

THIRD EDITION

HANDBOOK OF  
ENVIRONMENTAL  
HEALTH  
AND  
SAFETY

Principles and Practices  
VOLUME I

HERMAN KOREN  
MICHAEL BISESI

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VOLUME I

HERMAN KOREN  
MICHAEL BISESI



NATIONAL  
ENVIRONMENTAL  
HEALTH ASSOCIATION



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Boca Raton Boston London New York Washington, D.C.



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## Preface

This handbook, in two volumes, is designed to provide a comprehensive but concise discussion of each of the important environmental health areas, including energy, ecology and people, environmental epidemiology, risk assessment and risk management, environmental law, air quality management, food protection, insect control, rodent control, pesticides, the chemical environment, environmental economics, human disease and injury, occupational health and safety, noise, radiation, recreational environment, indoor environments, medical care institutions, schools and universities, prisons, solid and hazardous waste management, water supply, plumbing, swimming areas, sewage disposal, soils, water pollution control, environmental health emergencies, and nuisance complaints.

Sufficient background material is introduced throughout these books to provide students, practitioners, and other interested readers with an understanding of the areas under discussion. Common problems and potential solutions are described; graphs, inspection sheets, and flow charts are utilized as needed to consolidate or clarify textual material. All facts and data come from the most recent federal government documents, many of which date from the late 1980s and early 1990s. Rules and regulations specified will continue to be in effect into the late 1990s. For rapidly changing areas in which the existing material used is likely to become dated, the reader is referred to the appropriate sources to update a given environmental health area or portion of an area as needed. This enhances the value of the text by providing basic and current materials that will always be needed and secondary sources that will enable the reader to keep up to date.

These books are neither engineering texts nor comprehensive texts in each area of study. The purpose of these books is to provide a solid working knowledge of each environmental health area with sufficient detail for practitioners. The text can be used in basic courses in environmental health, environmental pollution, ecology, and the environment and people that are offered at all universities and colleges in the United States and abroad. These courses are generally taught in departments of Life Science, Geology, Science Education, Environmental Health, and Health and Safety. For general areas of study, the instructor can omit specific details, such as resources, standards, practices and techniques, and modes of surveillance and evaluation. This same approach may be used by schools of medicine, nursing, and allied health sciences for their students. These texts are also suitable for basic introductory courses in schools of public health, environ-

mental health, and sanitary science, as well as junior colleges offering 2-year degree programs in sanitary Science and Environmental Science.

Practitioners in a variety of environmental health and occupational health and safety fields will find these books handy references for resolving current problems and for obtaining a better understanding of unfamiliar areas. Practitioners and administrators in other areas, such as food processing, water-quality control, occupational health and safety, and solid and hazardous waste management, will also find these reference books useful.

High school teachers often must introduce environmental health topics in their classes and yet have no specific background in this area. These books could serve as a text in graduate education courses for high school teachers as well as a reference source.

Public interest groups and users of high school and community libraries will obtain an overall view of environmental problems by reading Chapter 1 and the Background and Status, Problems, Potential for Intervention, Resources, and Control sections in each chapter. This volume will also supply a concise reference for administrators in developing nations, for it explains tested controls and provides a better understanding of environmental problems, various standards, practices and techniques, and a variety of available resources.

The material divides easily into two separate courses. Course I would correspond to the content of Volume I and would include Chapter 1. Environment and Humans; Chapter 2. Food Protection; Chapter 3. Food Technology; Chapter 4. Insect Control; Chapter 5. Rodent Control; Chapter 6. Pesticides; Chapter 7. Indoor Environment; Chapter 8. Institutional Environment; Chapter 9. Recreational Environment; Chapter 10. Occupational Environment; and Chapter 11. Instrumentation.

Course II, corresponding to the content of the Volume II, would include Chapter 1. Air Quality Management; Chapter 2. Solid and Hazardous Waste Management; Chapter 3. Private and Public Water Supplies; Chapter 4. Swimming Areas; Chapter 5. Plumbing; Chapter 6. Private and Public Sewage Disposal and Soils; Chapter 7. Water Pollution and Water Quality Controls; Chapter 8. Environmental Health Emergencies, Nuisance Complaints, and Special Problems; and Chapter 9. Instrumentation.

Since the problems of the environment are so interrelated, certain materials must be presented at given points in order to give clarity and cohesiveness to the subject matter. As a result, the reader may encounter some duplication of materials throughout the text.

With the exception of Volume I, Chapters 1, 10, and 11 and Volume II, Chapters 8 and 9, all of the chapters have a consistent style and organization, facilitating retrieval. The introductory nature of Volume I, Chapter 1 and the unusual nature of Volume II, Chapter 8 do not lend themselves to the standard format. Volume I, Chapter 11 and Volume II, Chapter 9 discuss Instrumentation for the specific areas of each volume and therefore do not follow standard format.



In Volume I, Chapter 1, the reader is introduced to the underlying problems, basic concerns, and basic philosophy of environmental health. The ecologic, economic, energy, toxicologic, and epidemiologic bases provided help the individual to understand his or her relationship to the ecosystem and to the real world of economic and energy concerns; and to understand the relationship between biological, physical, and chemical agents and disease and injury causation. It also provides an understanding of the role of government and the environmental health practitioner in helping to resolve environmental and ecological dilemmas created by humans.

In Volume II, Chapter 8, the many varied facets of environmental emergencies, nuisances, and special problems are discussed. Students may refer to other chapters of the text to obtain a complete idea of each of the problems and the potential solutions.

