

# ESTIMATING THE HAZARD OF CHEMICAL SUBSTANCES TO AQUATIC LIFE

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and State University,  
K. L. Dickson, Virginia Polytechnic Institute  
and State University, and  
A. W. Maki, Procter & Gamble Co.  
editors

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## A Note of Appreciation to Reviewers

This publication is made possible by the authors and, also, the unheralded efforts of the reviewers. This body of technical experts whose dedication, sacrifice of time and effort, and collective wisdom in reviewing the papers must be acknowledged. The quality level of ASTM publications is a direct function of their respected opinions. On behalf of ASTM we acknowledge their contribution with appreciation.

*ASTM Committee on Publications*

## **Related ASTM Publications**

**Biological Methods for the Assessment of Water Quality, STP 528 (1973),  
\$16.25, 04-528000-16**

**Water Quality Parameters, STP 573 (1975), \$29.50, 04-573000-16**

**Water Pollution Assessment: Automatic Sampling and Measurement, STP  
582 (1975), 04-582000-16**

**Aquatic Toxicology and Hazard Evaluation, STP 634 (1977), \$30.75,  
04-634000-16**

# Preface

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As methods for evaluating toxicity proliferate, the differences in complexity, type of information generated, cost, skill of personnel to execute methods, and time required will vary enormously. Even now it is not possible or desirable to run all tests in every situation. As a consequence, one must have an orderly process that will ensure that the necessary information is available to make sound judgments regarding risks to aquatic organisms associated with the introduction of chemical substances into the environment. This process necessarily requires an appropriate mixture of chemical-physical-biological information. We emphasize that this mixture will vary substantially depending on the circumstances discussed in this book, but, more importantly, the overall process of determining whether the necessary information can be standardized to an acceptable degree.

With the signing of the Toxic Substances Control Act by President Ford on 11 Oct. 1976, provisions were created for the U.S. Environmental Protection Agency to require from the manufacturer premarket notification and safety testing for a new chemical substance. This law has served to underline the immediate need for the development of relevant testing methodology and integrated testing programs for effectively and efficiently assessing the potential hazard to aquatic life associated with the use of a new chemical substance. In response to this recognized need, this workshop was assembled with major authorities from the several disciplines of aquatic environmental sciences whose specific objective was to assess the current state of the art of aquatic toxicology.

In a letter dated 29 Nov. 1976, Dr. A. W. Maki of the Environmental Safety Department, the Procter & Gamble Company, Ivorydale Technical Center, Cincinnati, Ohio 45217, requested that a planning committee meet in Washington, D.C., on 9 Dec. 1976, to discuss the possibility of convening a Workshop on the Application of Aquatic Toxicity Methodology. If the reaction proved to be favorable, the organization, suggested participants, tentative program outline, and expected workshop goals would be outlined by this *ad hoc* committee.

The names and affiliations of the planning committee are as follows:

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Dr. C. E. Johnson  
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Following the planning session, suggestions regarding content, participants' goals and outlines, and so on were further detailed by all of the planning committee individually after returning to their respective institutions. This information was collected and summarized by Dr. Maki. Dr. Cairns was selected by the planning committee as the workshop chairman and senior editor, and he requested that Dr. Maki and Dr. K. L. Dickson (Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Va.) join as co-editors. Both had been named previously by the planning committee to participate in the workshop in associated roles. The *ad hoc* planning committee agreed that the primary responsibility for the preparation of this report covering the workshop proceedings would rest with this editorial committee. However, we emphasize that it was the workshop participants who made the most significant contribution to the workshop.

In order that the workshop discussion sessions be recorded accurately,

Northern Court Reporters, Alpena and Petoskey, Mich., were employed to record and transcribe the verbatim discussion, including the names of the participants. Transcripts of these discussion sessions were made available to all participants the following day to aid in the preparation of session conclusions. Thanks are due to the following for their expeditious preparation of these transcripts: Mr. M. R. Harris, C.S.R.; Ms. Louise Leathers, C.S.R.; Mrs. B. A. Harris; and Mrs. T. M. Moulton.

