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Part IX

Environmental Protection Agency

Twenty-Ninth Report of the Interagency Testing Committee to the Administrator; Notice

ENVIRONMENTAL PROTECTION AGENCY

[OPPTS-41036; FRL 4007-6]

Twenty-Ninth Report of the Interagency Testing Committee to the Administrator; Receipt of Report and Request for Comments Regarding Priority Testing List of Chemicals

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: The Interagency Testing Committee (ITC), established under section 4(e) of the Toxic Substances Control Act (TSCA), transmitted its Twenty-Ninth Report to the Administrator of EPA on November 27, 1991. As noted in this Report, which is included with this notice, the Committee revised the Priority Testing List by adding one chemical, white phosphorus, and one chemical group, the alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers. These chemicals are recommended. There are no designated or recommended with intent-to-designate chemicals.

The ITC removed six chemicals from the Priority Testing List in the 29th Report as a result of EPA actions. Five brominated flame retardants, designated in the 25th ITC Report, were removed because EPA issued a proposed rule on June 25, 1991 (56 FR 29140). 4-Vinylcyclohexene, designated in the 26th Report, was removed because EPA issued a consent order on September 23, 1991 (56 FR 47912).

EPA invites interested persons to submit written comments on the Report.

DATES: Written comments should be submitted by January 29, 1992.

ADDRESSES: Send four copies of written submissions to: TSCA Public Docket Office (TS-793), Office of Pollution Prevention and Toxics, Environmental Protection Agency, Rm. NE G-004, 401 M St., SW., Washington, DC 20460. Submissions should bear the document control number (OPPTS-41036; FRL 4007-6). The public record supporting this action, including comments, is available for public inspection in Rm. NE G-004 at the address noted above from 8 a.m. to noon and 1 p.m. to 4 p.m., Monday through Friday, except legal holidays.

FOR FURTHER INFORMATION CONTACT: David Kling, Acting Director, Environmental Assistance Division (TS-799), Office of Pollution Prevention and Toxics, Environmental Protection Agency, Rm. E-543B, 401 M St., SW., Washington, DC 20460, (202) 554-1404, TDD (202) 554-0551.

SUPPLEMENTARY INFORMATION: EPA has received the TSCA Interagency Testing Committee's Report to the Administrator.

I. Background

TSCA (Pub. L 94-469, 90 Stat. 2003 et seq; 15 U.S.C. 260l et seq.) authorizes the Administrator of EPA to promulgate regulations under section 4(a) requiring testing of chemicals and chemical groups in order to develop data relevant to determining the risks that such chemicals and chemical groups may present to health or the environment. Section 4(e) of TSCA established the Interagency Testing Committee to recommend chemicals and chemical groups to the Administrator of EPA for priority testing consideration. Section 4(e) directs the ITC to revise the TSCA section 4(e) Priority Testing List at least every 6 months. The ITC's most recent revisions to this List are included in the Committee's Twenty-Ninth Report. The Report was received by the Administrator on November 27, 1991, and is included in this Notice. The Report adds one chemical and one chemical group to the TSCA section 4(e) Priority Testing List.

II. Written and Oral Comments

EPA invites interested persons to submit detailed comments on the ITC's new recommendations. The Agency is interested in receiving information concerning additional or ongoing health and safety studies on the subject chemicals as well as information relating to the human and environmental exposure to these chemicals.

A notice will be published at a later date in the **Federal Register** adding the substances recommended in the ITC's Twenty-Ninth Report to the TSCA section 8(d) Health and Safety Data Reporting Rule (40 CFR part 716), which requires the reporting of unpublished health and safety studies on the listed chemicals. The delay in publishing this notice is necessary to avoid an overlap in the reporting period for chemicals included in the ITC's 28th list. That notice will also add the chemicals to the TSCA section 8(a) Preliminary Assessment Information Rule (40 CFR part 712). The section 8(a) rule requires the reporting of production volume, exposure, and release information on the listed chemicals.

III. Status of List

The ITC's Twenty-Ninth Report notes the addition of one chemical and one chemical group to the Priority Testing List, and the removal of 5 brominated flame retardants and 4-vinylcyclohexene from the List. The current Priority Testing List contains 26 chemicals and 21 chemical groups, 13 of these chemicals are designated.

Authority:15 U.S.C. 2603.

Dated: December 16, 1991.

Charles M. Auer,

Director, Existing Chemical Assessment Division, Office of Pollution Prevention and Toxics.

Twenty-Ninth Report of the TSCA Interagency Testing Committee to the Administrator, Environmental Protection Agency

Summary

The U.S. Congress created the Interagency Testing Committee (ITC) under the Toxic Substances Control Act (TSCA) to recommend chemicals and chemical groups to the Administrator of the U.S. Environmental Protection Agency (EPA) for priority testing consideration and to facilitate coordination of chemical testing sponsored or required by U.S. Government organizations represented on the Committee. Congress directed the Committee to: (1) Organize their recommendations as the Priority Testing List, (2) revise the Priority Testing List at least every 6 months and (3) transmit these revisions to the EPA Administrator for publication in the **Federal Register.**

As a result of its deliberations during this reporting period (5/16/91 to 11/27/91), the Committee is revising the TSCA section 4(e) Priority Testing List by recommending one chemical and one chemical group. The Committee's computerized, substructure-based chemical selection expert systems were used to identify the chemicals in groups that are likely to satisfy multiple data needs of Member Agencies and others. During this reporting period, the Committee (1) considered available information on 5 chemicals and 14 chemical groups, (2) discussed information on Committee activities at the North American Benthological Society Technical Information Workshop on Toxicity Assessment Techniques for Aquatic Invertebrates, (3) participated in CPSC's, EPA's and NCI's chemical testing meetings, (4) met with the Synthetic Organic Chemical Manufactures Association and the Chemical Manufactures Association to discuss completed, ongoing and planned testing of chemical groups, (5) processed chemicals nominated by Maryland's Department of the Environment, (6) prepared testimony for U.S. Senate hearings on chemicals causing adverse reproductive effects, (7) published

unambiguous tables of the 124 chemicals and 39 chemical groups on or removed from the Priority Testing List, (8) initiated a review of 350 studies submitted to the EPA or retrieved from recent literature for chloroalkyl phosphates, (9) shared test data resulting from EPA's implementation of ITC's testing recommendation with a permitting authority and (10) deferred one chemical from testing consideration.

Chemicals or chemical groups (entries) on the Priority Testing List are designated, recommended with intent-to-designate or recommended by the Committee. Designations were created by the U.S. Congress when they drafted TSCA. Recommendations with intent-to-designate were established by the Committee in their 17th Report (50 FR 47603; November 19, 1985). Recommendations were established by the Committee in their 11th Report (47 FR 54626; December 3, 1982).

Revisions to the Priority Testing List

Revisions to the Priority Testing List are presented, together with the types of testing recommended, in Table 1. The footnote letters following Table 1 acknowledge the Committee's efforts to comprehensively search ongoing testing-related activities for chemicals under section 110 of the Superfund Amendments and Reauthorization Act (SARA), section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA), section 301 of the Clean Air Act Amendments, Priority 1 substances in the Organization for Economic Cooperation and Development's chemical testing program and available information previously submitted under TSCA section 8(a) and 8(d). Table 1 reads as follows:

TABLE 1.—REVISIONS TO THE SECTION 4(E) PRIORITY TESTING LIST

Group	CAS No.	Chemical	Action	Date	Recommended Tests
	7723-14-0	White phosphorus[1] [2]	Recommended	11/91	Chemical fate: Persistence in surface waters and sediments. Health effects: None. Ecological effects: Toxicity to migratory birds and other wildlife.
Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers.			Recommended	11/91	Chemical fate: Physical and chemical properties and biodegradation screening. Health effects: Screening for subchronic, mutagenic, reproductive, developmental and neurotoxic effects, except diphenyl oxide. Ecological effects: Screening for toxicity to algae, aquatic invertebrates and fish.

[1] Superfund Amendments and Reauthorization ACt (SARA) Section 110.
[2] Emergency Planning and Community Right-to-Know Act (EPCRA) section 313.

Listed below are the individual chemicals for the diaryl ethers in Table 1. Chemical nos. 1 through 7 are alkyldiaryl ethers, chemical no. 8 is a bromodiaryl ether, chemical nos. 9 through 12 are chlorodiaryl ethers, chemical nos. 13 and 14 are hydroxymethyl diaryl ethers.

No.	Chemical Name	CAS No.
1.	Benzene, 1,1'-oxybis-	101-84-8[1] [2]
2.	1,4-Diphenoxybenzene	3061-36-7
3.	Benzene, 1-methyl-3-phenoxy-	3586-14-9
4.	Benzene, 1,1'-oxybis[methyl-	28299-41-4
5.	1,1'-Biphenyl, phenoxy-	28984-89-6
6.	Benzene, 1,1'-oxybis[(1,1,3,3-tetramethylbutyl)-	61702-88-3
7.	Benzene, 1,1'-oxybis[dodecyl-	69834-19-1
8.	Benzene, 1-(bromomethyl)-3-phenoxy-	51632-16-7
9.	2-Chloro-l-(3-methylphenoxy)-4-(trifluoromethyl)benzene	42874-96-4
10.	Phenol, 3-[2-chloro-4-(trifluoromethyl)phenoxy]-,acetate	50594-77-9
11.	Benzoic acid, 3-[2-chloro-4-(trifluoromethyl)phenoxy]-	63734-62-3
12.	Benzoic acid, 3-[2-chloro-4-(trifluoromethyl)phenoxy]-,potassium salt	72252-48-3
13.	Benzenemethanol, 3-phenoxy-,	13826-35-2
14.	Benzenemethanol, 3-phenoxy-, acetate	50789-44-1

[1] Toxic Substances Control Act (TSCA) section 8(a) Preliminary Assessment Information Rule (PAIR).
[2] TSCA section 8(d) Health and Safety Data Reporting Rule.

