforcement Summary by Statute for Selected Industries

Industry Sector	Facilities Inspected	Total Inspections	Total Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/ EPCRA/Other	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Pulp and Paper	189	576	88	56%	69%	35%	21%	10%	7%	0%	3%
Printing	397	676	72	50%	27%	5%	3%	44%	66%	0%	4%
Inorganic Chemicals	158	427	49	26%	38%	29%	21%	45%	36%	0%	6%
Organic Chemicals	**195**	**545**	**118**	**36%**	**34%**	**13%**	**16%**	**50%**	**49%**	**1%**	**1%**
Petroleum Refining	109	437	114	50%	31%	19%	16%	30%	47%	1%	6%
Iron and Steel	167	488	46	29%	18%	35%	26%	36%	50%	0%	6%
Dry Cleaning	80	111	11	21%	4%	1%	22%	78%	67%	0%	7%
Metal Mining	114	194	24	47%	42%	43%	34%	10%	6%	0%	19%
Non-metallic Mineral Mining	253	425	54	69%	58%	26%	16%	5%	16%	0%	11%
Lumber and Wood	142	268	42	29%	20%	8%	13%	63%	61%	0%	6%
Furniture	113	160	5	58%	67%	1%	10%	41%	10%	0%	13%
Rubber and Plastic	271	435	59	39%	14%	14%	4%	46%	71%	1%	11%
Stone, Clay, and Glass	146	330	66	45%	52%	18%	8%	38%	37%	0%	3%
Nonferrous Metals	202	402	72	33%	24%	21%	3%	44%	69%	1%	4%
Fabricated Metal	477	746	114	25%	14%	14%	8%	61%	77%	0%	2%
Electronics	60	87	21	17%	2%	14%	7%	69%	87%	0%	4%
Automobiles	169	284	28	34%	16%	10%	9%	56%	69%	1%	6%

VII.C. Review of Major Legal Actions

This section provides summary information about major cases that have affected this sector, and a list of Supplementary Environmental Projects (SEPs). SEPs are compliance agreements that reduce a facility's stipulated penalty in return for an environmental project that exceeds the value of the reduction. Often, these projects fund pollution prevention activities that can significantly reduce the future pollutant loadings of a facility.

VII.C.1. Review of major cases

Historically, OECA's Office of Enforcement Capacity and Outreach does not regularly compile information related to major cases and pending litigation within an industry sector. The staff are willing to pass along such information to Agency staff as requests are made. In addition, summaries of completed enforcement actions are published each fiscal year in the Enforcement Accomplishments Report. To date, these summaries are not organized by industry sector. (Contact: Office of Enforcement Capacity and Outreach, 202-260-4140)

VII.C.2. Supplementary Environmental Projects (SEPs)

Supplemental environmental projects (SEPs) are negotiated environmental projects such that a fraction of the costs may be applied to their fine. Regional summaries of SEPs actions undertaken in the 1993 and 1994 federal fiscal year were reviewed. Seventeen projects were undertaken that involved organic chemical manufacturing facilities, as shown in the following table. CERCLA violations engendered approximately half of all projects. Other actions were associated with EPCRA, CAA, RCRA and TSCA violations; the specifics of the original violations are not known.

The majority of SEPs were done in Region VI. Taken alone, Texas accounted for approximately one-third of all projects (6 of 17). The fact that only one fifth of all organic chemical manufactures are located in Region VI; may suggest that negotiating SEPs is a regional priority.

One project was conducted at a facility that manufactured both inorganic and organic chemicals. This project has been included in both industry sector project summaries. Unlike other sectors, none of the organic chemical manufacturing SEPs undertaken in FY-1993 and FY-1994 involved specific manufacturing process changes. The SEPs fall into two categories:

- Non-process related projects: Eleven of the seventeen SEPs involved projects not directly related to the organic chemical manufacturing process or its outputs. Ten of these projects involved a contribution to the Local Emergency Planning Committee (LEPC). Contributions ranged from donation of equipment (e.g., computer systems and emergency materials) to training programs for LEPC members. One project involved the replacement of QA/QC lab equipment with less solvent-requiring alternatives. The other project involved removing and properly disposing of 26 PCB capacitors. Cost to company ranged from $3,000 to $257,000 for these projects.

- Control and recovery technology improvement/installation: In four of the projects, control or recovery technologies were installed or upgraded to reduce toxic chemical production from manufacturing processes. Cost for project implementation ranged from $125,000 to $200,000.

Exhibit 31: FY-1993 and 1994 Supplemental Environmental Projects Overview: Organic Chemical Manufacture

General SEP Information				Violation Information					Pollutant Reduction		
FY	Docket #	Company Name	State/ Region	Type	Initial Penalty	Final Penalty	SEP Credit	SEP Cost to Company	Pollutant of Concern	Pollutant Reduction	Supplemental Environmental Project Description
93	---	High Plains Corp.	KS	EPCRA	---	$47,000	---	$125,000	---	---	Waste management equipment purchased, future computerized record keeping installed, and computer donated to LEPC
93*	---	LaRoche Chemicals, Inc.	LA	CAA	$88,360	$25,000	---	$158,400	CFC/HCFC	---	Company purchased, installed, and operated equipment for recovery of residual CFCs and HCFCs in used gas cylinders returned by customers
93	6-93-004	E.I. Dupont	LA	CERCLA 103(a)	$25,000	$2,000	---	$11,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
93	6-93-002	Union Carbide	LA	CERCLA 103(a)	$16,500	$7,000	---	$3,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
93	I-92-1083	Monsanto Chemical Company	MA	RCRA 3008(a)	$488,200	$107,000	$80,250	$160,500	Methanol	1.8 million lbs/yr	Will add methanol recovery systems to current process, which will result in an approx. reduction of 1.8 million pounds/yr. Previously, waste was burned in boiler
93	---	Markwest Hydrocarbon Partners	Reg. 4	EPCRA 311, 312	$28,000	$5,600	---	$22,400	---	---	Enhanced data management and emergency response capabilities of county LEPC
93	---	Chemical Systems Division, United Technologies Corp.	Reg. 9	RCRA	---	---	$160,000	$257,000	Toluene, chloroform, methanol, tetrahydrofuran, pyridine, formaldehyde, and heptane	950 liters	Replaced four pieces of QA/QC lab equipment with less solvent-requiring alternatives
93	6-92-008	Hoecst Celanese	TX	CERCLA 103(a)	$8,250	$0	---	$10,000	---	---	Conducted an outreach for four counties surrounding facility, mailed out information packets to 1,200 targeted facilities, and sponsored compliance workshop
93	6-93-011	OxyChem	TX	CERCLA 103(a)	$25,000	$12,000	---	$9,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies

Exhibit 31 (cont.): FY-1993 and 1994 Supplemental Environmental Projects Overview: Organic Chemical Manufacture