We are also indebted to the staff, particularly Mr. M. W. Paddock, Ms. M. A. Gockel, and Ms. M. L. Roark, of the University of Michigan's Biological Station, and Dr. D. M. Gates, Director, for coordinating the logistics and accommodations for the workshop. The financial support of The Procter & Gamble Company via a grant-in-aid to Virginia Polytechnic Institute and State University made the workshop possible and is appreciated. The editors want to acknowledge with sincere appreciation the capable assistance of two individuals, Ms. Darla Donald who helped with the organizational and editorial aspects of the workshop and Ms. Margie Fieler who completed the typing and collation of these proceedings.

# Contents

## Preface

vii

### CHAPTER 1—INTRODUCTION

<b>Introduction—JOHN CAIRNS, JR., K. L. DICKSON, AND A. W. MAKI</b>	<b>3</b>
---	----------

### CHAPTER 2—TOXICOLOGICAL EFFECTS

<b>Introduction to a Discussion of the Use of Aquatic Toxicity Tests for Evaluation of the Effects of Toxic Substances—W. A. BRUNGS AND D. I. MOUNT</b>	<b>15</b>
<b>Discussion Session Synopsis</b>	<b>27</b>

### CHAPTER 3—ENVIRONMENTAL CONCENTRATION AND FATE

<b>Prediction of Environmental Pollutant Concentration— G. L. BAUGHMAN AND R. R. LASSITER</b>	<b>35</b>
<b>Predicting the Fate of Chemicals in the Aquatic Environment from Laboratory Data—D. R. BRANSON</b>	<b>55</b>
<b>Discussion Session Synopsis</b>	<b>71</b>

### CHAPTER 4—HAZARD ASSESSMENT

<b>Hazard Assessment of Toxic Substances: Environmental Fate Testing of Organic Chemicals and Ecological Effects Testing— A. M. STERN AND C. R. WALKER</b>	<b>81</b>
<b>Environmental Safety Assessment of New Materials—R. A. KIMERLE, W. E. GLEDHILL, AND G. J. LEVINSKAS</b>	<b>132</b>
<b>Discussion Session Synopsis</b>	<b>147</b>

### CHAPTER 5—PROCEDURES FOR ESTIMATING HAZARDS TO AQUATIC LIFE

<b>Summary of Proposed Procedures for the Evaluation of Aquatic Hazard—A. W. MAKI AND J. R. DUTHIE</b>	<b>153</b>
<b>Discussion Session Synopsis</b>	<b>164</b>

### CHAPTER 6—SUMMARY AND CONCLUSIONS

<b>Summary and Conclusions—JOHN CAIRNS, JR., K. L. DICKSON, AND A. W. MAKI</b>	<b>191</b>
--	------------

## RELATED DOCUMENTS

<b>Proposed Working Document for the Development of an ASTM Draft Standard on Standard Practice for a Laboratory Testing Scheme to Evaluate Hazard to Non-Target Aquatic Organisms —ASTM SUBCOMMITTEE E35.21 ON SAFETY TO MAN AND ENVIRONMENT</b>	<b>201</b>
<b>Criteria and Rationale for Decision Making in Aquatic Hazard Evaluation (Third Draft)—AQUATIC HAZARDS OF PESTICIDES TASK GROUP OF THE AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES</b>	<b>241</b>
<b>Index</b>	<b>275</b>

# **CHAPTER 1**

## **INTRODUCTION**



## Introduction

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The science of aquatic toxicology is presently in an embryonic, although rapidly evolving, state. The vast majority of testing procedures and protocols now being used to assess the effects of chemical substances on the survival, growth, and reproduction of representative aquatic species were virtually unknown as recently as 10 years ago. The associated risks to aquatic life are being increasingly considered in marketing decisions along with the societal benefits gained from the ultimate use of new chemical substances.