TSCA Interagency Testing Committee

Statutory Member Agencies and Their Representatives

Council on Environmental Quality
Larry Clark, member (see Note 1)

Department of Commerce
Willie E. May, member (see Note 2)

Environmental Protection Agency
James B. Willis, member (see Note 3)
John S. Leizke, alternate (see Note 4)

National Cancer Institute
Thomas P. Cameron, member (see Note 5)
Richard Adamson, alternate (see Note 6)

National Institute for Environmental Health Sciences
Errol Zeiger, member (see Note 7)
James K. Selkirk, alternate

National Institute for Occupational Safety and Health
Robert W. Mason, member and Chairperson
Rodger L. Tatken, alternate

National Science Foundation
Carter Kimsey, member (see Note 8)
Jarvis L. Moyers, alternate

Occupational Safety and Health Administration
Christine Whittaker, member (see Note 9)
Stephen Mallinger, alternate

Liaison Agencies and Their Representatives

Agency for Toxic Substances and Disease Registry
Sharunda Buchanan (see Note 10)

Consumer Product Safety Commission
Lakshmi C. Mishra

Department of Agriculture
Donald Derr, member (see Note 11)
Richard M. Parry, Jr., alternate

Department of Defense
Randall S. Wentsel

Department of the Interior
Clifford P. Rice, member
Barnett A. Rattner, alternate

Department of Transportation
James O'Steen, member
George Cushmac, alternate

Food and Drug Administration
Charles J. Kokoski, member
Raju Kammula, alternate

National Library of Medicine
Vera Hudson

National Toxicology Program
Miriam Davis, member
Victor A. Fung, alternate and Vice Chairperson

U.S. International Trade Commission
James Raftery, member
Edward Matusik, alternate

Committee Staff

John D. Walker, Ph.D., Executive Director
Norma S.L. Williams, Executive Assistant

Support Staff

Alan Carpien, office of the General Counsel, EPA

Notes:
1. Appointed on November 21, 1991.
2. Appointed on November 8, 1991.
3. Appointed on August 5, 1991.
4. Appointed on August 5, 1991.
5. Appointed on November 22, 1991.
6. Appointed on November 22, 1991.
7. Appointed on November 15, 1991.
8. Appointed on September 28, 1991; on an IPA from August 1990 to August 1991.
9. Appointed on August 15, 1991
10. Appointed on September 11, 1991.
11. Appointed on November 26, 1991

The Committee very much appreciates the efforts of former members and alternates from ATSDR (Deborah Barsotti, member from 3/89-11/91), EPA (Letitia Tahan, member from 8/89-8/91 and Vince Nabholtz, alternate from 8/89-8/91), NSF (Bill Pengelly, member from 8/90-8/91), and OSHA (Loretta Schuman, member from 9/89-8/91). These members and alternates were responsible for initiating and sustaining intraagency efforts that resulted in Member Agency nomination of chemical groups (brominated flame retardants, isocyanates, IRIS (RfC/RfD) chemicals, aldehydes, alkynes, nitroalcohols, phophoniums, hydrazines, oxiranes, alkoxysilanes, aldehyde hydrates and isothiocyanates) and chemicals (1,1' methylenebis-4-isocyanatocyclohexane and *N*-phenyl-1-naphthylamine) that were included in the Committee's 25th, 26th, 27th and 28th Reports. The ITC acknowledges the assistance and support given by the staff of Syracuse Research Corp. (technical support contractor) and personnel of the EPA Office of Pollution Prevention and Toxics.

Chapter 1—Introduction

1.1 *Background.* The U.S. Congress created the TSCA Interagency Testing Committee (ITC) in 1976 and provided the ITC with statutory authority to screen, select and recommend chemicals and chemical groups to the EPA Administrator for priority health effects, chemical fate, and ecological effects testing consideration. When screening chemicals or chemical groups for consideration, Congress directed the Committee (which consists of members from 8 statutory and 10 liaison U.S. Government organizations) to consider 8 statutory factors including: (1) Quantities manufactured or released, (2) numbers of individuals exposed, (3) duration of exposure, (4) extent of human exposure, (5) structural relationships to known toxic substances, (6) availability of existing toxicity data, (7) reliability of available toxicity data to predict hazard, and (8) availability of testing facilities to develop data for the recommended tests. Congress also directed the Committee to give priority attention to those chemicals or chemical groups known to cause or suspected of causing cancer, gene mutations or birth defects. Based on these Congressional directives, the Committee recommends chemicals or chemical groups that appear to have insufficient health effects, chemical fate, or ecological effects test data and that may present an unreasonable risk of injury to health or the environment, reasonably be anticipated to enter the environment in substantial quantities or involve significant or substantial human exposure.

Congress also created the ITC to facilitate coordination of chemical testing sponsored or required by U.S. Government organizations and to enhance information exchange to promote cost-effective use of U.S. Government chemical testing resources by recommending testing of chemicals or chemical groups that are likely to satisfy multiple data needs of Member Agencies and others. The Committee's statutory responsibilities are described in section 4(e) of the Toxic Substances Control Act (TSCA; Public Law 94-469, 90 Stat. 2003 et seq., 15 U.S.C. 2601 et seq.).

The Committee prepares the Priority Testing List of chemicals or chemical groups recommended for testing (by the chemical's manufacturers), transmits the Priority Testing List to the Administrator of the U.S. Environmental Protection Agency (EPA) and determines the order in which the EPA Administrator shall implement the testing recommendations under TSCA section 4(a) by designating those chemicals, from among its recommendations, to which the Administrator should respond within 12 months. Congress directed the Committee to revise the Priority Testing List at least every 6 months and required the EPA Administrator to publish the Committee's Reports in the **Federal Register.**

1.2 *Committee's previous reports.* Twenty-eight previous Reports to the EPA Administrator have been issued by the Committee and published in the **Federal Register.** In these 28 Reports, the Committee recommended testing for 123 chemicals and 38 chemical groups. Chemical groups consist of one or more chemicals, isomers, congeners, mixtures, and so on that have a common substructure, use, testing information deficiency, exposure scenario, etc., and for which there is one common testing recommendation, e.g., aldehydes

recommended for ecological effects testing in the 27th Report. Chemicals can be members of chemical groups, but each is counted as a single chemical if their testing recommendations are different, e.g., the five chloroalkyl phosphates recommended in the 23rd Report.

1.3 *Committee's activities during this reporting period.* Between May 16, 1991 and November 27, 1991, the Committee examined lists of ongoing activities related to reducing testing information deficiencies for commercial chemicals, used their computerized, substructure-based, chemical selection expert systems to identify chemical groups in need of testing, identified chemicals that appeared to have insufficient health effects, chemical fate or ecological effects test data, considered the multiple data needs of Member Agencies and others, and recommended chemicals and chemical groups with insufficient test data based on concerns for potential toxicity, exposure or environmental release.

1.3.a *Chemical and chemical group selections.* The Committee recommended one chemical (white phosphorus) and one chemical group (alkyl-, bromo-, chloro-, hydroxymethyl diarylethers) for testing (Table 1). White phosphorus and alkyl-, bromo-, chloro-, hydroxymethyl diarylethers were recommended, not designated, because the Committee wants to review the TSCA section 8(a) and 8(d) information and any use exposure and release information as well as any physical chemical property information that is voluntarily submitted, before deciding whether to designate or withdraw these chemicals for testing. When the Committee recommended white phosphorus for chemical fate and ecological effects testing, it considered the data needs of the U.S. Department of the Interior, the ongoing activities of the Department of Defense and the regulatory authorities of the Department of Transportation. Test data needs are considered during selection of chemicals and chemical groups for testing. However, it may be difficult to identify test data needs or to anticipate how test data might be used until EPA implements the ITC's testing recommendations and industry develops sufficient data to distinguish between hazardous versus non-hazardous chemicals (e.g., see third paragraph of chapter 1.3.c below). When the Committee recommended alkyl-, bromo-, chloro-, hydroxymethyl diarylethers for health effects, chemical fate and ecological effects screening tests, it considered the uncertainties related to production and use, potential exposures and releases from production, processing and use, potential for persistence in the environment, potential to cause adverse health or ecological effects and the paucity of publicly-available data for over 90 percent of these chemicals. These recommendations are consistent with the Committee's comprehensive approach of using their computerized processes to: (1) Identify chemicals in substructure-based groups in need of screening tests, (2) review recently requested production and exposure data and non-public health and safety studies, (3) meet with interested groups to identify commercially-important chemicals that need to be tested (4) withdraw chemicals or tests to avoid unnecessary or duplicative testing, (5) characterize testing information deficiencies identified by Member Agencies as well as others, and (6) integrate available information into a consolidated testing program likely to serve multiple users.

There are numerous advantages associated with nominating chemicals to the Committee. These were described in detail in chapter 1.3.a of the 27th Report (56 FR 9534, March 6, 1991). Further information about nominating chemicals or chemical groups to the Committee can be obtained by calling the Committee's Executive Director at area code 202/260-1820 or the Committee's Executive Assistant at area code 202/260-1825.