General SEP Information				Violation Information					Pollutant Reduction		
FY	Docket #	Company Name	State/ Region	Type	Initial Penalty	Final Penalty	SEP Credit	SEP Cost to Company	Pollutant of Concern	Pollutant Reduction	Supplemental Environmental Project Description
93	6-93-003	E.I. Dupont	TX	CERCLA 103(a)	$25,000	$2,000	---	$14,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
93	6-93-020	Arco Chemical	TX	CERCLA 103(a)	$8,250	$2,000	---	$7,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
93	6-92-026	Elf Atochem	TX	EPCRA 312(a)	$8,250	$1,500	---	$5,500	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies, will participate in LEPC activities, and technical assistance
93	6-93-005	Rohm & Haas	TX	CERCLA 103(a)	$16,500	$10,000	---	$3,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
94	---	Eastman Kodak	NY	RCRA	$8,000,000	---	---	$12,000,000	---	---	---
94	---	Eastman Kodak	NY	TSCA	---	$42,000	$17,000	$3,600,000	---	---	---
94	---	Hatco Corp.	Reg. II	TSCA	---	$96,300	---	$647,000	TCA	---	Installed a purification system to replace TCA. Minimized waste generation by recovering and using unreacted raw materials
94	---	Allied Signal, Inc.	IN	TSCA	$7,000	$2,500	---	$7,000	---	---	Removed and properly disposed of 26 PCB capacitors

*Facilities identified as combined inorganic and organic chemical manufacturers

Violation Information Terms
Initial penalty: Initial proposed cash penalty for violation
Final penalty: Total penalty after SEP negotiation
SEP credit: Cash credit given for SEP so that, Final penalty - SEP credit = Final cash penalty
SEP cost to company: Actual cost to company of SEP implementation

NOTE: Due to differences in terminology and level of detail between regional SEP information, in some cases the figure listed as Final penalty may be the Final cash penalty after deduction for SEP credit

VIII. COMPLIANCE ACTIVITIES AND INITIATIVES

This section highlights the activities undertaken by this industry sector and public agencies to voluntarily improve the sector's environmental performance. These activities include those independently initiated by industrial trade associations. In this section, the notebook also contains a listing and description of national and regional trade associations.

VIII.A. Sector-related Environmental Programs and Activities

Chemical Manufacturer's Association and EPA are discussing developing plant level compliance guides, auditing protocols, and training materials for new regulations.

VIII.B. EPA Voluntary Programs

33/50 Program

The "33/50 Program" is EPA's voluntary program to reduce toxic chemical releases and transfers of seventeen chemicals from manufacturing facilities. Participating companies pledge to reduce their toxic chemical releases and transfers by 33 percent as of 1992 and by 50 percent as of 1995 from the 1988 baseline year. Certificates of Appreciation have been given out to participants meeting their 1992 goals. The list of chemicals includes seventeen high-use chemicals reported in the Toxics Release Inventory. Exhibit 32 lists those companies participating in the 33/50 program that reported the SIC code 286 to TRI. Many of the companies shown listed multiple SIC codes and, therefore, are likely to carry out operations in addition to organic chemical manufacturing. The SIC codes reported by each company are listed in no particular order. In addition, the number of facilities within each company that are participating in the 33/50 program and that report SIC 286 to TRI is shown. Finally, each company's total 1993 releases and transfers of 33/50 chemicals and the percent reduction in these chemicals since 1988 are presented.

The organic chemicals industry as a whole used, generated or processed all seventeen target TRI chemicals. Of the target chemicals, benzene, toluene, xylenes and methyl isobutyl ketone are released most frequently and in similar quantities. Significant amounts of methyl ethyl ketone are also released, although it is only the seventh most frequently reported 33/50 chemical. These five toxic chemicals account for about eight percent of TRI releases and transfers from organic chemicals facilities. From Exhibit 32, 115 companies representing 335 facilities listed under SIC 286 are currently participating in the 33/50 program. They account for 34 percent of the 986 facilities carrying out organic chemicals manufacturing operations (as identified by the 1992 Census of Manufacturers), which is significantly higher than the average for all industries of 14 percent participation. (Contact: Mike Burns, 202-260-6394 or the 33/50 Program 202-260-6907)

Exhibit 32: 33/50 Program Participants Reporting SIC 286 (Organic Chemicals)					
Parent Company	City, State	SIC Codes Reported	Number of Participating Facilities	1993 Releases and Transfers (lbs)	% Reduction 1988 to 1993
A. W. Chesterton Company	Stoneham, MA	2869, 3053, 3561	1	13,250	65
Air Products And Chemicals	Allentown, PA	2873, 2869	6	144,876	50
Akzo Nobel Inc.	Chicago, IL	2819, 2869	5	930,189	13
Albemarle Corporation	Richmond, VA	2869	3	1,005,108	51
Allied-Signal Inc.	Morristown, NJ	2819, 2869	10	2,080,501	50
American Home Products Corp.	New York, NY	2833, 2869	3	1,210,834	50
American Petrofina Holding Co.	Dallas, TX	2865	1	747,799	40
Amoco Corporation	Chicago, IL	2865	10	4,632,163	50
Aristech Chemical Corporation	Pittsburgh, PA	2865	4	196,400	18
Arrow Eng. Inc.	Dalton, GA	2843, 2865, 2869	1	250	50
Ashland Oil Inc.	Russell, KY	2865	3	723,562	50
Atlantic Richfield Company	Los Angeles, CA	2865, 2869	3	2,435,248	2
B F Goodrich Company	Akron, OH	2869	4	621,207	50
BASF Corporation	Parsippany, NJ	2869, 2865, 2819	6	1,157,548	50
Baxter International Inc.	Deerfield, IL	2869	1	42,570	80
Borden Chem. & Plas. Ltd. Partner	Columbus, OH	2813, 2821, 2869	1	12,662	***
Borden Inc.	New York, NY	2869, 2821	1	1,644,614	*
BP America Inc.	Cleveland, OH	2869	2	1,597,404	24
Buffalo Color Corporation	Parsippany, NJ	2865	1	10,705	8
CPH Holding Corporation	Chicago, IL	2869	1	7,003	50
Capital Resin Corporation	Columbus, OH	2869, 2821	1	62,850	50
Chemdesign Corporation	Fitchburg, MA	2869	2	47,435	*
Chemical Solvents Inc.	Cleveland, OH	2869	2	955,751	***
Chevron Corporation	San Francisco, CA	2865	4	2,794,502	50
Ciba-Geigy Corporation	Ardsley, NY	2879, 2821, 2865	4	1,875,028	50
Citgo Petroleum Corporation	Tulsa, OK	2911, 2819, 2869	1	1,164,354	20
Coopers Creek Chemical	West Conshohocken, PA	2865	1	19,690	20
Crompton & Knowles Corporation	Stamford, CT	2865	5	30,239	50
Cytec Industries	West Paterson, NJ	2819, 2869	2	1,074,646	50
Degussa Corporation	Ridgefield Park, NJ	2819, 2869, 2879	1	676,418	***
Dow Chemical Company	Midland, MI	2800, 2819, 2821	5	2,769,363	50
Dow Corning Corporation	Midland, MI	2869, 2822, 2821	2	1,134,610	16

