

# Hazard Assessment of Chemicals

*CURRENT DEVELOPMENTS*

**Volume 1**

*EDITED BY*

**Jitendra Saxena  
Farley Fisher**

# **Hazard Assessment of Chemicals**

## **Current Developments**

Volume 1

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VOLUME 1

Edited by

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# Contents

<b>List of Contributors</b> . . . . .	<b>ix</b>
<b>Preface</b> . . . . .	<b>xi</b>

## **Assessment of Toxic Substances Information Sources**

ANTHONY LEE

I. Introduction . . . . .	1
II. Computerized Data Bases . . . . .	2
III. Data Compendia and Handbooks . . . . .	9
IV. Problems in Data Gathering . . . . .	11
V. Future Developments . . . . .	15
Recommended Additional Reading . . . . .	16

## **Preconcentration of Trace Metals from Aquatic Environmental Samples**

A. CHOW and H. D. GESSER

I. Introduction . . . . .	17
II. Precipitation Methods . . . . .	20
III. Electrodeposition . . . . .	23
IV. Evaporation Methods . . . . .	25
V. Freezing . . . . .	27
VI. Sorption Methods . . . . .	28
VII. Solvent Extraction . . . . .	38
VIII. Miscellaneous Methods . . . . .	41
IX. Conclusion . . . . .	41
References . . . . .	42

## **The Reproductive Toxicology of Aquatic Contaminants**

WESLEY J. BIRGE, JEFFREY A. BLACK, and BARBARA A. RAMEY

I. Introduction .....	59
II. Testing Procedures Used to Evaluate Xenobiotics .....	61
III. Effects of Xenobiotics on the Reproduction of Aquatic Organisms .....	73
References .....	108

## **Partition Coefficient and Water Solubility in Environmental Chemistry**

CARY T. CHIOU

I. Introduction .....	117
II. Partition Theory .....	118
III. Relationship between Partition Coefficients .....	128
IV. Bioconcentration from Water .....	141
V. Soil-Water Distribution .....	144
VI. Conclusion .....	150
References .....	150

## **Chemical Carcinogens: *In Vitro* Metabolism and Activation**

EDMOND J. LAVOIE and STEPHEN S. HECHT

I. Introduction .....	156
II. Aromatic Amines .....	156
III. Polynuclear Aromatic Hydrocarbons .....	176
IV. Nitrosamines .....	203
V. Hydrazines and Azoxy Compounds .....	220
VI. Halogenated Hydrocarbons .....	223
VII. Aflatoxins and Substituted Propenylbenzenes: Carcinogenic Natural Products .....	227
References .....	233

## **Modeling of Toxic Spills into Waterways**

BARRY A. BENEDICT

I. Introduction .....	252
II. Development of Diffusion Equations .....	252

III. Coefficient Selection .....	262
IV. Techniques for Solution of Diffusion Equation .....	274
V. Available Models .....	282
VI. Example of Estimation of Spill Behavior .....	291
VII. Conclusions .....	294
References .....	296

## **Environmental and Laboratory Rates of Volatilization of Toxic Chemicals from Water**

DONALD MACKAY

I. Introduction .....	303
II. Mechanisms of Air-Water Exchange .....	304
III. Equilibrium between Phases .....	306
IV. Overall Transport Equation .....	312
V. Laboratory Measurements .....	319
VI. Conclusions .....	321
References .....	321

## **Estimation of Exposure to Hazardous Chemicals**

JUDITH M. HUSHON and ROBERT J. CLERMAN

I. Importance of Exposure Estimation as Part of the Chemical Risk Assessment Process .....	324
II. Information Required to Characterize Exposure .....	328
III. Steps in the Exposure-Assessment Process .....	331
IV. Sources of Data for Human Exposure Estimation .....	337
V. Environmental Exposure Estimation .....	365
VI. Uses of Exposure Estimates .....	382
VII. Conclusions .....	384
References .....	384

## **Structure-Activity in Hazard Assessment**

PAUL N. CRAIG and KURT ENSLEIN

I. Basic Considerations .....	389
II. Development of Structure-Activity Relationship Methods ...	395
III. Applications of QSAR Methods to Toxicity Data .....	399
References .....	418



# **Azaarenes: Sources, Distribution, Environmental Impact, and Health Effects**

JOSEPH SANTODONATO and PHILIP H. HOWARD

I. Introduction .....	421
II. Structure and Properties .....	421
III. Sources .....	423
IV. Environmental Levels .....	426
V. Biological Activity .....	432
VI. Conclusions .....	438
References .....	438
<b>Chemical Substance Index .....</b>	<b>441</b>
<b>Subject Index .....</b>	<b>455</b>

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## Preface

Industrialization of our civilization has resulted in the increased use of a wide variety of chemicals and the subsequent contamination of our environment. In the United States alone there are approximately 5,400 chemical producers and petroleum refiners that manufacture 50,000–70,000 chemicals. Approximately 1,000 new chemicals are introduced into the market every year.