1.3.b *Comprehensive information processing.* During this reporting period, several For Your Information (FYI), TSCA section 8(d) and 8(e) documents were reviewed. These documents are stored on microfiche in the TSCA Public Docket Office, Office of Pollution Prevention and Toxics, Environmental Protection Agency, Room G-004 NE Mall, 401 M Street, SW., Washington, D.C. 20460. These microfiched documents are also available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-336-4700), and from Chemical Information Systems, Inc., 7215 York Road, Baltimore, Maryland 21212 (1-800-CIS-USER). The Committee referenced several of these documents in chapter 2 of this report and readers are referred to the above addresses to obtain further information. Interested parties can also obtain, from the EPA address, copies of publicly-available reports, letters and published references supporting recommendations of chemicals in this report.

The Committee continues to comprehensively search available domestic and international lists of ongoing activities related to reducing testing information deficiencies on chemicals under review. Efforts to conduct these searches have identified numerous chemicals previously reviewed or recommended by the Committee. Many of the chemicals previously reviewed or recommended by the Committee are on ATSDR's list, the Toxics Release Inventory or the list of Hazardous Air Pollutants because of test data developed, in part, as a response to EPA's implementation of ITC's testing recommendation or as a result of other testing after ITC review. Committee recommendations have resulted in the submission of: (1) Substantive TSCA section 8(a) production, exposure and release information, (2) thousands of non-public TSCA section 8(d) studies and (3) hundreds of TSCA section 4(a) and (d) studies that were conducted as a result of the EPA's implementation of the Committee's testing recommendations. The Committee continues to review information on these and other lists. Efforts to conduct searches also identified chemicals for which TSCA information-gathering activities are ongoing (see Table 1 footnotes). The Committee makes the results of these searches publicly available by referencing TSCA submissions in Reports to the EPA Administrator or making tables and references of these submissions available in the public dockets supporting a Report to the EPA Administrator.

During this reporting period, the Committee considered available information on 5 chemicals and 14 chemical groups. Chemical groups under consideration include: alkenes, alkylamines, alkylethers, alkylsulfonates, amino aromatics, anhydrides, anthraquinones, aromatic dianhydrides, aromatic sulfhydryls, aromatic sulfonates, aryl ethers, benzothiazoles, carbamates, dialkylamines, dihydroxybenzenes, ethylhexyl derivatives, fluorinated and iodinated organics, glycol ethers, haloalkyl ethers, heterocyclics, hindered phenols, imidazoles, inorganics, isoindoles, isophthalic acids, IRIS chemicals, nitriles, nitroaromatics, nitroparaffins, *N*-phenylenediamines, phenolic antioxidants, phosphates, pyrrolidinones, sulfenamides, sulfonic acids, thiocarbamates, thiols, triazines, and xanthenes. The Committee recommended one chemical and one chemical group to the TSCA section 4(e) Priority Testing List. Review of the remaining chemicals and chemical groups is ongoing.

1.3.c *Information dissemination.* To emphasize the Committee's efforts to promote public understanding of the ITC's functions and purposes, the Committee is listing some of the Committee-related activities that occurred during this reporting period. On May 23, 1991, the Executive Director presented a keynote speech at the North American Benthological Society Technical Information Workshop on Toxicity Assessment Techniques for Aquatic Invertebrates. On several occasions, the Committee's Chairperson, Vice-Chairperson, Executive Director or Members participated in CPSC's, EPA's and NCI's meetings to discuss chemical testing.

To facilitate coordination of chemical testing and to promote conservation of chemical testing resources the Executive Director met with the Synthetic Organic Chemical Manufactures Association and the Chemical Manufactures Association to discuss completed, ongoing and planned testing of chemical groups. The Committee processed chemicals referred to the ITC by Maryland's Department of the Environment. The Executive Director prepared testimony for U.S. Senate hearings on chemicals causing adverse reproductive effects.

To enhance communication, the Executive Director and Executive Assistant frequently respond to questions related to chemicals reviewed or recommended by the ITC. During this reporting period, the Executive Director responded to a call from Peter Howe of EPA's Region V, who called to learn if the ITC had recommended 4-(1,1,3,3-tetramethylbutyl)phenol (TMBP) for testing. TMBP was recommended for testing in November 1982 as part of the Committee's 11th Report. EPA's implementation of the ITC's testing recommendation and industry testing of TMBP produced chemical fate and ecological effects data (TMBP is persistent and highly toxic to aquatic organisms) that Region V used as part of the Agency's National Pollutant Discharge Elimination System permitting activities.

To promote a comprehensive evaluation of recent exposure information similar to that requested in the 28th Report, the Committee is soliciting voluntary use exposure and release information that is unlikely to be submitted in response to the TSCA Section 8(a) rule that is promulgated for any chemical or chemical group recommended for testing. In this 29th Report, the Committee is soliciting voluntary use exposure and release information for the one chemical and one chemical group recommended for testing and listed in Table 1.

To promote a comprehensive evaluation of recent physical and chemical property information similar to that requested in the 28th Report, the Committee is soliciting voluntary submission of this information for the one chemical and one chemical group recommended for testing and listed in Table 1.The Committee is soliciting voluntary submissions, because under 40 CFR 716.50, TSCA Section 8(d) studies of physical and chemical properties must be submitted only if they are performed for the purpose of determining the environmental or biological fate of a substance, and only if they investigated water solubility, adsorption/desorption on particulate surfaces, vapor pressure, octanol/water partition coefficient, density, dissociation constant, etc. The Committee recognizes that before chemicals are manufactured, many physical and chemical properties are measured (including those mentioned above, but also including flash point, melting point, boiling point, etc.), but not for the purpose of determining the environmental or biological fate of a substance. Member Agencies often need these physical and chemical properties that would not be developed as part of an environmental or biological fate assessment.

The Committee hopes that a voluntary approach for use exposure data and physical chemical property information will prove more efficient than pursuing notice-and-comment rulemaking under a TSCA section 8(a) Comprehensive Assessment Information Rule.

1.3.d *Referrals.* During this reporting period, the Committee did not refer any chemicals to Member Agencies or other organizations for testing consideration.

1.3.e *Deferrals.* The Committee is deferring 5-chloro-2-(2,4-dichlorophenoxy) phenol (CAS No. 3380–34–5), because of uncertainties related to testing under TSCA. Deferred and other chemicals are recycled through the Committee's computerized processes to identify chemicals whose production volumes have substantially changed.

1.3.f *Removals.* Six chemicals were removed from the Priority Testing List as a result of EPA responses to Committee recommendations. Five brominated flame retardants designated in the Committee's 25th Report were removed from the Priority Testing List on June 25, 1991 when EPA promulgated a Notice of Proposed Rulemaking. 4-Vinylcyclohexene, designated in the Committee's 26th Report was removed from the Priority Testing List on September 23, 1991 when EPA published a negotiated Consent Order.

In addition, the Committee is providing a complete list of 98 chemicals and 18 chemical groups that have been recommended and removed from the Priority Testing List since the ITC's 1st Report in October 1977 (Table 2). Reasons for removing chemicals from the Priority Testing List as well as the reference for the original Committee designation or recommendation are contained in the FR citations listed in Table 2. The Report numbers for the original Committee designation or recommendation are listed in Table 2. Reports have been consistently published every 6 months since October 1977. Table 2 reads as follows:

TABLE 2.—REMOVALS FROM THE TSCA SECTION 4(E) PRIORITY TESTING LIST

Report	Chemical/Group	Citation	Publication Date
1	Alkyl epoxides	49 FR 449	January 4, 1984
1	Alkyl phthalates	46 FR 53775	October 30, 1981
1	Chlorinated benzenes (mono and di-health)	45 FR 48524	July 18, 1980
1	Chlorinated benzenes (mono and di-environmental)	49 FR 1760	January 13, 1984
1	Chlorinated paraffins	47 FR 1017	January 8, 1982
1	Chloromethane	45 FR 48524	July 18, 1980
1	Cresols	48 FR 31812	July 11, 1983
1	Hexachloro-1,3-butadiene	47 FR 58029	December 29, 1982
1	Nitrobenzene	46 FR 30300	June 5, 1981