Exhibit 32: 33/50 Program Participants Reporting SIC 286 (Organic Chemicals)

Parent Company	City, State	SIC Codes Reported	Number of Participating Facilities	1993 Releases and Transfers (lbs)	% Reduction 1988 to 1993
DSM Finance USA Inc.	Wilmington, DE	2869, 2873	1	964,346	32
E. I. Du Pont De Nemours & Co.	Wilmington, DE	2865, 2824, 2821	16	11,740,853	50
Eastman Kodak Company	Rochester, NY	2869, 2865	4	5,827,091	50
Elf Aquitaine Inc.	New York, NY	2869, 2821, 2819	4	273,274	43
EM Industries Incorporated	Hawthorne, NY	5169, 2869, 2899	1	9,055	15
Engelhard Corporation	Iselin, NJ	2816, 2865, 2819	1	236,302	50
Ethyl Corporation	Richmond, VA	2869	2	251,519	46
Exxon Corporation	Irving, TX	2869	6	2,469,930	50
Ferro Corporation	Cleveland, OH	2819, 2869	3	165,529	50
First Mississippi Corporation	Jackson, MS	2865	2	200,977	***
FMC Corporation	Chicago, IL	2879, 2869, 2819	2	502,318	50
Gaf Corporation	Wayne, NJ	2869, 2865, 2834	3	944,730	44
Gencorp Inc.	Akron, OH	3764, 2892, 3761	1	5,453,359	34
General Electric Company	Fairfield, CT	2821, 2812, 2869	3	5,010,856	50
Georgia Gulf Corporation	Atlanta, GA	2865, 2812, 2819	2	39,480	80
Georgia-Pacific Corporation	Atlanta, GA	2611, 2631, 2861	1	2,722,182	50
Goodyear Tire & Rubber Co.	Akron, OH	2865, 2869	3	3,932,157	50
Henkel Corporation	King Of Prussia, PA	2869	4	164,363	55
Hercules Incorporated	Wilmington, DE	2861, 2821, 2869	2	5,014,664	50
HM Anglo-American Ltd.	New York, NY	2869	1	1,265,741	2
Hoechst Celanese Corporation	Somerville, NJ	2869, 2821	12	2,603,661	50
Hoffman-La Roche	Nutley, NJ	2869, 2879, 2844	1	902,929	62
ICI Americas	Wilmington, DE	2869, 3089	3	165,162	50
International Paper Company	Purchase, NY	2861	2	2,784,831	50
James River Corp Virginia	Richmond, VA	2621, 2611, 2869	1	961,588	53
Johnson & Johnson	New Brunswick, NJ	2833, 2869	1	317,843	65
Kalama Chemical	Seattle, WA	2865, 2869	1	214,665	37
Laidlaw Environmental Services	Columbia, SC	2819, 2869	1	8,167	***
Laroche Holdings Inc.	Atlanta, GA	2812, 2869	1	81,470	*
Lubrizol Corp.	Wickliffe, OH	2869	4	466,871	50
Lyondell Petrochemical Co.	Houston, TX	2869, 2821	1	285,430	57
Mallinckrodt Group Inc.	Saint Louis, MO	2869, 2873	5	775,206	50
Merck & Co. Inc.	Rahway, NJ	2833, 2869, 2879	1	1,456,238	50
Miles Inc.	Pittsburgh, PA	2865	7	1,095,504	40

Exhibit 32: 33/50 Program Participants Reporting SIC 286 (Organic Chemicals)

Parent Company	City, State	SIC Codes Reported	Number of Participating Facilities	1993 Releases and Transfers (lbs)	% Reduction 1988 to 1993
Milliken & Company	Spartanburg, SC	2869, 2843, 2865	1	13,500	50
Millipore Corporation	Bedford, MA	2869	1	65,529	50
Mobil Corporation	Fairfax, VA	2911, 2869	5	4,263,284	50
Monsanto Company	Saint Louis, MO	2824, 2869, 2821	11	1,683,580	23
Moore Business Forms (Del)	Lake Forest, IL	2761, 2865, 2821	1	107,091	42
Morgan Stanley Leveraged Fund	New York, NY	2869	1	2,166,420	13
Morton International Inc.	Chicago, IL	2821, 2891, 2879	4	721,216	20
Nalco Chemical Company	Naperville, IL	2869, 2899, 2819	4	107,651	50
Nashua Corp.	Nashua, NH	2672, 3572, 3577	1	1,818,504	**
Occidental Petroleum Corp.	Los Angeles, CA	2869	10	8,896,126	19
Olin Corporation	Stamford, CT	2869, 2841, 2843	3	574,673	70
PCR Group Inc.	Jacksonville, FL	2869	1	26,510	3
PCL Group Inc.	Cincinnati, OH	2865, 2873, 2879	1	471,405	***
Perkin-Elmer Corporation	Norwalk, CT	3826, 2869	1	25,865	*
Philip Morris Companies Inc.	New York, NY	2022, 2869	1	259,053	**
Phillips Petroleum Company	Bartlesville, OK	2869, 2821	4	2,367,877	50
PPG Industries Inc.	Pittsburgh, PA	2812, 2816, 2869	3	2,772,331	50
Procter & Gamble Company	Cincinnati, OH	2869	3	612,520	*
Quantum Chemical Corporation	Iselin, NJ	2821, 2869	5	289,235	50
Rexene Corporation	Dallas, TX	2821, 2869	1	128,054	50
Rhone-Poulenc Inc.	Monmouth Junction, NJ	2879, 2869	5	1,437,778	50
Rohm and Haas Company	Philadelphia, PA	2869	5	1,210,244	50
Rubicon Inc.	Geismar, LA	2865, 2869, 2873	1	134,306	75
Sandoz Corporation	New York, NY	2865	1	104,490	50
Sartomer Company Inc.	Exton, PA	2821, 2869, 2899	1	41,893	*
Schenectady Chemical Inc.	Schenectady, NY	2821, 2869	1	239,285	***
Shell Petroleum Inc.	Houston, TX	2869	4	3,240,716	55
Shepherd Chemical Co.	Cincinnati, OH	2819, 2869	1	828	72
Standard Chlorine Chemical Co.	Kearny, NJ	2865, 2819	1	48,246	***
Stepan Company	Northfield, IL	2843, 2865, 2869	1	25,186	***
Sterling Chemicals Inc.	Houston, TX	2869, 2865, 2819	1	182,216	65
Syntex Usa Inc.	Palo Alto, CA	2833, 2048, 2869	2	499,873	33
Texaco Inc.	White Plains, NY	2869	4	514,803	50
Texas Olefins Company	Houston, TX	2869	1	214	33

Exhibit 32: 33/50 Program Participants Reporting SIC 286 (Organic Chemicals)