With President Ford's signature on 11 Oct. 1976, the Toxic Substances Control Act (TSCA) became law. This law provides that no person may manufacture a new chemical substance or manufacture or process a chemical substance for a new use without obtaining clearance from the U.S. Environmental Protection Agency (EPA). TSCA represents an attempt to establish a mechanism whereby the hazard to human health and the environment of a chemical substance can be assessed before it is introduced into the environment. After reviewing premarketing testing results on the potential effects of the chemical substance on human health and the environment, the Administrator of EPA must judge the degree of risk associated with the extraction, manufacturing distribution, processing, use, or disposal of the chemical substance. If the chemical substance presents an unreasonable risk of injury to health or the environment, the Administrator of EPA may restrict or ban the chemical substance.

The enactment of TSCA serves as a powerful new stimulus to the development of testing procedures to evaluate the hazard associated with potentially toxic substances to human health and the environment. Both those businesses responsible for the premarketing testing of chemical substances subject to the law and the EPA responsible for assessing the risk or hazard associated with the chemical substances must develop testing and decision-making

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procedures if the intent of the law is to be fulfilled. These hazard assessment procedures must represent a systematic and comprehensive approach to the problem. Because resources for such testing are limited and the number of insufficiently tested compounds is extremely large, with many more new ones appearing each year, it is extremely important to know how to prioritize testing requirements to ensure that an accurate hazard assessment considering all potential risks associated with the new chemical can be completed with a minimum of extraneous or superfluous testing.

Therefore, it was the purpose of this workshop to evaluate the "state of the art," the philosophies, the problems, and, thus, the needs for assessing the hazard of a chemical substance to aquatic life. The workshop was designed to bring together a diverse group of professionals having the necessary talents and viewpoints to accomplish this purpose. Participants were selected as *recognized authorities* in their respective fields, and an attempt was made to attain a balance among the many diverse disciplines needed to conduct a hazard assessment. The list of participants and their respective affiliations follows.

Mr. G. L. Baughman  
Environmental Chemist  
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It should be emphasized that institutional affiliations are listed for purposes of identification only, and it should not be interpreted that the institutions and organizations listed endorse the contents of this volume in any way.

### Statement of Purpose

The workshop on the Application of Aquatic Toxicity Testing Methods as Predictive Tools for Aquatic Hazard Evaluation, conducted with the assistance of The Procter & Gamble Company grant-in-aid to Virginia Polytechnic Institute and State University, was held at the University of

Michigan Biological Station at Douglas Lake, Pellston, Mich., during the week of 13–17 June 1977. The 27 invited participants included representatives from industry, university, and regulatory agencies, and all were selected as a consequence of their active involvement either directly in the field of toxicology or in the development and application of data for hazard assessment of materials potentially reaching the aquatic environment. The workshop emphasized the application of aquatic toxicity testing methodology and data interpretation. The specifics of how tests are conducted leading toward adoption of standardized methods are being addressed by other organizational efforts, and, thus, this aspect was not emphasized during this workshop. Since attendees were limited to active practitioners, discussions opened at a high level of understanding and focused rapidly on the interpretive questions, current issues, and problems. Thus, the state-of-the-art of aquatic toxicity and environmental hazard assessment was addressed.

The charge to participants and the major purpose of each of the individual workshop sessions follow.

*Session 1—Toxicological Effects:* discussion of the utility of existing methodology for the assessment of test material effects on aquatic organisms. The session should address the predictive utility of current standard toxicity testing methods and determine how these tests are useful in interpreting “real-world” community/ecosystem effects. Also included will be a consideration of the limitations of existing dose-response studies in the context of methods routinely being used today.

*Session 2—Environmental Concentration:* discussion of methods presently available for estimation of environmental exposure concentration. What physical/chemical factors interact to influence dosage and what confidence can be attached to computer simulations and modeling results?

*Session 3—Environmental Fate:* discussion of currently employed methods for the development of predicted/projected *environmental* fate of materials. What are current limitations of existing methodology and how well do methods predict environmental bioconcentration and potential. How are laboratory model ecosystems and partition coefficient data employed in the decision-making process and how valid are environmental projections derived from them?