TABLE 2.—REMOVALS FROM THE TSCA SECTION 4(E) PRIORITY TESTING LIST—Continued

Report	Chemical/Group	Citation	Publication Date
1	Toluene	47 FR 56391	December 16, 1982
1	Xylenes	47 FR 56392	December 16, 1982
2	1,1,1-Trichloroethane	46 FR 30300	June 5, 1981
2	Acrylamide (health)	45 FR 48510	July 18, 1980
2	Acrylamide (environmental)	48 FR 725	January 6, 1983
2	Aryl phosphates	48 FR 57452	December 29, 1983
2	Chlorinated naphthalenes	46 FR 54491	November 2, 1981
2	Dichloromethane	46 FR 30300	June 5, 1981
2	Halogenated alkyl epoxides	48 FR 57695	December 30, 1983
2	Polychlorinated terphenyls	46 FR 54482	November 2, 1981
2	Pyridine	47 FR 58031	December 29, 1982
3	1,2-Dichloropropane	49 FR 899	January 6, 1984
3	Chlorinated benzenes (tri, tetra and penta-health)	45 FR 48524	July 18, 1980
3	Chlorinated benzenes (tri, tetra and penta-environmental)	49 FR 1760	January 13, 1984
3	Glycidols	48 FR 57562	December 30, 1983
4	4,4'-Methylenedianiline	48 FR 31806	July 11, 1983
4	Acetonitrile	47 FR 58020	December 29, 1982
4	Aniline and bromo-, chloro- or nitroanilines	49 FR 108	January 3, 1984
4	Antimony metal	48 FR 717	January 6, 1983
4	Antimony sulfide	48 FR 717	January 6, 1983
4	Antimony trioxide	48 FR 717	January 6, 1983
4	Cyclohexanone	49 FR 136	January 3, 1984
4	Hexachlorocyclopentadiene	47 FR 58023	December 29, 1982
4	Isophorone	48 FR 727	January 6, 1983
4	Mesityl oxide	48 FR 30699	July 5, 1983
4	Methyl ethyl ketone	47 FR 50025	December 29, 1982
4	Methyl isobutyl ketone	47 FR 58025	December 29, 1982
5	Benzidine-, o-dianisidine and o-tolidine based dyes	46 FR 55004	November 5, 1981
5	Hydroquinone	49 FR 438	January 4, 1984
5	Quinone	49 FR 456	January 4, 1984
6	Phenylenediamines	47 FR 973	January 8, 1982
7	Alkyltins	47 FR 5456	February 5, 1982
7	Butyl benzyl phthalate	46 FR 53775	October 30, 1981
7	Butyl glycolyl butyl phthalate	46 FR 54487	November 2, 1981
7	Fluoroalkenes	46 FR 53704	October 30, 1981
8	2-Chlorotoluene	47 FR 3596	January 26, 1982
8	Diethylenetriamine	47 FR 18386	April 29, 1982
8	Hexachloroethane	47 FR 18175	April 28, 1982
9	4-Chlorobenzotrifluoride	47 FR 50555	November 8, 1982
9	Chlorendic acid	47 FR 44878	October 12, 1982
9	Tris(2-chloroethyl) phosphite	47 FR 49466	November 1, 1982
10	1,2,4-Trimethylbenzene	48 FR 23088	May 23, 1983
10	Biphenyl	48 FR 23080	May 23, 1983
10	Ethyltoluene	48 FR 23088	May 23, 1983
10	Formamide	48 FR 23098	May 23, 1983
11	1,3-Dioxolane	48 FR 51839	November 14, 1983
11	4-(1,1,3,3-Tetramethylbutyl)phenol	48 FR 51971	November 15, 1983
11	Bis(2-ethylhexyl)terephthalate	48 FR 51845	November 14, 1983
11	Carbofuran intermediates	50 FR 29761	July 22, 1985
11	Dibutyltin bis(isooctyl maleate)	48 FR 51361	November 8, 1983
11	Dibutyltin bis(isooctyl mercaptoacetate)	48 FR 51361	November 8, 1983
11	Dibutyltin bis(lauryl mercaptide)	48 FR 51361	November 8, 1983
11	Dibutyltin dilaurate	48 FR 51361	November 8, 1983

TABLE 2.—REMOVALS FROM THE TSCA SECTION 4(E) PRIORITY TESTING LIST—Continued

Report	Chemical/Group	Citation	Publication Date
11	Dimethyltin bis(isooctyl mercaptoacetate)	48 FR 5 361	November 8, 1983
11	Monobutyltin tris(isooctyl mercaptoacetate)	48 FR 51361	November 8, 1983
11	Monomethyltin tris(isooctyl mercaptoacetate)	48 FR 51361	November 8, 1983
11	Tris(2-ethylhexyl)trimellitate	48 FR 51824	November 14, 1983
12	2-Phenoxyethanol	49 FR 21407	May 21, 1984
12	Calcium naphthenate	49 FR 21411	May 21, 1984
12	Cobalt naphthenate	49 FR 21411	May 21, 1984
12	Lead naphthenate	49 FR 21411	May 21, 1984
12	Methylolurea	49 FR 21371	May 21, 1984
13	1,2,3,4,7,7-Hexachloronorbornadiene	49 FR 45654	November 19, 1984
13	Diethyleneglycol butyl ether acetate	49 FR 45606	November 19, 1984
13	Ethylene bis(oxyethylene) diacetate	49 FR 45651	November 19, 1984
13	Oleylamine	49 FR 45610	November 19, 1984
14	1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane	50 FR 19460	May 8, 1985
14	2-Ethylhexanoic acid	50 FR 20678	May 17, 1985
14	3,4-Dichlorobenzotrifluoride	52 FR 23547	June 23, 1987
14	Bisphenol A	50 FR 20691	May 17, 1985
14	Diisopropylbiphenyl	50 FR 18920	May 3, 1985
14	Isopropylbiphenyl	50 FR 18920	May 3, 1985
15	9,10-Anthraquinone	50 FR 46090	November 6, 1985
15	Chloroprene	50 FR 29761	August 26, 1985
15	Cumene	50 FR 46104	November 6, 1985
15	2-Mercaptobenzothiazole	50 FR 46121	November 6, 1985
15	Octamethylcyclotetrasiloxane	50 FR 45123	October 30, 1985
15	Pentabromoethylbenzene	50 FR 46785	November 13, 1985
15	Sodium *N*-methyl-*N*-oleoyltaurine	50 FR 46178	November 6, 1985
16	Methylcyclopentane	51 FR 17854	May 15, 1986
16	Tetrabromobisphenol A	51 FR 17872	May 16, 1986
16	Triethylene glycol monobutylether	51 FR 27883	May 15, 1986
16	Triethylene glycol monoethylether	51 FR 27883	May 15, 1986
16	Triethylene glycol monomethylether	51 FR 27883	May 15, 1986
17	Diisodecyl phenyl phosphite	54 FR 8112	February 24, 1989
18	2,6-Di-tert-butylphenol	52 FR 23862	June 25, 1987
18	Cyclohexane	52 FR 19096	May 20, 1987
19	Disperse blue dye 79 (bromo ethoxy substituted)	54 FR 48102	November 21, 1989
19	Methylethyl ketoxime	53 FR 35838	September 15, 1988
19	Tributylphosphate	52 FR 43346	November 12, 1987
20	Disperse blue dye (chloro ethoxy substituted)	54 FR 48102	November 21, 1989
20	Disperse blue dye (chloro methoxy substituted)	54 FR 48102	November 21, 1989
20	Disperse blue dye 79:1 (bromo methoxy substituted)	44 FR 48102	November 21, 1989
20	Ethylbenzene	53 FR 46262	November 16, 1988
20	Isopropanol	53 FR 8638	March 16, 1988
20	Methyl *tert*-butyl ether	53 FR 10391	March 31, 1988
21	Acid blue 40	53 FR 18196	May 20, 1988
21	Acid blue 45	53 FR 18196	May 20, 1988
21	Acid form of Acid blue 40	53 FR 18196	May 20, 1988
21	Acid form of Acid blue 45	53 FR 18196	May 20, 1988
21	Disperse blue 56	53 FR 18196	May 20, 1988
21	Disperse red 60	53 FR 18196	May 20, 1988
22	1,6-Hexamethylene diisocyanate	54 FR 21240	May 17 1989
23	Crotonaldehyde	54 FR 47062	November 9, 1989
25	1,2-Bis(2,4,6-tribromophenoxy)-ethane	56 FR 29140	June 25, 1991
25	Hexabromocyclododecane	56 FR 29140	June 25, 1991

TABLE 2.—REMOVALS FROM THE TSCA SECTION 4(E) PRIORITY TESTING LIST—Continued

Report	Chemical/Group	Citation	Publication Date
25	Pentabromodiphenyl ether	56 FR 29140	June 25, 1991
25	Octabromodiphenyl ether	5FR 29140	June 25, 1991
25	Decabromodiphenyl ether	56 FR 29140	June 25, 1991
26	4-Vinylcyclohexene	56 FR 47912	September 23, 1991

1.4 *The TSCA section 4(e) Priority Testing List.* Section 4(e)(1)(B) of TSCA directs the Committee to: "* * * make such revisions in the [priority] list as it determines to be necessary and * * * transmit them to the Administrator together with the Committee's reasons for the revisions." Under this authority, the Committee is revising the Priority Testing List by recommending one chemical and one chemical group. These revisions are listed in Table 1.

The Priority Testing List (Table 3) includes 26 chemicals and 21 chemical groups designated, recommended with intent-to-designate or recommended for testing. Individual chemicals in Priority Testing List chemical groups are listed in Table 1 or the paragraph following Table 1 of this and previous Reports with appropriate notes that minimize ambiguities related to TSCA section 8(a) and 8(d) reporting requirements. Tables 2 (Removals from the Priority Testing List) and 3 (the Priority Testing List) list the 124 chemicals and 39 chemical groups that have been recommended or designated for testing since the Committee's 1st Report in October 1977. Table 3 reads follows:

TABLE 3.—THE TSCA SECTION 4(E) PRIORITY TESTING LIST

Date	Entry	Action
May 1988	Ethoxylated quaternary ammonium compounds	Recommended
May 1988	Imidazolium quaternary ammonium compounds	Recommended
November 1988	Tetrakis(2-chloroethyl)ethylene diphosphate	Recommended with intent-to-designate
November 1988	Tris(1,3-dichloro-2-propyl) phosphate	Recommended with intent-to-designate
November 1988	Tris(1-chloro-2-propyl) phosphate	Recommended with intent-to-designate
November 1988	Tris(2-chloro-1-propyl) phosphate	Recommended with intent-to-designate
November 1988	Tris(2-chloroethyl)-phosphate	Recommended with intent-to-designate
November 1988	Butyraldehyde	Recommended
November 1989	Brominated flame retardants	Recommended
May 1990	Isocyanates	Recommended with intent-to-designte
May 1990	Brominated flame retardants	Recommended
May 1990	Alkyl phosphates	Recommended
November 1990	Sodium cyanide	Designated
November 1990	Acrylic acid	Designated
November 1990	Acetophenone	Designated
November 1990	Phenol	Designated
November 1990	*N,N*-Dimethylaniline	Designated
November 1990	Ethylacetate	Designated
November 1990	2,6-Dimethylphenol	Designated
November 1990	Aldehydes	Recommended with intent-to-designate
November 1990	2,4-Dinitrophenol	Recommended
November 1990	3,4-Dimethylphenol	Recommended
November 1990	*N*-phenyl-1-naphthylamine	Recommended
November 1990	Sulfones	Recommended
November 1990	Substantially produced chemicals in need of subchronic tests	Recommended
May 1991	Acetone	Designated
May 1991	*n*-Butanol	Designated
May 1991	Isobutanol	Designated
May 1991	Di-(2-ethylhexyl)adipate	Designated
May 1991	Dimethyl terephthalate	Designated
May 1991	Thiophenol	Designated
May 1991	*m*-Dinitrobenzene	Recommended
May 1991	Allyl alcohol	Recommended
May 1991	2,4-Dichlorophenol	Recommended