Parent Company	City, State	SIC Codes Reported	Number of Participating Facilities	1993 Releases and Transfers (lbs)	% Reduction 1988 to 1993
Unilever United States Inc.	New York, NY	2821, 2891, 2869	3	164,034	50
Union Camp Corporation	Wayne, NJ	2869	4	835,696	50
Union Carbide Corporation	Danbury, CT	2821, 2869	7	728,129	50
Uniroyal Chemical Corporation	Middlebury, CT	2822, 2869, 2879	2	1,970,357	20
United Organics Corp.	Williamston, NC	2869	1	14,127	*
UOP	Des Plaines, IL	2819, 2869	2	14,169	50
Veba Corporation	Houston, TX	2869, 2992	3	24,254	10
Velsicol Chemical Corporation	Rosemont, IL	2865, 2819, 2869	2	224,664	50
Vista Chemical Company	Houston, TX	2821, 2869	3	106,497	50
Vulcan Materials Company	Birmingham, AL	2869, 2812	2	679,566	85
Wacker Chemical Corporation	Williamsburg, VA	2821, 2891, 2869	1	772	*
Walter Industries Inc.	Tampa, FL	2869	1	859,751	***
Westvaco Corporation	New York, NY	2861	2	877,866	50
Witco Corporation	New York, NY	2869, 2899, 2841	6	327,611	50
Zeneca Holdings Inc.	Wilmington, DE	2869, 2843, 2899	5	1,609,047	*

* = not quantifiable against 1988 data.
** = use reduction goal only.
*** = no numerical goal.

Source: U.S. EPA, Toxics Release Inventory, 1993.

Environmental Leadership Program

The Environmental Leadership Program (ELP) is a national initiative piloted by EPA and state agencies in which facilities have volunteered to demonstrate innovative approaches to environmental management and compliance. EPA has selected 12 pilot projects at industrial facilities and federal installations which will demonstrate the principles of the ELP program. These principles include: environmental management systems, multimedia compliance assurance, third-party verification of compliance, public measures of accountability, community involvement, and mentor programs. In return for participating, pilot participants receive public recognition and are given a period of time to correct any violations discovered during these experimental projects.

Forty proposals were received from companies, trade associations, and federal facilities representing many manufacturing and service sectors. One chemical company's proposal was accepted (Ciba Geigy of St. Gabriel, LA). Another chemical firm (Akzo Chemicals of Edison, NJ), one pharmaceutical manufacturer (Schering Plough of Kenilworth, NJ) and one manufacturer of agricultural chemicals (Gowan Milling of Yuma, AZ) have submitted proposals. (Contact: Tia-Ming Chang, ELP Director 202-564-5081 or Robert Fentress 202-564-7023)

Project XL

Project XL was initiated in March 1995 as a part of President Clinton's *Reinventing Environmental Regulation* initiative. The projects seek to achieve cost effective environmental benefits by allowing participants to replace or modify existing regulatory requirements on the condition that they produce greater environmental benefits. EPA and program participants will negotiate and sign a Final Project Agreement, detailing specifc objectives that the regulated entity shall satisfy. In exchange, EPA will allow the participant a certain degree of regulatory flexibility and may seek changes in underlying regulations or statutes. Participants are encouraged to seek stakeholder support from local governments, businesses, and environmental groups. EPA hopes to implement fifty pilot projects in four categories including facilities, sectors, communities, and government agencies regulated by EPA. Applications will be accepted on a rolling basis and projects will move to implementation within six months of their selection. For additional information regarding XL Projects, including application procedures and criteria, see the May 23, 1995 Federal Register Notice. (Contact: Jon Kessler at EPA's Office of Policy Analysis 202 260-4034)

Green Lights Program

EPA's Green Lights program was initiated in 1991 and has the goal of preventing pollution by encouraging U.S. institutions to use energy-efficient lighting technologies. The program has over 1,500 participants which include major corporations; small and medium sized businesses; federal, state, and local governments; non-profit groups; schools; universities; and health care facilities. Each participant is required to survey their facilities and upgrade lighting wherever it is profitable. EPA provides technical assistance to the participants through a decision support software package, workshops and manuals, and a financing registry. EPA's Office of Air and Radiation is responsible for operating the Green Lights Program. (Contact: Maria Tikoff at 202-233-9178 or the Green Light/Energy Star Hotline at 202-775-6650)

WasteWi$e Program

The WasteWi$e Program was started in 1994 by EPA's Office of Solid Waste and Emergency Response. The program is aimed at reducing municipal solid wastes by promoting waste minimization, recycling collection, and the manufacturing and purchase of recycled products. As of 1994, the program had about 300 companies as members, including a number of major corporations. Members agree to identify and implement actions to reduce their solid wastes and must provide EPA with their waste reduction goals along with yearly progress reports. EPA, in turn, provides technical assistance to member companies and allows the use of the WasteWi$e logo for promotional purposes. (Contact: Lynda Wynn 202-260-0700 or the WasteWi$e Hotline at 800-372-9473)

Climate Wise Recognition Program

The Climate Change Action Plan was initiated in response to the U.S. commitment to reduce greenhouse gas emissions in accordance with the Climate Change Convention of the 1990 Earth Summit. As part of the Climate Change Action Plan, the Climate Wise Recognition Program is a partnership initiative run jointly by EPA and the Department of Energy. The program is designed to reduce greenhouse gas emissions by encouraging reductions across all sectors of the economy, encouraging participation in the full range of Climate Change Action Plan initiatives, and fostering innovation. Participants in the program are required to identify and commit to actions that reduce greenhouse gas emissions. The program, in turn, gives organizations early recognition for their reduction commitments; provides technical assistance through consulting services, workshops, and guides; and provides access to the program's centralized information system. At EPA, the program is operated by the Air and Energy Policy Division within the Office of Policy Planning and Evaluation. (Contact: Pamela Herman 202-260-4407)

NICE^3

The U.S. Department of Energy and EPA's Office of Pollution Prevention are jointly administering a grant program called The National Industrial Competitiveness through Energy, Environment, and Economics (NICE^3). By providing grants of up to 50 percent of the total project cost, the program encourages industry to reduce industrial waste at its source and become more energy-efficient and cost-competitive through waste minimization efforts. Grants are used by industry to design, test, demonstrate, and assess the feasibility of new processes and/or equipment with the potential to reduce pollution and increase energy efficiency. The program is open to all industries; however, priority is given to proposals from participants in the pulp and paper, chemicals, primary metals, and petroleum and coal products sectors. (Contact: DOE's Golden Field Office 303-275-4729)

VIII.C. Trade Association/Industry Sponsored Activity

VIII.C.1. Environmental Programs

The Global Environmental Management Initiative (GEMI) is made up of group of leading companies dedicated to fostering environmental excellence by business. GEMI promotes a worldwide business ethic for environmental management and sustainable development, to improve the environmental performance of business through example and leadership. In 1994, GEMI's membership consisted of about 30 major corporations including Union Carbide Corporation and Dow Chemical.

Center for Waste Reduction Technologies under the aegis of the American Institute of Chemical Engineers sponsored research on innovative technologies to reduce waste in the chemical processing industries. The primary mechanism is through funding of academic research.