The hazards posed to man and his environment are now widely recognized. For example, the Toxic Substances Control Act requires premarket screening of all chemical substances and all new uses of existing chemicals. The presence of hazardous chemicals in drinking water is being regulated. The National Institute for Occupational Safety and Health is addressing the hazards from exposure to chemicals in occupational settings. Academic institutions have responded by establishing departments to meet research and training needs in this area. Industry has responded by establishing centers to monitor compliance with environmental regulations. The general public has responded by forming environmental groups.

Assessment of environmental and health hazards from chemicals requires a multidisciplinary approach. One needs to consider chemical economics, production, usage, etc., environmental release, monitoring data, environmental behavior, health, and environmental effects. Often events can be predicted concerning environmental and health hazards based upon structure and activity relationships and physical-chemical characteristics.

A vast amount of new information about new pollutants, new effects, and new measures to deal with the problem of the increasing presence of chemicals in the environment is accumulating continuously. This annual serial publication is intended to present comprehensive and authoritative reviews of new and significant developments in the area of hazard assessment of chemicals. A unique feature of this serial is that each volume, in addition to subject reviews, will contain case histories of topical chemicals and/or chemical classes. While providing com-

prehensive reviews and evaluations of all pertinent information on topical chemicals or chemical classes to the reader, case histories are also intended to show examples of the applications of available methods and approaches for evaluating chemicals.

The first volume of this publication has made available current information in several important areas of chemical hazard assessment. In addition, an in-depth discussion of the primary and secondary sources for obtaining information on chemicals and for assessing their environmental and health hazards is also presented. Since estimation of the level of exposure to susceptible targets, both living and nonliving, is a logical early step in evaluation of a chemical, a chapter devoted to this subject has been included here. The chapters by Mackay on a theoretical framework for assessing environmental behavior of volatilizing chemicals, by Chiou on the estimation of distribution of organic compounds between water, aquatic organisms, and sediment by use of the partition coefficient and/or water solubility, and by Benedict on available models for predicting concentrations of chemicals on water bodies from spills conveniently collect diverse information on key environmental transport processes. While models can be valuable in identifying critical pathways that a chemical is likely to follow in the environment, ultimately it is necessary to measure the chemical's presence in selected compartments of the environment. Despite the trend of modern instrumental methods toward lower levels of detection there is often a need to remove the species of interest from its milieu, to concentrate it, or to prevent some interference. The subject of preconcentration with respect to trace metals is brought up to date in the chapter by Chow and Gesser.

Three chapters in this volume deal with environmental and health effects of chemicals. An exhaustive review of the literature on *in vitro* mammalian metabolic systems and their utility as activation systems in *in vitro* bioassays is provided in the chapter by LaVoie and Hecht. Craig and Enslein, on the other hand, provide an excellent discussion of our ability to predict metabolic transformations and mutagenic and carcinogenic potential of chemicals based on structural and physical parameters. An area of growing concern in aquatic toxicology is reproductive toxicology. Test procedures used for evaluating effects of xenobiotics on the reproduction of aquatic organisms along with reported effects of selected inorganic and organic toxicants are summarized in the chapter contributed by Birge, Black, and Ramey.

The case history of azaarenes (nitrogen analogs of polycyclic aromatic hydrocarbons) also included here presents up-to-date information concerning environmental sources, levels, and toxicological and carcinogenic activity. Azaarenes, believed to be formed during combustion or pyrolysis involving fossil fuels, have gained increased attention in recent days because of the anticipated increased utilization of coal as fuel in the years ahead.

