DISCLAIMER

The use of company or product name(s) is for identification only and does not imply endorsement by the Agency for Toxic Substances and Disease Registry.
UPDATE STATEMENT

A Toxicological Profile for endrin was released in May 1989. This edition supersedes any previously released draft or final profile.

Toxicological profiles are revised and republished as necessary, but no less than once every three years. For information regarding the update status of previously released profiles, contact ATSDR at:

Agency for Toxic Substances and Disease Registry
Division of Toxicology/Toxicology Information Branch
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
FOREWORD

This toxicological profile is prepared in accordance with guidelines* developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Environmental Protection Agency (EPA). The original guidelines were published in the Federal Register on April 17, 1987. Each profile will be revised and republished as necessary.

The ATSDR toxicological profile succinctly characterizes the toxicologic and adverse health effects information for the hazardous substance described therein. Each peer-reviewed profile identifies and reviews the key literature that describes a hazardous substance's toxicologic properties. Other pertinent literature is also presented, but is described in less detail than the key studies. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced.

The focus of the profiles is on health and toxicologic information; therefore, each toxicological profile begins with a public health statement that describes, in nontechnical language, a substance's relevant toxicological properties. Following the public health statement is information concerning levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine a substance's health effects is described in a health effects summary. Data needs that are of significance to protection of public health are identified by ATSDR and EPA.

Each profile includes the following:

(A) The examination, summary, and interpretation of available toxicologic information and epidemiologic evaluations on a hazardous substance to ascertain the levels of significant human exposure for the substance and the associated acute, subacute, and chronic health effects;

(B) A determination of whether adequate information on the health effects of each substance is available or in the process of development to determine levels of exposure that present a significant risk to human health of acute, subacute, and chronic health effects; and

(C) Where appropriate, identification of toxicologic testing needed to identify the types or levels of exposure that may present significant risk of adverse health effects in humans.

The principal audience for the toxicological profiles is health professionals at the Federal, State, and local levels; interested private sector organizations and groups; and members of the public.

This profile reflects ATSDR's assessment of all relevant toxicologic testing and information that has been peer-reviewed. Staff of the Centers for Disease Control and Prevention and other Federal scientists have also reviewed the profile. In addition, this profile has been peer-reviewed by a nongovernmental panel and was made available for public review. Final responsibility for the contents and views expressed in this toxicological profile resides with ATSDR.

David Satcher, M.D., Ph.D.
Administrator
Agency for Toxic Substances and Disease Registry
*Legislative Background*

The toxicological profiles are developed in response to the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499) which amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Super-fund). This public law directed ATSDR to prepare toxicological profiles for hazardous substances most commonly found at facilities on the CERCLA National Priorities List and that pose the most significant potential threat to human health, as determined by ATSDR and the EPA. The availability of the revised priority list of 275 hazardous substances was announced in the *Federal Register* on April 29, 1996 (61 FR 18744). For prior versions of the list of substances, see *Federal Register* notices dated April 17, 1987 (52 FR 12866); October 20, 1988 (53 FR 41280); October 26, 1989 (54 FR 43619); October 17, 1990 (55 FR 42067); October 17, 1991 (56 FR 52166); October 28, 1992 (57 FR 48801); and February 28, 1994 (59 FR 9486). Section 104(I)(3) of CERCLA, as amended, directs the Administrator of ATSDR to prepare a toxicological profile for each substance on the list.
CONTRIBUTORS

CHEMICAL MANAGER(S)/AUTHOR(S):

Jessilyn Taylor, M.S.
ATSDR, Division of Toxicology, Atlanta, GA

Jerry W. Spoo, DVM
Research Triangle Institute, Research Triangle Park, NC

Lorrene Buckley Kedderis, Ph.D., DABT
Research Triangle Institute, Research Triangle Park, NC

THE PROFILE HAS UNDERGONE THE FOLLOWING ATSDR INTERNAL REVIEWS:


2. Health Effects Review. The Health Effects Review Committee examines the health effects chapter of each profile for consistency and accuracy in interpreting health effects and classifying end points.

3. Minimal Risk Level Review. The Minimal Risk Level Workgroup considers issues relevant to substance-specific minimal risk levels (MRLs), reviews the health effects database of each profile, and makes recommendations for derivation of MRLs.
A peer review panel was assembled for endrin. The panel consisted of the following members:

1. Dr. Gary Booth, Brigham Young University, Provo, Utah;
2. Dr. Donald Morgan, Private Consultant, Iowa City, Iowa; and
3. Dr. Martha J. Radike, Department of Environmental Health, University of Cincinnati, Cincinnati, Ohio.

These experts collectively have knowledge of endrin’s physical and chemical properties, toxicokinetics, key health end points, mechanisms of action, human and animal exposure, and quantification of risk to humans. All reviewers were selected in conformity with the conditions for peer review specified in Section 104(1)(13) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended.