The National Science Foundation and the Environmental Protection Agency's Office of Pollution Prevention and Toxics signed an agreement in January of 1994 to coordinate the two agencies' programs of **basic research related to pollution prevention**. The collaboration will stress research in the use of less toxic chemical and synthetic feedstocks, use of photochemical processes instead of traditional ones that employ toxic reagents, use of recyclable catalysts to reduce metal contamination, and use of natural feedstocks when synthesizing chemicals in large quantities.

The **Chemical Manufacturer's Association** funds research on issues of interest to their members particularly in support of their positions on proposed or possible legislation. They recently funded a study to characterize the environmental fate of organochlorine compounds.

ISO 9000 is a series of international total quality management guidelines. After a successful independent audit of their management plans, firms are qualified to be ISO 9000 registered. In June of 1993, the International Standards Organization created a technical committee to work on new standards for environmental management systems.

The **Responsible Care® Initiative** of the Chemical Manufacturer's Association requires all members and partners to continuously improve their health, safety, and environmental performance in a manner that is responsive to the public. Launched in 1988, the Responsible Care® concepts are now being applied in 36 countries around the world. Responsible Care® is a comprehensive, performance-oriented initiative composed of ten progressive Guiding Principles and six board Codes of Management Practices. These Management Practices cover all aspects of the chemical industry's operations, from research to manufacturing, distribution, transportation, sales and marketing, and to downstream users of chemical products. Through Responsible Care®, CMA members and partners gain insight from the public through, among other means, a national Public Advisory Panel and over 250 local Community Advisory Panels. This, coupled with the fact that participation in Responsible Care® is an obligation of membership with the Chemical Manufacturer's Association, make this performance improvement initiative unique. The Synthetic Organic Chemical Manufacturer's Association whose membership consists of smaller batch and custom chemical manufacturers with typically fewer than 50 employees and less than $50 million in annual sales, encourages its members to achieve continuous performance improvement in their health, safety, and environmental programs through implementation of the chemical industry's Responsible Care® initiative. SOCMA is a partner in Responsible Care®.

VIII.C.2. Summary of Trade Associations

American Chemical Society
1155 16th Street, NW
Washington, D.C. 20036
Phone: (202) 872-8724
Fax: (202) 872-6206

Budget: $192,000,000
Staff: 1700
Members: 145,000

The American Chemical Society (ACS) has an educational and research focus. The ACS produces approximately thirty different industry periodicals and research journals, including *Environmental Science and Technology* and *Chemical Research in Toxicology*. In addition to publishing, the ACS presently conducts studies and surveys; legislation monitoring, analysis, and reporting; and operates a variety of educational programs. The ACS library and on-line information services are extensive. Some available on-line services are *Chemical Journals Online*, containing the full text of 18 ACS journals, 10 Royal Society of Chemistry journals, five polymer journals and the Chemical Abstracts Service, *CAS*, which provides a variety of information on chemical compounds. Founded in 1876, the ACS is presently comprised of 184 local groups and 843 student groups nationwide.

Chemical Manufacturer's Association
2501 M St., NW
Washington, D.C. 20037
Phone: (202) 887-1100
Fax: (202) 887-1237

Members: 185
Staff: 246
Budget: $36,000,000

A principal focus of the Chemical Manufacturer's Association (CMA) is on regulatory issues facing chemical manufacturers at the local, state, and federal levels. At its inception in 1872, the focus of CMA was on serving chemical manufacturers through research. Research is still ongoing at CMA. Member committees, task groups, and work groups routinely sponsor research and technical data collection that is then provided to the public in support of CMA's advocacy. Much additional research takes place through the CHEMSTAR® program. CHEMSTAR® consists of a variety of self-funded panels working on single-chemical research agendas. This research fits within the overall regulatory focus of CMA; CHEMSTAR® study results are provided to both CMA membership and regulatory agencies. Other initiatives include the Responsible Care® program, which includes six codes of management practices designed to go beyond simple regulatory compliance. CAM is currently developing measurement and appropriate verification systems for these codes. CMA also conducts workshops and technical symposia, promotes in-plant safety, operates a chemical emergency center (CHEMTREC®) which offers guidance in chemical emergency situations, and operates the Chemical Referral Center which provides chemical health and safety information to the public. Publications include the annual *U.S. Chemical Industry Statistical Handbook*, containing detailed data on the industry; *Responsible Care in Action*, the 1993-94 progress report on implementing Responsible Care®; and *Preventing Pollution: A Chemical Industry Progress Report (1988-1992)*, summarizing waste generation and reduction data for the years 1988-92. CMA holds an annual meeting for its membership in White Sulphur Springs, WV.

Ethylene Oxide Industry Council
2501 M St. NW, Ste. 330
Washington, DC 20037
Phone: (202) 887-1198

The Ethylene Oxide Industry Council (EOIC), founded in 1981, is an example of a panel group within the CHEMSTAR® program of the Chemical Manufacturer's Association (CMA). The EOIC consists of ethylene oxide producers and users. Ethylene oxide is used in the manufacture of antifreeze and polyester fibers, and is widely used as a sterilizing agent. The EOIC develops scientific, technological, and economic data on the safe use and manufacture of ethylene oxide. Other duties include informing scientific and governmental organizations of the industry's views and interests.

Synthetic Organic Chemicals
Manufacturer's Association
1100 New York Avenue, NW
Washington, D.C. 20005
Phone: (202) 414-4100
Fax: (202) 289-8584

Members: 250
Staff: 50

Synthetic Organic Chemicals Manufacturer's Association (SOCMA) is the national trade association representing the legislative, regulatory, and commercial interests of some 250 companies that manufacture, distribute, or market organic chemicals. Most of SOCMA's members are batch and custom chemical manufacturers who are the highly innovative, entrepreneurial and customer-driven sector of the U.S. chemical industry. The majority of SOCMA's members are small businesses with annual sales of less than $50 million and fewer than 50 employees. SOCMA assists its members in improving their environmental, safety, and health performance through various programs focusing on continuous improvement. A bi-monthly newsletter provides information on legislative and regulatory developments, as well as on education and training opportunities. SOCMA holds an annual meeting in May and also sponsors INFORMEX, the largest custom chemical trade show in the U.S. In addition, SOCMA's Association Management Center includes two dozen self-funded groups that focus on single chemical issues.

Chemical Specialties Manufacturer's
Association
1913 I St. NW
Washington, D.C. 20006
Phone: (202) 872-8110
Fax: (202) 872-8114

Members: 425
Staff: 31

This organization represents the manufacturers of such specialty chemical products as pesticides, cleaners, disinfectants, sanitizers, and polishes. The Chemical Specialties Manufacturer's Association (CSMA) was founded in 1914. Today, the CSMA works with federal and state agencies and public representatives, to provide their membership with information on governmental activities and scientific developments. Some committees include: Government Affairs Advisory and Scientific Affairs. Publications include the quarterly *Chemical Times & Trends*, the biweekly *Legislative Reporter*, and compilations of laws and regulations. CSMA holds an annual December meeting in Washington, D.C.