# Assessment of Toxic Substances Information Sources

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I. Introduction .....	1
II. Computerized Data Bases .....	2
III. Data Compendia and Handbooks .....	9
IV. Problems in Data Gathering .....	11
A. Manufacturing and Production .....	11
B. Pollution-Control Technology .....	13
C. Use .....	14
D. Exposure .....	14
E. Health and Environmental Effects .....	14
V. Future Developments .....	15
Recommended Additional Reading .....	16

## I. INTRODUCTION

During the last decade, several health, safety, and environmental legislations were passed or amended to further protect the public and the environment from toxic substances. These legislations include

- The Toxic Substances Control Act (TSCA)
- The Resources Conservation and Recovery Act (RCRA)
- The Occupational Safety and Health Act
- The Federal Water Pollution Control Act (FWPCA)
- The Clean Air Act (CAA)
- The Safe Drinking Water Act (SDWA)
- The Federal Insecticides, Fungicides, and Rodenticides Act (FIFRA)
- The Food, Drug, and Cosmetic Act (FDCA)

The responsibility for implementing these legislations is shared by a number of Federal agencies. The four principal agencies, with regulatory authorities, are the Environmental Protection Agency (EPA), the Occupational Safety and Health Agency (OSHA), the Food and Drug Administration (FDA), and the Consumer Product Safety Commission (CPSC). Other agencies such as the National Institute for Occupational Safety and Health (NIOSH), the National Cancer Institute (NCI), and the National Institute for Environmental Health Sciences (NIEHS), perform support research to regulate toxic substances.

Within EPA, the Office of Pesticides and Toxic Substances (OPTS) has the primary responsibility for implementation of TSCA; OPTS has the largest chemical hazard assessment program in the federal government. In its early days, OPTS developed the Investigatory Report series, which was one of the earliest chemical hazard assessment programs in the federal government. Expanding on that program, OPTS now prepares a variety of reports (e.g., Material Balance Studies, Phase I Assessment Studies, Chemical Hazard Information Profiles, etc.), all of which are used in developing TSCA regulations. Another part of EPA, the Office of Research and Development (ORD), provides research and development support for all of EPA's regulatory programs. ORD has been active in the development of air and water quality criteria documents, which are used to develop regulations under the Clean Air and the Clean Water Acts. There are similar assessment programs at CPSC and NIOSH as well. CPSC studies are concerned with substances to which consumers may be exposed, and NIOSH criteria and standards documents are prepared in support of OSHA's health standards regulations development.

All of the assessment programs involve a common process. The key to the process is the gathering of a wide variety of information on chemical substances in order to assess the potential health and environmental risks and to identify ways to control exposure. Gathering the information requires a meticulous search of hundreds of data sources encompassing books, journals, computerized data bases, and data files in libraries and in the hands of governmental agencies and the private sector. This article reviews these various data sources. Its purpose is to familiarize those involved in hazard assessment activities with frequently used data sources, their contents and their limitations.

## **II. COMPUTERIZED DATA BASES**

Over the last decade, rapid advances in information-processing technology have greatly facilitated science and technology information searches. A large number of data bases are now available as easily accessible on-line computerized data bases. This achievement has resulted from cooperative efforts between

governmental agencies and the private sector. Currently, two of the largest commercial data-base dealers are

Systems Development Corporation (SDC)	Lockheed Information System (LIS)
2500 Colorado Avenue	3460 Hillview Avenue
Santa Monica, California 90406	Palo Alto, California 94304

Both offer access to data bases in chemistry, biology, and environmental sciences, in addition to business, energy, and sociology. Access to these data bases is quite simple, requiring only a user-identification code, which can be obtained by writing to the above addresses. There is no initial charge for signing up as a user. The user only pays for the computer connect time when performing searches and for the printouts of the data files.

Table I lists the various SDC or LIS data bases that provide useful information for chemical hazard-assessment studies. These data bases usually provide refer-

**TABLE I**  
**Commercial Data Bases Offered by Systems Development Corporation (SDC) and the Lockheed Information Systems (LIS)**

Name	Sponsor/owner	Subject area	System
AGRICOLA	U.S. National Agricultural Library	Agriculture	SDC/LIS
APILIT	American Petroleum Institute	Petroleum refining	SDC
APIPAT	American Petroleum Institute	Petroleum-refining patents	SDC
APTIC	Environmental Protection Agency	Air pollution	LIS
BIOSIS	Biosciences Information Services	Life sciences	SDC/LIS
CAS77/CAS7276	Chemical Abstracts Services	Chemistry	SDC/LIS
CIN	Chemical Abstracts Services	Chemical industry	SDC/LIS
		News note	
CHEMDEX	Chemical Abstracts Services	Chemical names	SDC/LIS
CLAIMS/CHEM	IFI/Plenum Data Co.	Chemical patents	LIS
COMPENDEX	Engineering Index	Engineering	SDC/LIS
ENVIROLINE	Environmental Information Center, Inc.	Environmental studies	SDC/LIS
NTIS	National Technical Information Service	Government-sponsored research	SDC/LIS
POLLUTION	Cambridge Scientific Abstracts Inc.	Pollution	SDC/LIS
SAFETY SCIENCE ABSTRACTS	Cambridge Scientific Abstracts Inc.	Health and safety	SDC
SSIE	Smithsonian Science Information Exchange	Current scientific research	SDC/LIS