TABLE 3.—THE TSCA SECTION 4(E) PRIORITY TESTING LIST—Continued

Date	Entry	Action
May 1991	Alkynes	Recommended
May 1991	Nitroalcohols	Recommended
May 1991	Phosphoniums	Recommended
May 1991	Hydrazines	Recommended
May 1991	Oxiranes	Recommended
May 1991	Alkoxysilanes	Recommended
May 1991	Aldehyde hydrates	Recommended
May 1991	Propylene glycol ethers and esters	Recommended
May 1991	Methyl ethylene glycol ethers	Recommended
May 1991	Isothiocyanates	Recommended
May 1991	Cyanoacrylates	Recommended
November 1991	White phosphorus	Recommended
November 1991	Alkyl-, bromo-, chloro-, hydroxymethyl diarylethers	Recommended

Chapter 2—Recommendations of the Committee

2.1 *Chemicals recommended for priority consideration by the EPA Administrator.* As provided by section 4(e)(1)(B) of TSCA, the Committee is adding to the section 4(e) Priority Testing List one chemical and one chemical group (see Table 1). The recommendation of these chemicals is made after considering the factors identified in section 4(e)(1)(A) and other relevant information, such as the chemical testing data needs of Member Agencies.

2.2 *Designated chemicals.* None.

2.3 *Recommended with intent-to-designate chemicals.* None.

2.4 *Recommended chemicals—2.4.a White phosphorus.* White Phosphorus is recommended for testing based on concerns of the Department of Interior (DOI). DOI is concerned about and has few data on the persistence of white phosphorus in wetland sediments, the adverse effects of persistent white phosphorus to birds and wildlife that feed on sediments contaminated with white phosphorus, the potential for food chain effects and potential elimination of endangered species that may feed on carcasses of birds and wildlife that die from white phosphorus poisoning. The Department of Defense (DOD) is also concerned about the persistence and adverse effects of white phosphorus and has a task force that is developing a strategy for remediation of military sites contaminated with white phosphorus. The ITC is working with DOI and DOD to facilitate coordination of testing efforts and is aware of the Department of Transportation's regulation of white phosphorus as a flammable solid.

Summary of recommended studies. It is recommended that white phosphorus be tested for:

Chemical fate. Persistence in surface waters and sediments.

Health effects. None.

Ecological Effects. Toxicity to migratory birds and other wildlife.

White phosphorus

Physical and Chemical Information

CAS Number: 7723-14-0
Synonyms: Yellow phosphorus
Empirical Formula: P_4
Molecular Weight: 123.9
Physical State at 25 °C: Solid.
Description of Chemical: Colorless off white waxy solid, cubic crystals that spontaneously inflame in air at 30 °C. (Ref. 32, Windholz et al., 1983)
Melting Point: 44.1 °C
Vapor Pressure: 0.023 torr 25 °C (Ref. 26, Spanggord et al., 1985)1 atm at 76.6 °C (Ref. 3, Berkowitz et al., 1981)
Specific Gravity: Not Applicable
Log Octanol/Water
Partition Coefficient: 1200 ± 100 (Ref. 26, Spanggord et al., 1985)
Water Solubility at 25 °C: 4.1 mg/L (Ref. 26, Spanggord et al., 1985)
Log K_{oc}: 2,400 (Ref. 17, Lyman et al., 1990)
Henry's Law Constant: 2.1 x 10^{-3} atm m^3 $mole^{-1}$ at 25 °C.

Rationale for Recommendations

A. *Exposure information—Production/use/disposal/exposure/release.* In 1990, approximately 700 million pounds of white phosphorus were produced (Ref. 5, CMR, 1991); 1991 production is expected to be 792 million lbs (Ref. 27, SRI International, 1991).

Direct use of P_4 is mainly restricted to military applications (Ref. 30, Van Wazer, 1982); however, white phosphorus is commercially available for other applications such as in rodenticides (Ref. 23, Sax and Lewis, 1987). Otherwise white phosphorus is converted to phosphorus sulfides, halides, phosphorus pentoxide, phosphoric acid, and red phosphorus. The major uses of phosphorus compounds are in detergents, in the food and beverage industry and as fertilizers.

B. *Evidence for exposure—Human exposure.* The NOES conducted during 1981-83 by NIOSH reported that 135,453 workers (6811 females) were exposed to white phosphorus at 7,697 production and use facilities involving 83 occupations in 86 industries. The OSHA Permissible Exposure Limit for occupational exposure to white phosphorus is 0.1 mg/m^3 8-hour Time Weighted Average.

C. *Environmental exposure.* Catastrophic waterfowl mortality has been observed in the Eagle River Flats firing range, a salt marsh in Cook inlet in Alaska. Careful study of dying birds indicated that white phosphorus residues were present in their fat, gizzard contents and other digestive tissues, liver, skin, and breast muscle. White phosphorus was also found in the sediments on which they were feeding. Other munitions-derived chemicals were also found, but not at levels high enough to cause death. Feeding studies at levels similar to those found in the sediment produced death (Ref. 21, Racine et al., 1991). Other sites of exposure would be manufacturing operations and munitions packaging facilities. Direct release occurs during the production of white phosphorus (Ref. 15, Idler, 1969) and during the manufacture and combustion of white phosphorus/felt smoke-producing devices (Ref. 2, Bentley et al., 1978). During deployment of munitions, about 10 percent of the white phosphorus is not oxidized; thus it is

available for release in the environment (Ref. 26, Spanggord et al., 1985).

Test firing of U.S. Army munitions, especially smokes, into marshy areas may have serious consequences to waterfowl inhabiting these areas. A memorandum from the Regional Contaminants Coordinator (Region 7 - Alaska) describing the problem of white phosphorus in Eagle River Flats contained the following description (Ref. 22, Robinson-Wilson, 1991):

> White phosphorus is used in both flares and smokes by the U.S. Army. Shells are fired out over the impact area where they explode in the air, releasing the burning white phosphorus into the atmosphere. At ERF [Eagle River Flats], the falling particles of burning white phosphorus fall either onto snow or water, where they are quenched. Waterfowl, mainly dabbling ducks and swans, pick up white phosphorus particles during feeding. The particles are believed to have an oxidized coating and the birds are not exposed to the white phosphorus until the particles are ground up in their gizzards and released during digestion.

According to the TRI, 19,097 lbs were released to air, 11,569 lbs were discharged to water, 3,719,412 lbs were released to land, and 219,456 lbs were transferred to other off-site locations in 1988 (Ref. 29, TRI, 1991). In 1989, 16,174 lbs were released to air, 3,033 lbs were discharged to water, 3,291,402 lbs were released to land, and 85,573 lbs were transferred to other off-site locations (Ref. 29, TRI, 1991).

I. Chemical Fate Information

A. *Persistence.* In the few studies conducted near discharge sites, rapid dissipation out from the source was noted; however, it was determined in studies on the sediments from these locations that the surface deposits of a few parts per million probably oxidized quickly; whereas deeper deposits of higher concentrations could be stable for years (Ref. 1, Ackman et al., 1971; Ref. 26, Spanggord et al., 1985). This persistence is ascribed to the fact that most sediments are anaerobic a short distance below the surface, (Ref. 26, Spanggord et al., 1985; Ref. 8, Davidson et al., 1987; Ref. 28, Sullivan et al., 1979). This type of persistence is especially of concern to waterfowl which feed in these areas, since the particles of white phosphorus which are embedded in the sediment of the shallow water are believed to be ingested by ducks and swans.

B. *Rationale for chemical fate testing.* The U.S. Department of Interior is concerned about the fate of white phosphorus in sediments of a dabbling duck feeding environment. Release and persistence under these conditions is only poorly understood and further testing is needed.

II. Health Effects Information

The Committee is not recommending health effects testing at this time because it wants to review non-public health effects studies that may be submitted in response to the TSCA section 8(d) rule that EPA will publish for chemicals in the ITC's 29th Report.

A. *Metabolism and pharmacokinetics.* White phosphorus is rapidly absorbed from the digestive tract of mice, rats, and rabbits (complete within 24 hours). When radioactive P_4 is administered, radioactivity accumulates primarily in the liver, kidney, lung, bone, and skeletal muscle (Ref. 4, Cameron and Patrick, 1966; Ref. 13, Ghoshal et al., 1971; Ref. 16, Lee et al., 1975). Elimination is mainly via urinary excretion as inorganic and organic phosphates; some fecal elimination also occurs (Ref. 4, Cameron and Patrick, 1966; Ref. 16, Lee et al., 1975). It does not appear that white phosphorus is absorbed from the lungs or skin of laboratory animals (Ref. 7, Dalhamn and Holma, 1959).

There is no direct pharmacokinetic information for humans, but absorption from the digestive tract can be inferred by toxicity data (Ref. 20, Polson et al., 1983). There is no convincing evidence that white phosphorus is absorbed as a result of exposure by inhalation or dermal contact (Ref. 8, Davidson et al., 1987).