Scientists from the Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed the peer reviewers’ comments and determined which comments will be included in the profile. A listing of the peer reviewers’ comments not incorporated in the profile, with a brief explanation of the rationale for their exclusion, exists as part of the administrative record for this compound. A list of databases reviewed and a list of unpublished documents cited are also included in the administrative record.

The citation of the peer review panel should not be understood to imply its approval of the profile’s final content. The responsibility for the content of this profile lies with the ATSDR.
# CONTENTS

FOREWORD ................................................................. v

CONTRIBUTORS .......................................................... vii

PEER REVIEW ............................................................. ix

LIST OF FIGURES ........................................................ xv

LIST OF TABLES ........................................................... xvii

1. PUBLIC HEALTH STATEMENT ........................................ 1
   1.1 WHAT IS ENDRRIN? .................................................. 2
   1.2 WHAT HAPPENS TO ENDRRIN WHEN IT ENTERS THE ENVIRONMENT? .................. 2
   1.3 HOW MIGHT I BE EXPOSED TO ENDRRIN? .............................. 3
   1.4 HOW CAN ENDRRIN ENTER AND LEAVE MY BODY? ....................... 4
   1.5 HOW CAN ENDRRIN AFFECT MY HEALTH? ................................. 4
   1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ENDRRIN? .................. 6
   1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH? .................. 6
   1.8 WHERE CAN I GET MORE INFORMATION? ............................... 7

2. HEALTH EFFECTS ..................................................... 9
   2.1 INTRODUCTION ...................................................... 9
   2.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE ................. 9
      2.2.1 Inhalation Exposure ............................................. 11
      2.2.1.1 Death .......................................................... 11
      2.2.1.2 Systemic Effects ............................................. 16
      2.2.1.3 Immunological and Lymphoreticular Effects .................... 17
      2.2.1.4 Neurological Effects ........................................ 17
      2.2.1.5 Reproductive Effects ....................................... 18
      2.2.1.6 Developmental Effects ...................................... 18
      2.2.1.7 Genotoxic Effects ........................................... 18
      2.2.1.8 Cancer ........................................................ 18
      2.2.2 Oral Exposure ................................................. 19
      2.2.2.1 Death .......................................................... 19
      2.2.2.2 Systemic Effects ............................................. 21
      2.2.2.3 Immunological and Lymphoreticular Effects .................... 45
      2.2.2.4 Neurological Effects ........................................ 46
      2.2.2.5 Reproductive Effects ....................................... 47
      2.2.2.6 Developmental Effects ...................................... 48
      2.2.2.7 Genotoxic Effects ........................................... 50
      2.2.2.8 Cancer ........................................................ 50
2.2.3 Dermal Exposure ........................................ 51
  2.2.3.1 Death ........................................ 52
  2.2.3.2 Systemic Effects .................................. 52
  2.2.3.3 Immunological and Lymphoreticular Effects .......... 55
  2.2.3.4 Neurological Effects ............................... 55
  2.2.3.5 Reproductive Effects ............................... 56
  2.2.3.6 Developmental Effects ............................. 56
  2.2.3.7 Genotoxic Effects ................................. 56
  2.2.3.8 Cancer ........................................ 56
2.3 TOXICO KINETICS ........................................ 56
  2.3.1 Absorption ........................................ 57
    2.3.1.1 Inhalation Exposure .............................. 57
    2.3.1.2 Oral Exposure .................................. 57
    2.3.1.3 Dermal Exposure ............................... 57
  2.3.2 Distribution ....................................... 58
    2.3.2.1 Inhalation Exposure .............................. 58
    2.3.2.2 Oral Exposure .................................. 58
    2.3.2.3 Dermal Exposure ............................... 60
  2.3.3 Metabolism ......................................... 60
  2.3.4 Excretion ......................................... 62
    2.3.4.1 Inhalation Exposure .............................. 62
    2.3.4.2 Oral Exposure .................................. 62
    2.3.4.3 Dermal Exposure ............................... 63
2.4 MECHANISMS OF ACTION .................................. 63
2.5 RELEVANCE TO PUBLIC HEALTH ............................ 65
2.6 BIOMARKERS OF EXPOSURE AND EFFECT .................... 72
  2.6.1 Biomarkers Used to Identify or Quantify Exposure to Endrin .... 73
  2.6.2 Biomarkers Used to Characterize Effects Caused by Endrin .......... 74
2.7 INTERACTIONS WITH OTHER CHEMICALS ................. 75
2.8 POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE ........... 75
2.9 METHODS FOR REDUCING TOXIC EFFECTS .................. 76
  2.9.1 Reducing Peak Absorption Following Exposure .......... 76
  2.9.2 Reducing Body Burden ................................ 77
  2.9.3 Interfering with the Mechanism of Action for Toxic Effects .......... 78
2.10 ADEQUACY OF THE DATABASE ............................ 79
  2.10.1 Existing Information on Health Effects of Endrin .......... 79
  2.10.2 Identification of Data Needs ........................ 81
  2.10.3 Ongoing Studies .................................. 87