ence citations and/or abstracts of reports that have appeared previously in journals, books, patents, preprints, conference proceedings, technical reports, and government publications.

### *Agricola*

Covers worldwide reports from January 1970 in agriculture and related subject fields, including general agriculture and rural sociology; agricultural economics; consumer protection and human nutrition; animal science, veterinary medicine; forestry and plant-related areas; agricultural chemistry; natural resources; entomology; and agricultural engineering.

### *Apilit*

Covers worldwide refining literature from January 1964. Includes petroleum refining, petrochemicals, air and water conservation, transportation and storage, and petroleum substitutes. Source documents include trade magazines, technical journals, meeting papers, and government reports. Available on a limited basis to nonsubscribing organizations in the United States, Canada, and France.

### *Apipat*

Contains citations to refining patents from the United States and nine other countries: Belgium, Canada, France, Germany, Great Britain, Holland, Italy, Japan, and South Africa. Subject coverage includes the same areas covered by APILIT. Available on a limited basis to nonsubscribing organizations in the United States, Canada, and France.

### *Aptic*

Covers all aspects of air pollution, its effects, prevention, and control from 1966 to 1978. The records added to the data base from 1977 through September 1978 were taken from periodicals, books, and conference proceedings not covered by other major discipline-oriented data bases.

APTIC covers the field of air pollution in the broadest sense, including the social, political, legal, and administrative aspects of the field. Subjects treated in this data base include: atmospheric interaction, control methods, economic aspects, effects on human health, effects on materials, effects on plants and livestock, emission sources, government participation (legal and administrative), measurement methods, pollution data (air quality and emission inventories), and social aspects and public involvement.

### *Biosis*

Includes contents of *Biological Abstracts* (BA) and *Bioresearch Index* (Biol) covering the life sciences from 1969. Literature selected must meet one of the following selection criteria: original research reports in biological and biomedical

fields, reviews of original research in biology, history, and philosophy of the biological and biomedical sciences, or documentation and retrieval of biological and biomedical information. Citations are taken from approximately 8000 serial publications as well as books, notes, research communications, and symposia.

#### *CAS77 and CAS7276*

Provides worldwide coverage of the chemical sciences literature from over 12,000 journals, patents from 26 countries, new books, conference proceedings, and government research reports. Coverage corresponds to the printed *Chemical Abstracts Condensates*, including 80 main subject sections such as biochemistry, organic chemistry, macromolecular chemistry, applied chemistry and chemical engineering, and physical and analytical chemistry. Includes special searching features from *Chemical Abstracts Subject Index Alert* (e.g., registry numbers, molecular formula fragment).

#### *Chemdex*

This compound-oriented chemical dictionary file covers all compounds cited in the literature from 1972 to date. It may be searched by chemical name or fragment, by molecular formula or molecular formula fragment, or by group or row within the periodic chart. Each record contains a registry number, the molecular formula, and *Chemical Abstract's* rigorous nomenclature for a specific chemical.

#### *Claims/Chem*

Provides access to chemical and chemically related patents. Subject indexing for each chemical patent from a controlled vocabulary designed to facilitate retrieval of chemical structures and polymers. Indexing is prepared from a review of the full text of patent documents; 20 or more uniterm codes are then added to each record. CLAIMS/UNITERM 1950-1970, File 223, parallels coverage of File 23, CLAIMS/CHEM 1950-1970; CLAIMS/UNITERM 1971-1977, File 224, parallels File 24, CLAIMS/U.S. PATENTS 1971-1977; and CLAIMS/UNITERM 1978 to present, File 225, parallels File 25, CLAIMS/U.S. PATENT ABSTRACTS.