B. *Acute and subchronic (short-term) effects.* White phosphorus is highly toxic to humans and laboratory animals exposed by the oral route. Oral LD_{50} values for male and female rats are 3.76 and 3.03 mg/kg, and for male and female mice, 4.85 and 4.82 mg/kg, respectively (Ref. 16, Lee et al., 1975). The estimated minimal lethal oral dose in humans is 50 mg (0.7 mg/kg), but 15 mg (0.2 mg/kg) may cause serious toxicity (gastrointestinal, liver, renal, cardiovascular, and CNS effects) (Ref. 25, Sollman, 1957; Ref. 18, McCarron et al., 1981; Ref. 9, Diaz-Rivera et al., 1950).

Acute inhalation LC_{50} values for rats and mice are 1,400 and 660 mg/m^3, respectively. Because white phosphorus ignites spontaneously, (Ref. 30, Van Wazer, 1982), its contact with skin can cause serious burns. Dermal exposure of humans to white phosphorus via industrial accidents and on the battlefield has led to 3rd degree burns and death, massive hemolysis, and low plasma calcium (Ref. 31, Walker et al., 1947).

Young female rats fed diets containing median daily doses of white phosphorus of 0.075 mg/kg/day for 22 weeks showed severely depressed weight gain and weight loss, leading to a final weight less than the starting weight. Male rats fed 0.0027 mg per kg per day showed fluctuations in growth prior to the 15th week, but from the 15th to 25th week of exposure growth was rapid and was 13 percent above that of controls by the 25th treatment week (Ref. 24, Sollman, 1925).

C. *Genotoxicity.* White phosphorus was negative in Ames/*Salmonella* tests when evaluated as an undiluted saturated solution in distilled water; a concentration of up to 100 μL/plate in both the presence and absence of S9 fraction of liver did not induce increased incidence of mutations (Ref. 10, Ellis et al., 1978).

No data were located regarding the genotoxicity of white phosphorus in humans.

D. *Chronic toxicity.* Oral exposure of groups of 6 rats to 0.2, 0.4, 0.8, or 1.6 mg per kg per day of white phosphorus dissolved in peanut oil and mixed with stock diet for their lifetimes (up to 512 days) caused dose-related mortality. Retarded growth (effect level not reported) was believed due to inanition rather than systemic toxicity. Histopathological evaluation showed changes in the long bones (thickening of the epiphyseal line; extension of the trabeculae into the shaft). White phosphorus (0.05 mg per kg per day) dissolved in peanut oil and administered by subcutaneous injection to rats and guinea pigs for their lifetimes caused the same effects on bone, but to a lesser degree in the guinea pigs. Livers of these treated rats showed mild fatty degeneration, and lungs were also affected (bronchopneumonia, pneumonitis, bronchitis). These effects were not seen in guinea pigs (Ref. 11, Fleming et al., 1942).

Chronic exposure of humans to white phosphorus causes a characteristic lesion, necrosis of the jaw, which has been documented through numerous cases involving occupational exposure. In one study, the incidence of this condition was less than 5 percent of those exposed (Ref. 25, Sollman, 1957), and the estimated mortality rate from white phosphorus necrosis was about 20 percent, according to another study (Ref. 14, Hunter, 1969). Levels of exposure were not quantified.

E. *Reproductive and developmental effects.* Elemental yellow phosphorus was administered by gavage in corn oil to 8-week-old male and female rats in doses of 0, 0.005, 0.015, or 0.075 mg per kg per day for 80 days prior to mating, and continued through mating, gestation and lactation, then through a second

cycle from mating through lactation. Seven of the 30 high-dose females died during parturition, and hair loss was noted on both forelimbs of the high-dose males and females. No effects were seen on body weights or reproductive indices. No evidence of developmental toxicity was noted. The NOAEL was 0.015 mg per kg per day (Ref. 19, Monsanto, 1985).

No data were found on the reproductive or developmental toxicity of white phosphorus in humans.

III. Ecological Effects Information.

A. Acute and subchronic (short-term) effects. Both laboratory and field studies indicated that white phosphorus is highly toxic to aquatic organisms. The effluent from white phosphorus production contains both suspended and dissolved white phosphorus, and environmental release can occur from the combustion of munitions with remobilization from aquatic sediments as well as sinks in anaerobic soils. The LC_{50} values for five freshwater fish species range from 2.4 to 73 µg/L; the most sensitive species is *Lepomis macrochirus*. The LC_{50} values for five invertebrate species range from 30 to >560 µg/L; the most sensitive species is *Daphnia magna*. Available LC_{50} data for fish and invertebrates indicate that the toxicity of white phosphorus is cumulative. Single doses of 3 to 6 mg/kg have been reported to cause death in mallards and black ducks within 24 hours (Ref. 6, Coburn et al., 1950). A memo from the Regional Contaminants Coordinator (Region 7 - Alaska) describing the problem of white phosphorus in Eagle River Flats contained the following description (Ref. 22, Robinson-Wilson, 1991).

> Birds typically go through protracted convulsions before death, indicating a possible nervous system involvement. Birds that are affected are often taken by bald eagles and/or gulls before they die. However, few bald eagles or gulls have been found dead on ERF [Eagle River Flats] to date. ..[one] bald eagle was found and subsequent analysis of tissues found that WP [white phosphorus] was present. Since no data are available on WP toxicity in raptors and since no data exists on transfer of WP between trophic levels, we cannot state that WP was the toxic agent, but all the circumstantial evidence points to WP as the toxic agent.

B. Chronic (long-term) effects. Chronic white phosphorus exposure in *Pimephales promelas* reduced survival at 1.5 µg/L, and hatchability was reduced at 0.4 µg/L. In studies with macroinvertebrates, exposure to 8.7 µg/L reduced survival in *Daphnia magna* (Ref. 8, Davidson et al., 1987).

C. Other ecological effects (biological, behavioral, or ecosystem processes). The issue of wildlife toxicity was raised when it was discovered that a long-standing problem of waterfowl mortality at Eagle River Flats in Alaska was apparently being caused by the ingestion of particles of white phosphorus that had settled into marsh sediments. This has resulted in the death of 1000 to 2000 migratory dabbling ducks and 10 to 50 swans per year for the last 10 years (Ref. 21, Racine et al., 1991).

D. Bioconcentration and Food-chain transport. Bioconcentration in 3 species of fish ranged from 11.7 to 67.7 in muscle and from 51.5 to 2,000 fold in liver (Ref. 8, Davidson et al., 1987). In 6 species of invertebrates, bioconcentration ranged from 10.5 to 1,267 fold. In 2 species of seaweed the factor was 22.2 to 22.8 fold (Ref. 12, Fletcher, 1971).

E. Rationale for ecological effects testing recommendation. The U.S. Department of Interior is concerned about the toxicity of white phosphorus to migratory birds that seasonally reside on bodies of water containing white phosphorus particles in the water and in the sediment. Ecological effects testing is recommended because data are insufficient to reasonably determine or predict the toxicity of white phosphorus to migratory birds and other wildlife.

References

(1) Ackman, R.G., Addison, R.F. and Hingley, J. "An assessment of the assimilation of elemental phosphorus by Newfoundland marine organisms in the 1969 pollution problem and in the 1970 monitoring operation." Fisheries Research Board of Canada. Technical Report 208 (1970).

(2) Bentley, R.E., Dean, J.W., Hollister, T.A., LeBlanc, G.A., Sauter, S., Sleight, B.H., III, and Wilson, W.G. "Laboratory evaluation of the toxicity of elemental Phosphorus (P_4) to aquatic organisms." AD AO61785. EG G, Bionomics, Wareham, MA. DAMD17-74-C-4101 (1978).

(3) Berkowitz, J.B., Young, G.S., Anderson, R.C., Colella, A.J., Lyman, W.J., Preston, A.L., Steber, W.D., Thomas, R.G., and Vranka, R.G. "Research and Development of Health and Environmental Hazard Assessment Task Order 5. Occupational and environmental hazards associated with the formulation and use of white phosphorus-felt and red phosphorus butyl rubber screening smokes." AD A116956/4. Arthur D. Little, Inc., Cambridge, MA. DAMD1779-C-9139 (1981).

(4) Cameron, J.M. and Patrick, R.S. "Acute phosphorus poisoning--The distribution of toxic doses of yellow phosphorus in the tissues of experimental animals." *Medical Science Law* 8:209-214 (1968).

(5) CMR (Chemical Marketing Reporter). "Chemical Profile: Phosphorus." February 18 (1991).

(6) Coburn, D.R., DeWitt, J.B., Derby, J.V., Jr., and Ediger, E. "Phosphorus poisoning in waterfowl." *Journal of the American Pharmaceutical Association*. 39:151-158 (1950).

(7) Delhamn, T. and Holma, B. "Animal experiments on the spread of inhaled radioactive red phosphorus in the body." *AMA Archives of Industrial Health* 20:429-431 (1959).

(8) Davidson, K.A., Hovatter, P.S., and Sigmon, C.F. "Water quality criteria for white phosphorus." Oak Ridge National Laboratory, Oak Ridge, TN 37831, ORNL-6336 (1987).

(9) Diaz-Rivera, R.S., Collazo, P.J., Pons, E.R., and Torregrosa, M.V. "Acute phosphorus poisoning in man: A study of 56 cases." *Medicine*. 29:269-298 (1950).

(10) Ellis, H.V., Hodgson, J.R., Hwang, S.W., Halfpap, L.M., Helton, D.O., Anderson, B.S., VanGoethem, D.L., and Lee, C.-C. "Mammalian toxicity of munitions compounds. Phase I: Acute oral toxicity, primary skin and eye irritation, dermal sensitization, disposition and metabolism, and Ames tests of additional compounds." Report, AD A069333. Midwest Research Institute, Kansas City, MO. DAMD 17-74-C-4073 (1978).