*Session 4—Hazard Assessment:* a presentation of independently derived environmental hazard assessment programs. A major objective will be the listing of physical/chemical properties that are significant to a hazard assessment program and the major toxicity data and fate information considered important. Independent assessments developed by industrial and regulatory representatives will identify the component research needs and assist in overall program design.

*Session 5—Evaluation of Proposed Test Procedures for Estimating Hazards to Aquatic Life:* the attainment of a consensus on specific decision criteria that can be used to determine if (a) more testing is required, (b)

enough information is known to begin safe use, and (c) data indicate high risk; therefore, cancel plans to use the material.

Discussion initiation papers for each session were prepared by designated authors and circulated to all session participants two weeks before the workshop date. The crucial points in these papers were summarized at the beginning of each workshop session to initiate discussion and provoke comments. The ensuing discussion sessions were moderated by a chairperson who, with the assistance of five or six participants, had the responsibility of summarizing and condensing the consensus recommendations and conclusions for that session.

### Conduct of Workshop

The general plan of the workshop was to have discussion initiation papers prepared on the major topics selected by the *ad hoc* planning committee and circulated to all participants before the workshop convened. Due to the pressures of time and the fact that some final drafts of papers were not in the editors' hands until the day before the workshop, this was not possible. However, early drafts of individual discussion initiation papers were distributed to all respective session participants approximately two weeks in advance. On Sunday, 12 June 1977, workshop participants arrived at the University of Michigan Biological Station, Pellston, Mich. and were requested to be there until Friday noon, 17 June 1977. On Sunday, arrivals were given a loose-leaf notebook containing final drafts of all the discussion initiation papers which were indexed by category. These papers were summarized verbally to a plenary session consisting of all participants on Monday, Tuesday, and Wednesday mornings of the workshop. Discussion of the presentations occupied nearly all of these three days since it was not necessary for extended or detailed presentations as a consequence of having the printed material available as described. However, in order to expedite the preparation for publication of the basic ideas developed during the discussion, discussion session chairpersons were appointed well in advance and an associated committee designated to assist them in this preparation. All of these assignments and the general plan of procedure were discussed with all participants prior to the workshop date. A program outline listing these assignments follows.

#### *Session 1—Toxicological Effects*

Discussion Initiation Paper:	W. A. Brungs* and D. I. Mount	
Session Chairman:	Kenneth Macek	
Committee:	Wesley Birge	A. L. Buikema, Jr.
	F. L. Mayer	A. W. Maki

\*Presented the discussion initiation paper.

*Session 2—Environmental Concentration*

Discussion Initiation Paper: G. L. Baughman\* and R. R. Lassiter  
 Session Chairman: H. E. Johnson  
 Committee: G. F. Lee  
 C. E. Johnson

*Session 3—Environmental Fate*

Discussion Initiation Paper: D. R. Branson\*  
 Session Chairman: Rod Parrish  
 Committee: James Sanborn  
 David Hansen  
 J. L. Hamelink

*Session 4—Hazard Assessment**Regulatory*

Discussion Initiation Paper: C. R. Walker\* and A. M. Stern

*Industrial*

Discussion Initiation Paper: R. A. Kimerle,\* W. E. Gledhill, and G. J. Levinskas  
 Session Chairman: L. L. Smith, Jr.  
 Committee: J. B. Sprague  
 N. T. de Oude

*Session 5—Procedures for Estimating Hazards to Aquatic Life*

Discussion Initiation Paper: A. W. Maki\* and J. R. Duthie  
 Chairman: K. L. Dickson  
 Committee: James Peterson  
 R. C. Wands  
 Arthur Scheier

Tapes were made of all discussion sessions and the court recorders produced transcripts by the end of the day. Transcripts were made available immediately to members of appropriate sessions so that the discussion of entire plenary sessions could be reviewed. The session chairmen and their committees met on Monday and Tuesday evenings, Wednesday afternoon and evening, and from 8 to 10 a.m. Thursday. They prepared a concise documentation of the plenary session consensus response to each discussion