#### *CIN*

*Chemical Industry Notes* contains citations to the business literature in the chemical industry, including pharmaceutical, petroleum, paper and pulp, agriculture and food industries. Subject coverage ranges to include production, pricing, sales, facilities, products and processes, corporate activities, government activities, and people. Covers over 80 United States and non-United States publications from 1974.

### *Compendex*

Covers civil-environmental-geological engineering; mining-metals-petroleum-fuel engineering; mechanical-automotive-nuclear-aerospace engineering; electrical-electronics-control engineering; chemical-agricultural-food engineering; and industrial engineering, management, mathematics, physics, and instruments, including approximately 1500 serial and over 900 monographic publications from 1970. Corresponds to *Engineering Index Monthly*.

### *Enviroline*

Contains citations on all areas of environmental studies. Subject areas covered include air pollution, chemical and biological contamination, energy, environmental education, environmental design and urban ecology, food and drugs, international affairs, land use, nonrenewable resources, oceans and estuaries, population planning, geophysical change, and wildlife. References are gathered primarily from English-language journals, as well as government reports and documents, monographs, and conference papers. Corresponds in coverage to *Environment Abstracts*.

### *NTIS*

Broad and cross-disciplinary file containing citations to United States government-sponsored research and development technical reports from over 200 federal agencies and some reprints, federally sponsored translations, and foreign-language reports in areas of major technical interest. Multidisciplinary scope includes aeronautics; agriculture; astronomy and astrophysics; behavioral-social sciences; biological and medical sciences; chemistry; earth sciences; oceanography; electronics; engineering; energy; materials; mathematical sciences; military sciences; communications; space technology. Corresponds to *Weekly Government Abstracts* and semimonthly *Government Reports Announcements*.

### *Pollution*

Corresponds in coverage to the printed *Pollution Abstracts* publication. Covers domestic and non-United States reports; some 2500 journals; selected conference proceedings and papers; symposia; contracts and patents; monographs and government documents in the areas of pollution control and research including air pollution, water pollution, solid wastes, noise, pesticides, radiation, and general environmental quality.

### *Safety Science Abstracts*

Broad, interdisciplinary coverage of literature related to the science of safety; a relatively new field devoted to identifying, evaluating, and eliminating or controlling hazards. Major subject categories are general safety, industrial and occu-

pational safety, transportation safety, aviation and aerospace safety, environmental and ecological safety, and medical safety. Topics covered include pollution, fire, waste disposal, prediction and reporting of natural disasters, legislative regulations and their impact, urban development, radiation, drug dosages, criminal acts (e.g., arson, child abuse), epidemics, pesticides, education, prevention, and psychological factors related to safety.

### SSIE

Covers ongoing and recently completed research in the agricultural sciences, behavioral sciences, biological sciences, earth sciences, chemistry and chemical engineering, electronics, engineering, materials, mathematics, medical sciences, physics, and social sciences—both basic and applied research projects. Research in progress is included from over 1300 funding organizations such as federal, state, and local governments; nonprofit associations; colleges and universities; nonaffiliated investigators; and some non-United States organizations and private industry.

The National Library of Medicine (NLM) has its own data systems network. Under NLM's MEDLARS program, a number of data bases on toxicological and health effects of chemical substances are now available. One very useful data base is TOXLINE, which stands for Toxicology Information On-Line. Full information on TOXLINE and other data bases within the NLM MEDLARS program can be obtained by contacting MEDLARS Management Section, Specialized Information Services, National Library of Medicine, 8600 Rockville Pike, Bethesda, Maryland 20209 [(301) 496-6193], or (800) 638-8480.

TOXLINE is a major data resource for health and toxicological effects information. It contains several subfiles:

- Toxicity Bibliography (TOXBIB)
- Abstracts of Health Effects of Environmental Pollutants (HEEP)
- Eleven sections from *Chemical Abstracts* including the Chemical-Biological Activities (CBAC) files
- *International Pharmaceutical Abstracts*
- Environmental Mutagen Information Center (EMIC) Data Base
- Environmental Teratology Information Center (ETIC) Data Base
- Toxic Materials Information Center (TMIC) Data Base
- Biosciences Information Service (BIOSIS)

Associated with TOXLINE is the CHEMLINE file, which stands for *Chemical Dictionary On Line*. This file contains the CAS registry number, molecular formulas, and nomenclature for thousands of chemical substances. It can be used to identify names and synonyms of chemical substances that are often necessary as key words to search a data base.