(11) Fleming, R.B.L., Miller, J.W., and Swayne, V.R., Jr. "Some recent observations on phosphorus toxicology." *Journal of Industrial Hygiene and Toxicology*. 24:154-158 (1942).

(12) Fletcher, G.L. "Accumulation of yellow phosphorus by several marine invertebrates and seaweed." *Journal Fisheries Research Board of Canada*. 28:793-796 (1971).

(13) Ghoshal, A.K., Porta, E.A., and Hartroft, W.S. "Isotopic studies on the absorption and tissue distribution of white phosporus in rats." *Experimental and Molecular Pathology*. 14(2):212-219 (1971).

(14) Hunter, D. *The Diseases of Occupations*. 5th ed., pp. 127, 374-383 (1969). English University Press, London, England.

(15) Idler, D.R. "Coexistence of a fishery and a major industry in Placentia Bay." *Chemistry in Canada*. 21:16-21 (1968).

(16) Lee, C.-C., Dilley, J.V., Hodgson, J.R., Helton, D.O., Wiegand, W.J., Roberts, D.N., Anderson, B.S., Halfpap, M., Kurtz, L.D., and West, N. "Mammalian toxicity of munition compounds. Phase I: Acute oral toxicity, primary skin and eye irritation, dermal sensitization, and disposition and metabolism." Report No. 1, AD B011150 (1975). Midwest Research Institute, Kansas City, MO.

(17) Lyman, W.J., Reehl, W.F., and Rosenblatt, D.H. Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds. Washington D.C.: American Chemical Society. pp. 4-1, 5-4 (1990).

(18) McCarron, M.M., Caddis, G.P., and Trotter, A.T. "Acute yellow phosphorus poisoning from pesticide pastes." "Clinical Toxicology." 18(6):693-711 (1981).

(19) Monsanto. "Elemental yellow phosphorus one generation reproduction study in rats." FYI-OTS-0785-0423 (1985). Initial Sequence A. Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Washington, DC.

(20) Polson, C.J., Green, M.A., and Lee, M.R. "Phosphorus." In *Clinical Toxicology*, 3rd ed.,

pp. 522–539 (1983). J.B. Lippincott, Philadelphia, PA.

(21) Racine, C.H., Walsh, M.E., Collins, C.M., Calkins, D.J., and Roebuck, B.D. "Waterfowl mortality in Eagle River Flats, Alaska: The role of munition compounds." U.S. Army Cold Regions Research and Engineering Laboratory. US. Army Corps of Engineers, Toxic and Hazardous Materials Agency. Report No. CETHA-IR-91008 (1991).

(22) Robinson-Wilson, E. Memorandum from Everett Robinson-Wilson, Contaminants Coordinator, U.S. Fish And Wildlife Service, Region 7 (Alaska) to Barnett Rattner, Deputy Branch Chief, Environmental Contaminants Branch, Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service. Expressing concern for waterfowl toxicity from white phosphorus at Eagle River Flats and research testing. Dated June 4, 1991.

(23) Sax, N.I., and Lewis, R.J. *Hawley's Condensed Chemical Dictionary*. 11:911 (1987). New York, NY: VanNostrand Reinhold Company.

(24) Sollman, T. "Studies of chronic intoxications on albino rats: VIII. Yellow phosphorus." *Journal of Pharmacology and Experimental Therapy*. 24:119–122 (1925).

(25) Sollman, T. "Elementary phosphorus." In *A Manual of Pharmacology and Its Applications to Therapeutics and Toxicology*, 8th ed. pp. 1068–1073 (1957). W.B. Saunders, Philadelphia, PA.

(26) Spanggord, R.J., Rewick, R., Chou, T.W., Wilson, R., Podoll, R.T., Mill, T., Parnas, R., Platz, R., and Roberts, D. "Environmental fate of White Phosphorus/Felt and Red Phosphorus/Butyl Rubber Military Screening Smokes." Final Report PYU-4937. SRI International, Menlo Park, CA. DAMD17–82–C–2320 (1985).

(27) SRI (SRI International). Directory of Chemical Producers. Menlo Park, CA: SRI International. pp. 864 (1991).

(28) Sullivan, J.H., Putnam, H.D., Keirn, M.A., Pruitt, B.C., Jr., Nichols, J.C., and McClave, J.T. "A summary and evaluation aquatic environmental data in relation to establishing water quality criteria for munition-unique compounds. Part 3: White phosphorus." (1979). Water and Air Research, Inc., Gainesville, FL 32602.

(29) TRI (Toxics Release Inventory). Data base retrieval 10/9/91. U.S. EPA (1991).

(30) Van Wazer, J.R. "Phosphorus and the Phosphides." In: *Kirk-Othmer Encyclopedia of Chemical Technology*. 3rd edition. New York, NY: John Wiley Sons 17:473–490 (1982).

(31) Walker, J., Jr., Caldston, M., Wexler, J., Hill, M.L., and Midgely, G. "WP Casualties at Edgewood Arsenal, Maryland, 1945." Report 103, AD 824420 (1947). Edgewood Arsenal, MD.

(32) Windholz, M., Budavari, S., Blumetti, R.F., and Otterhein, E.S., eds. 1983. The Merck Index. An Encyclopedia of Chemicals, Drugs, and Biologicals. 10th ed., pp. 1059–1060. Merck and Company, Rahway, NJ (1983).

2.4.b *Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers*. The Committee is recommending 14 alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers for physical chemical property, biodegradation rate, health effects and ecological effects screening tests. These chemicals will allow the Committee to evaluate the persistence and toxicity of the diaryl ether substructure. Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers are defined as any two aromatic rings joined by an oxygen (i.e., Ar-*O*-Ar where Ar is any aryl group) where there are alkyl, bromo, chloro or hydroxymethyl substituents on one or both of the aromatic rings or on a methyl group attached to one of the aromatic rings. One minor exception to this definition is an acetate ester of hydroxymethyl diaryl ether. This chemical was included because the Committee believed that the ester would be metabolized to the alcohol. The Committee is making this recommendation based on: (1) concerns for potential persistence and toxicity, (2) the paucity of publicly-available data for a majority of these chemicals, and (3) the need to carefully review any studies that may be submitted under TSCA section 8(d), before designating or withdrawing recommended testing for any of these diaryl ethers.

Several diaryl ethers were previously reviewed. Diphenyl oxide was previously nominated for oncogenicity testing by the National Cancer Institute's Chemical Selection Working Group. The chemical was not selected for testing, pending the results of industry testing (Helmes et al., 1983, Ref. 13). 1-Amino-4-hydroxy-2-phenoxy-9,10-anthraquinone was recommended in ITC's 21st Report. Penta-, octa- and decabromodiphenyl ethers were designated in the ITC's 25th Report. 3-Phenoxybenzaldehyde was recommended in the ITC's 27th Report. Benzenesulfonic acid, 4,4'-oxybis-, dihydrazide was recommended in the ITC's 28th Report.

The 14 chemicals being recommended at this time were selected from a TSCA Inventory group of 55 diaryl ethers that have the general formula Ar-*O*-Ar. Of the 55 diaryl ethers that were considered, all but 16 were eliminated on the basis of substructural characteristics which indicated they would be better considered along with other chemical groups such as xanthenes, anthraquinones, sulfonic acids, isoindoles, amino and nitro aromatics, etc. Nonabromodiphenyl ether was not recommended because the Committee wanted to review any data developed for bromodiphenyl ethers. 5-Chloro-2-(2,4-dichlorophenoxy) phenol was deferred because of pesticide uses.

The Committee hopes that manufacturers, processors, and users will voluntarily provide use, exposure, and release data not required under TSCA section 8(a). Uncertainties related to production, toxicity and persistence may be clarified after the Committee's review of the data obtained from the automatic 8(a) and 8(d) rules.

Summary of recommended studies. Testing recommendations for the 14 diaryl ethers listed in the paragraph following Table 1 are summarized in Table 1.

Physical and Chemical Information

The Committee found limited information on measured physical and chemical properties for the diaryl ethers listed in the paragraph following Table 1: four boiling points, one log octanol/water partition coefficient, three melting points, one water solubility, and one vapor pressure (Ref. 1, Aldrich, 1988; Ref. 2, Ambrose et al., 1976; Ref. 4, Banerjee et al., 1980; Ref. 5, Bein, 1985; Ref. 9, Dean, 1985; Ref. 12, Hansch and Leo, 1985; Ref. 24, Weast, 1985).

Rationale for Recommendation

A. *Exposure information—Production/use/disposal/exposure/release.* The Committee believes that the diaryl ethers listed in the paragraph following Table 1 are commercially available, and that some of them may be produced in substantial quantities. Composite production volume for this group exceeds 70 million pounds; actual production volumes are confidential business information.

Alkyl diaryl ethers are used as heat transfer fluids, resins for laminated electrical insulators, chemical intermediates and antioxidants; the bromodiaryl ether is used as an intermediate in production of pyrethroids; chlorodiaryl ethers are used as bacteriostatic and preservative agents for cosmetics and detergents (Ref. 7, Chemcyclopedia 91, 1990; Ref. 8, Dagani, 1985; Ref. 11, Gusten et al., 1973; Ref. 18, Sax and Lewis, 1987). No use information was found for the hydroxymethyl diaryl ethers.