Halogenated Solvents Industry Alliance
1225 19th St. NW, Ste. 300
Washington, D.C. 20036
Phone: (202) 223-5890

Members: 200
Budget: $1,400,000

The goal of the Halogenated Solvents Industry Alliance (HSIA) is to develop programs to address problems involving halogenated solvents. The group is actively involved in legislative and regulatory issues affecting the industry, providing industry comments and information to agencies, and representing the industry at administrative hearings. The HSIA also sponsors working groups on issues specific to the solvent industry. Publications include the bimonthly newsletter *Halogenated Solvents Industry Alliance*, which includes a listing of publications available from the group and the monthly newsletter *Solvents Update*, which covers regulatory development and HSIA actions.

Methyl Chloride Industry Association
c/o Robert Sussman
Latham and Watkins
1001 Pennsylvania Ave. NW, Ste.1300
Washington, D.C. 20004
Phone: (202) 637-2200

The Methyl Chloride Industry Association (MCIA) was founded in 1981 to meet the needs of the methyl chloride manufacturing industry on the issue of government regulation. The group participates in EPA rulemakings as an industry representative. The MCIA has no publications or annual meetings.

American Institute of Chemical Engineers
1707 L Street, NW, Ste. 333
Washington, D.C. 20036
Phone: (202) 962-8690
Fax: (202) 833-3014

Members: 54,000
Staff: 103

The American Institute of Chemical Engineers (AICHE) is a professional society of chemical engineers. AICHE develops chemical engineering curricula and sponsors a variety of chemical study forums. AICHE is split into twelve divisions including the Environmental, Forest Products, Fuels and Petrochemical, and Safety and Health divisions. Approximately fourteen publications are produced by AICHE, such as the quarterly *Environmental Progress*, a periodic directory of members, and a variety of pamphlets. AICHE holds three conferences per year in various locations.

Color Pigments Manufacturer's Association, Inc.
300 N. Washington St., Ste. 102
Alexandria, VA 22314
Phone: (703) 684-4044
Fax: (703) 684-1795

Members: 50
Staff: 5

The Color Pigments Manufacturer's Association (CPMA) represents North American manufacturers of pigments and pigment ingredients (i.e., dyes). The CPMA also represents the affiliates of manufacturers of those products who happen to manufacture the product overseas. The CPMA represents its membership before government agencies. No further information is available at this time.

Fire Retardant Chemical Association
851 New Holland Ave., Box 3535
Lancaster, PA 17604
Phone: (717) 291-5616
Fax: (717) 295-4538

Members: 42
Staff: 5

Chemical distributors/manufacturers active in promoting fire safety through chemical technology comprise the Fire Retardant Chemical Association (FRCA), founded in 1973. The FRCA serves as a forum for information dissemination on new developments, new applications, and current testing procedures for fire retardants and chemical fire safety products. Publications include the periodic *Fire Retardant Chemicals Association - Membership Directory* and the *Fire Retardant Chemical Association Proceedings.* Educational conferences are held semiannually.

National Paint and Coatings Association
1500 Rhode Island Avenue, NW
Washington, DC 20005
Phone: (202) 462-6272
Fax: (202) 462-8549

Members: 700
Staff: 40

Founded in 1933, the National Paint and Coatings Association (NPCA) represents manufacturers of paints and chemical coatings as well as suppliers of paint manufacturing equipment and raw materials. NPCA is involved in government relations programs, statistical surveys, and industry research. Committees include Labeling, Scientific, and Government Supply. The NPCA publishes an annual report, a periodic newsletter and trade directory, and a variety of guides. The NPCA holds an annual meeting.

Drug, Chemical, and Allied Trades Association
2 Roosevelt Ave., Suite 301
Syosset, NY 11791 Members: 500
Phone: 516-496-3317 Staff: 3
Fax: 516-496-2231

Members: 500
Staff: 3
Budget: $500,000

Drug, Chemical, and Allied Trades Association (DCAT) is comprised of drug, chemical, and related product (e.g., packaging, cosmetics, essential oils) manufacturers, advertisers, brokers, and importers. The association publishes *DCAT*, a monthly with coverage of federal regulations.

National Association of Chemical Recyclers
1875 Connecticut Ave., NW
Suite 1200
Washington, DC 20009
Phone: 202-986-8150
Fax: 202-986-2021

Members: 70
Staff: 3

National Association of Chemical Recyclers (NACR) founded in 1980, consists of recyclers of used industrial solvents. The organization promotes "responsible and intelligent" regulation and the beneficial reuse of waste. NACR monitors and reports on regulatory and legislative action affecting the practice of solvent recycling. NACR also compiles industry statistics. NACR publishes *Flashpoint* and a semiannual membership list. NACR holds a semiannual conference, usually in April or October.

IX. CONTACTS/ACKNOWLEDGMENTS/RESOURCE MATERIALS/BIBLIOGRAPHY

For further information on selected topics within the organic chemical industry a list of publications and contacts are provided below:

Contacts[g]

Name	Organization	Telephone	Subject
Walter DeRieux	EPA/OECA	(202) 564-7067	Regulatory requirements and compliance assistance
Jim Gould	EPA Region VI	(713) 983-2153	Industrial processes and regulatory requirements (CAA, CWA)
David Langston	EPA Region IV	(404) 347-7603	Industrial resources and regulatory requirements (RCRA)
Jim Seidel	EPA/NEIC	(303) 236-5132	Industrial processes and regulatory requirements
Mary J. Legatski	Synthetic Organic Chemical Manufacturers Association	(202) 414-4100	Federal environmental requirements

CAA: Clean Air Act
CWA: Clean Water Act
OECA: Office of Enforcement and Compliance Assurance
NEIC: National Enforcement Investigations Center
RCRA: Resource Conservation and Recovery Act

General Profile

U.S. Industrial Outlook, 1994, Department of Commerce

Chemical and Engineering News, July 4, 1994 "Facts and Figures for the Chemical Industry." This information is produced annually.

[g] Many of the contacts listed above have provided valuable background information and comments during development of this document. EPA appreciates this support and acknowledges that the individuals listed do not necessarily endorse all statements made within this notebook.

United States International Trade Commission, Synthetic Organic Chemicals, United States Production and Sales, 1992. [Published annually]

1992 Census of Manufactures, Industry Series, Industrial Organic Chemicals, Bureau of the Census.

Process Descriptions and Chemical Use Profiles

Kirk-Othmer Encyclopedia of Chemical Technology (appropriate volumes)

Ullman's Encyclopedia of Chemical Technology (appropriate volumes)

SRI Chemical Economics Handbook (This is a proprietary data source and EPA's Regulatory Impacts Branch has a copy)

SRI Directory of Chemical Producers

Franck, H.G. and J.W. Stadelhofer, 1987. Industrial Aromatic Chemistry, Berlin: Springer-Verlag.

Perry, Robert H. and Cecil H. Chilton, "Chemical Engineers' Handbook" New York: McGraw-Hill Book Company.

Peters, Max S. and Klaus D. Timmerhaus, "Plant Design and Economics for Chemical Engineers," New York: McGraw-Hill Book Company.

Kent, J.(ed.) Reigel's Handbook of Industrial Chemistry, 1992. New York: von Nostrand Reinhold, Ninth Edition.