*Toxicology Data Bank* is another on-line interactive retrieval system offered by the National Library of Medicine (NLM) as part of the MEDLARS family of data bases. It provides information on 2500 chemical substances, extracted from 80 reference books and journals.

CANCERLINE, the acronym for Cancer Information On Line is another MEDLAR data base. Sponsored by the National Cancer Institute, it consists of three files:

- CANCERLIT, abstracts of all cancer-related literature
- CANCERPROJ, descriptions of current cancer research projects
- CLIN PROT, summaries of clinical protocols

Access to TOXLINE also allows access to CANCERLINE. No additional user code is necessary.

Another United States government-sponsored on-line data system is the NIH/EPA Chemical Information System (CIS), which contains some 12 subfiles of toxicological, analytical, and physical properties of chemical substances. It also has the Federal Register Search System (FRSS), a subfile containing notices related to chemicals that have appeared in the Federal Register since January, 1978. The system is administered for the United States government by Interactive Sciences Corporation, Suite 301, 918 16th Street, N.W., Washington, D.C. 20006.

The data bases mentioned so far are readily available to the public. The Federal government alone has over 220 chemical data files in various agencies and in different forms, from file cards to computer files. Many of these are not open to the public, and those that are usually require a formal request for a data-base search. Often, access is limited to those employed in government or as contract researchers for the agency.

The EPA Section 308 file is one of these data bases with limited access. Under the authority of Section 308 of the Clean Water Act, EPA conducted an extensive survey of several industries that discharge toxic effluents. The data were gathered on a plant-by-plant basis and include details on levels of production, manufacturing processes, waste-treatment technologies in place, and levels of toxic discharge. The data are utilized to develop effluent limitations on 21 industries for the 131 priority toxic pollutants. The information is considered confidential and access is limited to EPA personnel and contractors supporting EPA in the effluent guidelines program.

Another EPA data base is the Organic Chemical Producers Data Base, which is maintained by EPA/ORD Cincinnati Research Laboratory. Data on physical/chemical properties, manufacturing processes, uses, and by-products have been collected from published literature for approximately 500 compounds. Portions of the data base have been published and are available from EPA or NTIS. A researcher, however, can request a search of the files from EPA Cincinnati.

Recently, the EPA/OPTS announced the availability of nonconfidential information of the TSCA inventory on a computer tape through NTIS. The inventory is a list of chemicals that are in commercial use in the United States, together with the levels of production.

NIOSH offers search on request of its two primary data bases: NIOSHTIC and the National Occupational Hazard Survey (NOHS). The first provides abstracts and citations on published literature dealing with occupational safety and health, the latter is a survey to determine occupational exposure in United States workplaces.

Data bases have also been developed to provide information in emergency situations involving spills of chemicals and other hazardous materials. The three most prominent are the OHM-TADS on-line data base, the manual CHEMTREC data files, and the CHRIS Condensed Guide to Chemical Hazards.

OHM-TADS is a specialized file designed originally for EPA Oil and Hazardous Materials Spill Response field teams. The file includes a wide variety of physical, chemical, biological, and toxicological data for about 1000 substances with the emphasis on deleterious effects on water quality. The data base is available to the public through on-line interactive data terminals. CHEMTREC is a manual data base of the Chemical Manufacturers Association Chemical Transportation Emergency Center. The data base consists of file cards with information on hazards, what to do in case of spills, leaks, fire, and exposure; odor, effect with water, ignition point, and vapor density. The toll-free national emergency number for CHEMTREC is 800-424-9300.

CHRIS, which stands for Chemical Hazards Response Information System, is a handbook on chemical hazards prepared by the U.S. Coast Guard. The handbook is intended to provide Coast Guard field personnel with some technical information necessary for an initial response to hazardous chemical spills and to treat people who have been exposed. Brief information on approximately 900 chemicals covering chemical identification, response protocol, and types of hazards is provided.

### III. DATA COMPENDIA AND HANDBOOKS

Access to handbooks and data compendia will facilitate the assessment of a chemical's potential hazard. The following identifies some of the data compendia that have been particularly useful, and they should be considered in building up a library resource for assessing chemical hazards.

*Synthetic Organic Chemicals, U.S. Production and Sale, U.S. International Tariff Commission, Washington, D.C. 20436.* An annual publication on production and sales for all synthetic organic chemicals produced commercially in

the United States. About 8000 chemicals and 800 manufacturers are included in the USITC surveys, but because of confidentiality requirements, only parts of the data base are published. USITC also collects and publishes monthly statistics for 108 of the most important synthetic organic chemicals. Additionally, an annual publication of the import/export of benzenoid chemicals is also prepared.