B. *Evidence for exposure—Human exposure.* The National Occupational Exposure Survey (NOES) conducted during 1981-83 by NIOSH reported that 90,789 workers were potentially exposed to diphenyl oxide in 24 industries and 145 workers were potentially exposed to 1-methyl-3-phenoxybenzene in business services (Ref. 16, NIOSH, 1989). Only diphenyl oxide has an OSHA Permissable Exposure Limit.

C. *Environmental exposure.* Diphenyl oxide has been detected in 1 of 14 treated drinking water supplies (Ref. 10, Fielding et al., 1981) and detected at concentrations of 69 and 388 μg/L in wastewater extract from the organics and plastics industry, 12 μg/L from the plastics and synthetics industry, 18 μg/L

from rubber processing industry, 30 and 38 μg/L from the soaps and detergents industry, 35 μg/L from the electronics industry, and 1620 μg/L in wastewater extract from the organic chemicals industry (Ref. 6, Bursey and Pellizzari, 1982). Diphenyl oxide has been identified in wastewater, river and estuary water, and river, estuary and bay sediment (Ref. 14, Hites and Lopez-Avila, 1980).

I. Chemical Fate Information

The Committee searched published and unpublished chemical fate literature and found that there were studies on only one of the recommended diaryl ethers. In acclimated river water, diphenyl oxide (23.8 mg/L initial concentration) exhibited approximately 20 percent biodegradation under aerobic conditions during an 80 day incubation period (Ref. 15, Ludzack and Ettinger, 1963). In a review, diphenyl oxide was characterized as "unlikely to be removed during biological sewage treatment even after prolonged exposure" (Ref. 19, Thom and Agg, 1975). A degradation half-life in soil of 11 days was estimated from analysis of percolate groundwater samples; biodegradation is expected to be the primary fate process contributing to environmental degradation (Ref. 25, Zoeteman et al., 1981).

Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers are recommended for physical and chemical property and biodegradation rate screening tests because there are insufficient data to reasonably determine or predict environmental persistence.

II. Health Effects Information

A search of published and unpublished health effects literature revealed that there were studies on six of the recommended diaryl ethers. The majority of health effects studies were published on diphenyl oxide or mixtures containing diphenyl oxide including: 18 oral, dermal and inhalation acute toxicity studies on 5 mammalian species (Ref. 17, RTECS 1991, Ref. 22, TSCATS 1991); 6 oral and inhalation prechronic studies on 3 mammalian species (Ref. 20, TOXLINE 1991); 9 genotoxicity studies, including those on mutagenicity in bacteria and yeast (Ref. 20, TOXLINE 1991, Ref. 22, TSCATS 1991), negative cytogenetics in hamsters (Ref. 22, TSCATS 1991), and DNA effects in rats (Ref. 22, TSCATS 1991); 1 negative developmental toxicity study in rats that used 77 percent diphenyl oxide and 33 percent biphenyl as the test substance (Ref. 20, TOXLINE 1991);1 positive developmental toxicity study in sea urchins (Ref. 20, TOXLINE); and 3 oral and intraperitoneal pharmacokinetics studies in rats (Ref. 20, TOXLINE 1991).

For the other five diaryl ethers recommended for testing [benzene, 1-methyl-3-phenoxy-; benzenemethanol, 3-phenoxy-; benzene, 1,1'-oxybis[methyl-; 1,1'-biphenyl, phenoxy-; benzene, 1(bromomethyl)-3-phenoxy-], there were 7 oral and dermal acute toxicity studies on 4 mammalian species (Ref. 20, TOXLINE 1991, Ref. 21, TOXLIT 1991, Ref. 17, RTECS 1991); 2 prechronic studies in rats (Ref. 22, TSCATS 1991, Ref. 20, TOXLINE 1991); and six genotoxicity studies, including those on mutagenicity in bacteria and cytogenetics in mice (Ref. 21, TOXLIT 1991, Ref. 20, TOXLINE 1991).

Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers are recommended for health effects screening tests (except for diphenyl oxide) because there are insufficient data to reasonably determine or predict health effects.

III. Ecological Effects Information

Except for acute aquatic toxicity data for diphenyl oxide (LC_{50} values ranged from 3 to 4 mg/L for freshwater fish and 0.67 to 1.4 mg/L for freshwater invertebrates, Ref. 3, AQUIRE 1991) and 3-phenoxy-benzenemethanol (EC_{50} values ranged from 1.4 to 95.0 mg/L for freshwater algae, Ref. 3, AQUIRE 1991), no ecological effects testing information was located for the other 12 diaryl ethers.

Alkyl-, bromo-, chloro-, hydroxymethyl diaryl ethers are recommended for ecological effects screening tests because there are insufficient data to reasonably determine or predict ecological effects.

References

(1) Aldrich. *Catalog Handbook of Fine Chemicals*. Milwaukee, WI: Aldrich Chemical Company. p. 1189 (1988).

(2) Ambrose, D., Ellender, J.H., Sprake, C.H.S., Townsend, R. "Thermodynamic properties of organic oxygen compounds. XLIII. Vapor pressures of some ethers." *Journal of Chemical Thermodynamics*. 8:165–178 (1976).

(3) AQUIRE (Aquatic Toxicity Information Retrieval Data Base). Environmental Research Laboratory, Duluth, MN. On-Line. (1991).

(4) Banerjee, S., Yalkowsky, S.H., Valvani, S.C. "Water solubility and Octanol/Water Partition Coefficients of Organics. Limitations of the Solubility-Partition Coefficient Correlation." *Environmental Science and Technology*. 14:1227–1229 (1980).

(5) Bein, H., Stawitz, J., Wunderlich, K. "Anthraquinone Dyes and Intermediates" In: *Ullmann's Encyclopedia of Industrial Chemistry*, Fifth Edition. Gerhartz, W., Yamamoto, Y.S., eds. Deerfield Beach, FL: VCH Publishers. Volume A2, 355–417 (1985).

(6) Bursey, J.T. and Pellizzari, E.D. "Analysis of Industrial Wastewater for Organic Pollutants in Consent Decree Survey." U.S.EPA–68–03–2867. Environmental Research Laboratory, Office of Research and Development. Athens, GA (1982).

(7) Chemcyclopedia. The Manual of Commercially Available Chemicals. Volume 9. J.H. Kuney, Ed. Washington, DC: American Chemical Society. p. 98 (1991).

(8) Dagani, M.J., Barda, H.J., Benya, T.J., Sanders, D.C. "Bromine Compounds." In: *Ullmann's Encyclopedia of Industrial Chemistry*, Fifth Edition. W. Gerhartz, and Y.S. Yamamoto, eds. Deerfield Beach, FL: VCH Publishers. Volume A4, 405–429 (1985).

(9) Dean, J.A. *Lange's Handbook of Chemistry*. 13th Ed. McGraw-Hill Book Co., New York, NY. pp. 7–264, 7–366, 7–582 (1985).

(10) Fielding, M., Gibson, T.M., James, H.A., McLoughlin, K. "Organic Micropollutants in Drinking Water" Technical Report TR 159. Water Research Centre. (1981).

(11) Gusten, H., Kolle, W., Schweer, K.H., Stieglitz, L. "Antioxidants, A New Class of Environmental Contaminants?" *Environmental Letters*. 5:209–213 (1973).

(12) Hansch, C., and Leo, A.J. Medchem Project. Issue 26. Claremont, CA: Pomona College. (1985).

(13) Helmes, C.T., Sigman, C.C., Atkinson, D.L., Papa, P.A., Thompson, K.L., Valentini, M.A., McCaleb, K.E., Bulian, E.S., and Rich, P.A. "A study of ethers for the selection of candidates for carcinogen bioassay." *Journal of Environmental Science Health*, A18(6), 797–839 (1983).

(14) Hites, R.A. and Lopez-Avila, V. "Sedimentary Accumulation of Industrial Organic Compounds Discharged into a River System." In: Contaminants and Sediments, Fate and Transport Case Studies, Modeling Toxicity. Baker, R.A., ed. Ann Arbor, MI: Ann Arbor Science. 1:53–66 (1980).

(15) Ludzack, F.J. and Ettinger, M.B. "Biodegradability of Organic Chemicals Isolated from Rivers." Purdue University, Engineering Extension Series No. 115. pp. 278–82 (1963).

(16) NIOSH. National Institute for Occupational Safety and Health, National Occupational Exposure Survey (NOES). (1989).

(17) RTECS. Computer printout of the Registry of Toxic Effects of Chemical Substances (RTECS). (1991).

(18) Sax, N.I., and Lewis, R.J. *Hawley's Condensed Chemical Dictionary*. 11th edition. New York, NY: Van Nostrand Reinhold Company. pp. 429, 530, 641, 864 (1987).

(19) Thom, N.S., and Agg, A.R. "The Breakdown of Synthetic Organic Compounds in Biological Processes." Proceedings of the Royal Society of London. B189:347–357 (1975).

(20) TOXLINE. Computer printout of TOXLINE data base. (1991).

(21) TOXLIT. Computer printout of TOXLIT data base. (1991).

(22) TSCATS. Computer printout of the Toxics Substances Control Act Test Submissions (TSCATS) data base. (1991).

(23) U.S. EPA. "Brominated Flame Retardants (Group I); Proposed Test Rule." *Federal Register*. 56:9140–9166 (1991).

(24) Weast, R.C., Astle, M.J., and Beyer, W.H. *CRC Handbook of Chemistry and Physics*. 66th ed. CRC Press, Inc., Boca Raton, FL. p. C–528 (1985).

(25) Zoeteman, B.C.J., De Greef, E., and Brinkmann, F.J.J. "Persistency of Organic Contaminants in Groundwater, Lessons from Soil Pollution Incidents in the Netherlands." *The Science of the Total Environment*. 21:187–202 (1981).

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