Shreve, Chemical Process Industries.

Szmant, H. Harry, 1989. Organic Building Blocks of the Chemical Industry, New York: John Wiley and Sons.

Tomes Plus Information System. Denver, CO: Micromedia, Inc. Contains information on chemical use, production, and health effects. (303) 831-1400.

Chemical Manufacturer's Association, Undated. Designing Pollution Prevention into the Process - Research, Development and Engineering.

U.S. Environmental Protection Agency, 1987. Development Document of Effluent Limitations Guidelines for the Organic Chemicals, Plastics and Synthetic Fibers Point Source Category, EPA 440/1-87/009.

Wells, G. Margaret, 1991. Handbook of Petrochemicals and Processes. Aldershot, England: Gower Publishing Company.

Regulatory Profile

Hazardous Waste Consultant, Volume 12, October/November 1994. RCRA Land Disposal Restrictions: A Guide to Compliance, 1995 Edition.

Sustainable Environmental Law, Environmental Law Institute, West Publishing Co., St. Paul, Minn., 1993.

Pollution Prevention

Breen, Joseph J., and Michael J. Dellarco. Pollution Prevention in Industrial Processes: The Role of Process Analytical Chemistry. Washington, DC: American Chemical Society, 1992.

Chemical and Engineering News "Design for the Environment: Chemical Syntheses that Don't Pollute" September 5, 1994. Article on the 1994 American Chemical Society symposium "Design for the Environment: A New Paradigm for the 21st Century."

Chemical Manufacturer's Association, "Designing Pollution Prevention into the Process: Research, Development and Engineering," Washington, DC, 1993. [The reference section from this document is reproduced below to provide reference to additional sources of information.]

Du Pont Corporation and U.S. Environmental Protection Agency, "Du Pont Chamber Works Waste Minimization Project" 1993.

Dorfman, M.H. et al. "Environmental Dividends: Cutting More Chemical Wastes. New York, NY: INFORM, Inc.

Forester, William S., and John H. Skinner. Waste Minimization and Clean Technology: Waste Management Strategies for the Future. San Diego, CA: Academic Press, 1992.

The Hazardous Waste Consultant, New York: Elsevier Science Inc. (A bimonthly journal.)

Overcash, Michael R. "Techniques for Industrial Pollution Prevention: A Compendium for Hazardous and Non-Hazardous Waste Minimization. Chelsea, MI: Lewis Publishers, 1986.

Sawyer, Donald T., and Arthur E. Martell, Industrial Environmental Chemistry: Waste Minimization in Industrial Processes and Remediation of Hazardous Waste. New York, NY: Plenum Press, 1992.

SOCMA Pollution Prevention Study. Prepared for SOCMA Washington, D.C. January 1993. Profiles pollution prevention activities at four specialty chemical manufacturers.

Theodore, Louis, and Young C. McGuinn. Pollution Prevention. New York: Van Nostrand Reinhold, 1992.

U.S. Congress, Office of Technology Assessment "Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities," OTA-ITE-586 (Washington, DC: U.S. Government Printing Office, January 1994).

References from CMA's "Designing Pollution Prevention into the Process".

Information Sources and Agencies

Pollution Prevention Information Clearinghouse (PPIC) U.S. EPA

The International Cleaner Production Information Clearinghouse (ICPIC); United Nations Environmental Programme (UNEP), U.S. EPA

Books, Reports and Documents

Noyes Data Corporation, "Alternative Formulations and Packaging to Reduce Use of Chlorofluorocarbons," 1990, ISBN0-8155-1257-0.

Research Triangle Institute, "Alternatives for Measuring Hazardous Waste Reduction," 1991, PB91-208595.

Noyes Data Corporation, "Aqueous Cleaning as an Alternative to CFC and Chlorinated Solvent-Based Cleaning," 1991, ISBN0-8155-1285-6.

EPA, "Background Document on Clean Products Research and Implementation," 1990, EPA/600/S2-90/048.

EPA, "Case Studies from the Pollution Prevention Information Clearinghouse: Solvent Recovery," 1989, ISM-4 (PPIC).

Government Institutes, "Case Studies in Waste Minimization," 1991, ISBN0-86587-267-8.

United Nations Environmental Programme (UNEP), "Cleaner Production Newsletter," Industry and Environmental Office, ICPIC-1 (PPIC).

EPA, "Degreaser System Pollution Prevention Evaluation," 1990, EPA/600/S2-90/052.

Oregon Department of Environmental Quality, "Guidelines for Waste Reduction and Recycling: Solvents," 1989, ISM-13 (PPIC).

EPA, "Guides to Pollution Prevention: Research and Educational Institutions," 1990, ISM-19 (PPIC).

EPA, "Guides to Pollution Prevention: The Fiberglass-Reinforced and Composite Plastics Industry," ISM-19 (PPIC).

McGraw-Hill, Inc., "Hazardous Waste Minimization," 1990, ISBN0-07-022043-3.

Lewis Publishers, "Hazardous Waste Minimization Handbook," 1989, ISBN0-87371-176-9.

ASTM, "Hazardous and Industrial Solid Waste Minimization Practices," 1989, ISBN0-8031-1269-6.

EPA, "Industrial Pollution Prevention for the 1990s," 1991, EPA/600/S8-91/052.

EPA, "Pollution Prevention Benefits Manual: Volume 1 (Draft), 1989, WAM-1 (PPIC).

EPA, "Pollution Prevention Fact Sheets: Chemical Production," FREG-1 (PPIC), free.

EPA, "Pollution Prevention Information Exchange System (PIES) User Guide," Version 1.1, 1989, EPA/600/9-89/086, free.

City of Los Angeles, "Pollution Prevention Opportunities Checklist: Chemical Manufacturing," FCLA-1-1 (PPIC).

CMA, "Pollution Prevention Resource Manual," 1991, $75.00 (non-members), $50.00 (members, Order no. 018031).

EPA, "Prevention Reference Manual: Chemical Specific, Volume 10: Control of Accidental Releases of Hydrogen Cyanide," 1987, EPA/600-S8-87/034j.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 11: Control of Accidental Releases of Ammonia," 1987, EPA/600-S8-87/034k.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 12: Control of Accidental Releases of Sulfur Dioxide," 1987, EPA/600/S8-87/034l.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 13: Control of Accidental Releases of Methyl Isocyanate," 1987, EPA/600/S8-87/034m.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 14: Control of Accidental Releases of Phosgene," 1987, EPA/600/S8-87/034n.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 15: Control of Accidental Releases of Sulfur Trioxide," 1987, EPA/600/S8-87/034o.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 1: Control of Accidental Releases of Hydrogen Fluoride (SCAQMD)," 1987, EPA/600/S8-87/034a.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 2: Control of Accidental Releases of Chlorine (SCAQMD)," 1987, EPA/600/S8-87/034b.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 3: Control of Accidental Releases of Hydrogen Cyanide (SCAQMD)," 1987, EPA/600/S8-87/034c.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 4: Control of Accidental Releases of Ammonia Cyanide (SCAQMD)," 1987, EPA/600/S8-87/034d.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 7: Control of Accidental Releases of Chloropicrin Cyanide (SCAQMD)," 1987, EPA/600/S8-87/034g.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 8: Control of Accidental Releases of Hydrogen Fluoride," 1987, EPA/600/S8-87/034h.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 9: Control of Accidental Releases of Chlorine," 1987, EPA/600/S8-87/034i.