*Chemical Economics Handbook*, SRI International, Inc., Menlo Park, California 94023. This is a multivolume publication that is available only to subscribers. It provides an in-depth evaluation of the present and future economic status of major chemical substances.

*Directory of Chemical Producers*, SRI International, Inc., Menlo Park, California 94025. This book is essentially a chemical-buyers guide. It lists both plants and products for 1300 companies and approximately 10,000 commercial chemicals. Some information on capacity, process, and raw materials is included for major chemicals.

*Kirk-Othmer Encyclopedia of Chemical Technology*, Wiley (Interscience), New York 10016. This 24-volume encyclopedia provides the most comprehensive source of information on industrial chemistry and technology. Approximately 12,500 compounds are included in the series. The encyclopedia is being updated at the present time.

*Registry of Toxic Effects of Chemical Substances*, U.S. Government Printing Office, Washington, D.C. 20402. This annual publication is sponsored by the National Institute for Occupational Safety and Health. It contains toxic dose data with reference to the source document and it also references major standards and regulations for over 35,000 chemicals.

*Survey of Compounds Which Have Been Tested for Carcinogenic Activity*. U.S. Government Printing Office, Washington, D.C. 20402. This data resource is a series of books with extracted data from scientific literature regarding the test of chemical compounds in experimental animals. Over 4500 compounds are identified in the available seven-volume series.

*Toxicology Research Projects Directory (TRDB)*, National Library of Medicine, Bethesda, Maryland 20014. TRDB is a monthly publication containing selections from the Smithsonian Science Information Exchange data base. It provides on-going project summaries related to toxicology manuals.

*IARC Monograph Series*, International Agency for Research on Cancer, Lyon, France. These monographs assess the carcinogenic risk of chemicals to man and present evaluations by an international panel of cancer researchers organized by the International Agency for Research on Cancer. The *Survey of Chemicals Being Tested for Carcinogenicity* by IARC should also be of interest. The U.S. National Cancer Institute is funding the program.

There are scores of other books and publications that could be of use in assessing chemical hazards. The following identifies a few that are widely recognized as highly useful and quick-access sources for information on chemical hazards:

- Sax, N. I. "Dangerous Properties of Industrial Materials." Van Nostrand-Reinhold, Princeton, New Jersey.
- "Chemical Safety Data Sheets." Chemical Manufacturers Association, Washington, D.C.
- "Hygienic Guide Series." American Industrial Hygiene Association, Detroit, Michigan.
- Browning, E. "Toxicity and Metabolism of Industrial Solvents." Elsevier Publishing Company, New York.
- Browning, E. "Toxicity of Industrial Metals." Butterworth, London.
- Patty, F. A. "Industrial Hygiene and Toxicology." Wiley (Interscience), New York.
- Stecher, P. G., ed. "The Merck Index." Merck & Co., Inc., Rahway, New Jersey.
- International Labor Office. "Encyclopedia of Occupational Health and Safety." McGraw-Hill Book Company, New York.
- "Clinical Toxicology of Commercial Products." Williams & Wilkins, Baltimore, Maryland.
- "NIOSH/OSHA Pocket Guide to Chemical Hazards." DHEW (NIOSH), Publ. No. 78-210. National Institutes for Occupational Safety and Health, Washington, D.C.

#### IV. PROBLEMS IN DATA GATHERING

Assessing the potential hazard of a substance often involves two basic questions:

- What is the degree of human and environmental exposure?
- What are the environmental and health risks?

To assess exposure, the release and exposure sources of the chemical should be tracked through its entire extraction/production—consumption/use—disposal/destruction cycle. Data categories for exposure include: physical and chemical properties, manufacturing and processing technologies, process chemistry, markets, geographic factors of plant and disposal site locations, waste-treatment and disposal technologies, uses and consumption, environmental fate and direct-exposure monitoring data. An equally broad range of data on environmental and health effects is required to evaluate the risk of a substance to man and the environment, including data on effects and uptake by microorganisms, acute and chronic effects in animals and man, and epidemiological studies. This section addresses some of the frequently encountered problems in searching for the wide variety of data necessary for assessing the hazards of a particular substance.

##### A. Manufacturing and Production

Acquiring reliable information on production levels and manufacturing methods has always been very difficult, but with the establishment of the TSCA