3. CHEMICAL AND PHYSICAL INFORMATION ..................... 89
  3.1 CHEMICAL IDENTITY .................................... 89
  3.2 PHYSICAL AND CHEMICAL PROPERTIES ..................... 89

4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL ............. 95
  4.1 PRODUCTION .................................... 95
  4.2 IMPORT/EXPORT .................................... 96
  4.3 USE ........................................... 96
  4.4 DISPOSAL ......................................... 96
5.1 OVERVIEW ................................................................. 99
5.2 RELEASES TO THE ENVIRONMENT ................................. 104
  5.2.1 Air ................................................................. 104
  5.2.2 Water ............................................................ 104
  5.2.3 Soil ............................................................... 105
5.3 ENVIRONMENTAL FATE .................................................. 105
  5.3.1 Transport and Partitioning ......................................... 105
  5.3.2 Transformation and Degradation ................................. 110
    5.3.2.1 Air .......................................................... 110
    5.3.2.2 Water ....................................................... 111
    5.3.2.3 Sediment and Soil ......................................... 112
5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT .......... 114
  5.4.1 Air ................................................................. 114
  5.4.2 Water ............................................................ 115
  5.4.3 Sediment and Soil ................................................ 117
  5.4.4 Other Environmental Media ...................................... 119
5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE ............... 123
5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES ................. 126
5.7 ADEQUACY OF THE DATABASE .......................................... 126
  5.7.1 Identification of Data Needs ..................................... 126
  5.7.2 Ongoing Studies ................................................ 131

6. ANALYTICAL METHODS .................................................... 133
  6.1 BIOLOGICAL SAMPLES ............................................... 133
  6.2 ENVIRONMENTAL SAMPLES .......................................... 135
  6.3 ADEQUACY OF THE DATABASE ........................................ 138
    6.3.1 Identification of Data Needs ................................ 143
    6.3.2 Ongoing Studies ............................................. 144

7. REGULATIONS AND ADVISORIES ........................................ 145

8. REFERENCES ............................................................. 161

9. GLOSSARY ................................................................. 189

APPENDICES

A. MINIMAL RISK LEVEL (MRL) WORKSHEET(S) ............................ A-3

B. USER'S GUIDE ......................................................... B-1

C. ACRONYMS, ABBREVIATIONS, AND SYMBOLS ............................ C-1
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Levels of Significant Exposure to Endrin - Inhalation</td>
<td>14</td>
</tr>
<tr>
<td>2-2</td>
<td>Levels of Significant Exposure to Endrin - Oral</td>
<td>37</td>
</tr>
<tr>
<td>2-3</td>
<td>Proposed Metabolic Scheme for Endrin in Mammals</td>
<td>61</td>
</tr>
<tr>
<td>2-4</td>
<td>Existing Information on Health Effects of Endrin</td>
<td>80</td>
</tr>
<tr>
<td>5-1</td>
<td>Frequency of Sites with Endrin Contamination</td>
<td>102</td>
</tr>
<tr>
<td>5-2</td>
<td>Frequency of Sites with Endrin Ketone Contamination</td>
<td>103</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2-1</td>
<td>Levels of Significant Exposure to Endrin - Inhalation</td>
<td>12</td>
</tr>
<tr>
<td>2-2</td>
<td>Levels of Significant Exposure to Endrin - Oral</td>
<td>22</td>
</tr>
<tr>
<td>2-3</td>
<td>Levels of Significant Exposure to Endrin - Dermal</td>
<td>53</td>
</tr>
<tr>
<td>2-4</td>
<td>Genotoxicity of Endrin <em>In Vitro</em></td>
<td>71</td>
</tr>
<tr>
<td>2-5</td>
<td>Ongoing Research for Endrin, Endrin Aldehyde, or Endrin Ketone</td>
<td>80</td>
</tr>
<tr>
<td>3-1</td>
<td>Chemical Identity of Endrin, Endrin Aldehyde, and Endrin Ketone</td>
<td>90</td>
</tr>
<tr>
<td>3-2</td>
<td>Physical and Chemical Properties of Endrin</td>
<td>92</td>
</tr>
<tr>
<td>5-1</td>
<td>Bioconcentration Data for Endrin</td>
<td>108</td>
</tr>
<tr>
<td>6-1</td>
<td>Analytical Methods for Determining Endrin and Metabolites in Biological Samples</td>
<td>136</td>
</tr>
<tr>
<td>6-2</td>
<td>Analytical Methods for Determining Endrin and Transformation Products in Environmental Samples</td>
<td>139</td>
</tr>
<tr>
<td>7-1</td>
<td>Regulations and Guidelines Applicable to Endrin/Endrin Aldehyde/Endrin Ketone</td>
<td>147</td>
</tr>
</tbody>
</table>