EPA, "Prevention Reference Manual: Chemical Specific, Volume 6: Control of Accidental Releases of Carbon Tetrachloride (SCAQMD)," 1987, EPA/600/S8-87/034f.

EPA, "Prevention Reference Manual: Control Technologies. Volume 2: Post-Release Mitigation Measures for Controlling Accidental Releases of Air Toxics," 1987, EPA/600/S8-87/039b.

EPA, "Prevention Reference Manual: Control Technologies. Volume 1: Prevention and Protection Technologies for Controlling Accidental Releases of Air Toxics," 1987, EPA/600/S8-87/039a.

EPA, "Prevention Reference Manual: Overviews on Preventing and Controlling Accidental Releases of Selected Toxic Chemicals," 1988, EPA/600/S8-88/074.

EPA, "Prevention Reference Manual: User's Guide, Overview for Controlling Accidental Releases of Air Toxics," 1987, EPA/600/S8-87/028.

EPA, "Proceedings of the International Workshop on Research in Pesticide Treatment/Disposal/ Waste Minimization," 1991, EPA/600-S9-91/047.

Alaska Health Project, "Profiting from Waste Reduction in Your Small Business," 1988, free, QAM-2 (PPIC).

National Academy Press, "Reducing Hazardous Waste Generation: An Evaluation and a Call for Action," 1985, $9.95, ISBN 0-309-03498-1.

Noyes, Data Corporation, "Solvent Waste Reduction," 1990, $45, ISBN 0-8155-1254-6.

EPA, "Solvent Waste Reduction Alternatives," 1989, EPA/625/4-89/021.

EPA, "Source Characterization and Control Technology Assessment of Methylene Choride Emissions from Eastman Kodak Company," Rochester, NY, 1989, EPA/600-S2-043.

Government Institutes, "The Greening of American Business: Making Bottom-Line Sense of Environmental Responsibility," 1992, $24.95, ISBN: 0-86587-295-3.

Van Nostrand Reinhold, "The Recycler's Manual for Business, Government, and the Environmental Community," 1992, $64.95, ISBN 0-442-01190-3.

National Academy Press, "Tracking Toxic Substances at Industrial Facilities: Engineering Mass Balance Versus Materials Accounting," 1990, ISBN 0-0309-04086-8.

EPA, "Waste Exchange Information Package," 1991, free, GEN-13 (PPIC).

EPA, "Waste Minimization: Environmental Quality with Economic Benefits," 1990, free, EPA/530-SW-87-026 (also GEN-14 (PPIC)).

Government Institutes, "Waste Minimization Manual," 1987, $57.00, ISBN: 0-86587-731-9.

EPA, "Waste Minimization Opportunity Assessment Manual," 1988, EPA/625/7-88/003.

CMA, "Waste Minimization Workshop Handbook," 1987, $250.00 (non-members); $100.00 (members), Order no. 018016.

API, "Waste Minimization in the Petroleum Industry: A Compendium of Practices," 1991, $35.00, Order no. 849-30200.

Lewis Publishers, "Waste Minimization: Implementing an Effective Program," due 1992, $59.00, ISBN 0-87371-521-7.

Noyes Data Corporation, "Waste Oil: Reclaiming Technology, Utilization, and Disposal," 1989, $39.00, ISBN 0-8155-1193-0.

California Department of Health Service, "Waste Reduction Fact Sheet: Pesticide Formulating Industry," free, FCAD-7 (PPIC).

Executive Enterprises, "Waste Reduction: Policy and Practice, $39.95, ISBN 1-55840-272-1.

Journals/Newsletters

ChemEcology, Chemical Manufacturer's Association, (202) 887-1100.

Chemical Research in Toxicology, American Chemical Society, (700) 333-9511.

CMA News, Chemical Manufacturer's Association, (202) 887-1100.

Dangerous Properties of Industrial Materials Report, Van Nostrand Reinhold, (212) 254-3232.

Environmental Technology and Chemistry, Persimmon Press, Inc., (914) 524-9200.

Fundamental and Applied Toxicology, Society of Toxicology, Academic Press, Inc., (619) 230-1840.

Green Business Letter, Tilden Press Inc., (202) 332-1700.

Green Marketing Report, Business Publishers, Inc., (301) 587-6300.

Hazard Prevention, System Safety Society, Inc.

Hazardous Substances and Public Health, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, (404) 639-6206.

Incorporate Environmental Reviews into Facility Design, Chemical Engineering Progress, pp. 46-52 (August 1992).

Industrial Health & Hazards Update, Merton Allen Associates, Info Team Inc., (305) 473-9560.

Journal of Environmental Pathology, Toxicology and Oncology, Blackwell Scientific Publications, Inc., (617), 225-0401.

Literature Abstracts: Health & Environment, American Petroleum Institute, (212), 366-4040.

Occupational Hazards, Penton Publishing Inc., (216) 696-7000.

Pollution Prevention Review, Executive Enterprises, (800) 332-8804.

Recycling--Reclamation Digest, ASM International, (216) 338-5151.

Responsible Care® Newsletter, Chemical Manufacturer's Association, (202) 887-1100.

Reuse-Recycle, Technomic Publishing Co., Inc., (717) 291-5609.

Toxic Substances Journal, Hemisphere Publishing Corporation.

Waste Minimization and Recycling Report, Government Institutes, Inc., (301) 921-2300.

Software/Databases

AQUIRE, Aquatic Toxicity Information Retrieval Database, NTIS, (703) 487-4650.

ATTIC, Alternative Treatment Technology Information Center Database, (301) 816-9153.

CESARS, Chemical Evaluation Search & Retrieval System, Chemical Information Systems Inc., (301) 321-8440.

IRIS, Integrated Risk Information System Database (summary information related to human health risk assessment), EPA, NTIS No. PB90-591330/CCE.

NIOSHTIC, database on bibliographic occupational safety and health, DIALOG Information Services.

STARA, Studies on Toxicity Applicable to Risk Assessment, EPA (919) 541-3629.

SWAMI, Strategic Waste Minimization Initiative, Version 2.0, EPA, contact Doug Williams at (513) 569-7361.

TERRE-TOX, Terrestrial Toxicity Database (aid in evaluating pre-manufacturing notices and research), NTIS.

TOXNET, Toxicology Data Network, National Library of Medicine.

WHWTD, Waste & Hazardous Waste Treatability Database, EPA.

ENDNOTES

1. Amoco - U.S. EPA Pollution Prevention Project, Yorktown, Virginia, Project Summary, January 1992.

2. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Chapter 9, Petroleum Industry.* U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, U.S. Government Printing Office, Washington, D.C., September 1985.

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