The general format of Volume I, Chapters 2–10 and Volume II, Chapters 1–7 is as follows:

## **STANDARD CHAPTER OUTLINE**

1. Background and Status (Brief)
2. Scientific, Technological, and General Information
3. Problem
  - A. Types
  - B. Sources of Exposure
  - C. Impact on Other Problems
  - D. Disease Potential
  - E. Injury Potential
  - F. Other Sources of Exposure Contributing to Problems
  - G. Economics
4. Potential for Intervention
  - A. General
  - B. Specific
5. Resources
  - A. Scientific and Technical; Industry, Labor, University; Research Groups
  - B. Civic
  - C. Governmental
6. Standards, Practices, and Techniques
7. Modes of Surveillance and Evaluation
  - A. Inspections and Surveys
  - B. Sampling and Laboratory Analysis
  - C. Plans Review
8. Control
  - A. Scientific and Technological
  - B. Governmental Programs
  - C. Other Programs
  - D. Education

9. Summary
10. Research Needs

- The Background and Status section of each chapter presents a brief introduction to, and the current status of, each problem area. An attempt has been made in each case to present the current status of the problem.
- The Problem section is subdivided into several important areas to give the reader a better grasp of the total concerns. To avoid disruption in continuity of the standard outline, the precise subtitles listed may not be found in each chapter. However, the content of the subtitles will be present. The subtitle, Impact on Other Problems, is given as a constant reminder that one impact on the environment may precipitate numerous other problems.
- The Potential for Intervention section is designed to succinctly illustrate whether a given problem can be controlled, the degree of control possible, and some techniques of control. The reader should refer to the Controls section for additional information.
- Resources is a unique section providing a listing of scientific, technical, civic, and governmental resources available at all levels to assist the student and practitioner.
- The section of Standards, Practices, and Techniques is specifically geared to the reader who requires an understanding of some of the specifics related to surveys, environmental studies, operation, and control of a variety of program areas.
- The Modes of Surveillance and Evaluation Section explains many of the techniques available to determine the extent and significance of environmental problems.
- The Control section presents existing scientific, technological, governmental, educational, legal, and civic controls. The reader may refer to the Standards, Practices, and Techniques section in some instances to get a better understanding of controls.
- The Summary presents the highlights of the chapter.
- Research Needs is another unique section that is intended to increase reader awareness to the constantly changing nature of the environment and of the need for continued reading or in-service education on the future concerns of our society.
- The Reference section is extensive and as current as possible. It appears as the last chapter in each volume. It provides the reader with sources for further research and names of individuals and organizations involved in current research.

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To Boris Osheroﬀ, my friend, teacher, and colleague, for opening the numerous doors needed to obtain the most current information in the environmental health field, and for his many fine suggestions and ideas before and after reading the manuscript; to Ed O'Rourke for his intensive review of the manuscript and his recommendations for revisions and improvements; to Karol Wisniewski for his review and comments on the manuscript; to Dr. John Hanlon for his encouragement and for helping a young teacher realize his potential; to all the environmental health administrators, supervisors, practitioners, and students who have shared their experiences and problems with me and have given me the opportunity to test many of the practical approaches used in the book; to the National Institute of Occupational Safety and Health, National Institutes of Health, National Institute of Environmental Health Science, U.S. Environmental Protection Agency, U.S. Food and Drug Administration, Cunningham Memorial Library, Indiana State University, Indiana University Library, Purdue University Library, and the many other libraries and resources for providing the material that was used in developing the manuscript; to my wife, Donna Koren, and my student, Evelyn Hutton, for typing substantial portions of the manuscript; to my daughter, Debbie Koren, for helping me organize the materials and for working along with me throughout the night at the time of deadlines to complete the work.

In the second edition, Kim Malone has typed portions of the new manuscript, retyped the entire manuscript, and has been of great value to me. Pat Ensor, Librarian, Indiana State University, has been of considerable value in helping gather large numbers of references in all areas of the book. A very special thanks to my sister-in-law, Betty Gardner, for typing a substantial portion of the new manuscript, despite recurring severe illness. Her cheerfulness during my low periods has helped me complete my work. Finally, thanks to my wife Donna for putting up with my thousands of hours of seclusion in the den, while I was working, and for encouraging me throughout the project and my life with her. She has truly been my best friend.

In the third edition, Alma Mary Anderson, CSC, and her assistants, Carlos Gonzalez and Brian Flynn, redid the existing illustrations and added new ones to enhance the manuscript. Professor Anderson directed the production of all of the new artwork. In addition, thanks to Bill Farms for his assistance with the original computer assisted drawings for the Instrumentation chapters in both volumes. My wife Donna typed much new material, and the previously mentioned libraries,

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# Chapter 1

## ENVIRONMENT AND HUMANS

*Health and safety* refer to the avoidance of disease and injury through efficient use of the environment, a properly functioning society, and an inner sense of well-being. *Environmental health and safety* is the art and science of protection of human function, the promotion of aesthetic values, and the prevention of disease and injury through the control of positive environmental factors and the reduction of potential hazards — physical, biological, and chemical.

To understand the relationship of the environment to humans and to understand how to protect humans from disease and injury, it will be necessary to discuss the ecosystem, ecosystem dynamics, and energy. Human impact on the environment and the various approaches used to evaluate and resolve environmental problems, including risk assessment, epidemiological, economic, legal, and governmental aspects also will be discussed. In order to understand abnormal physiology, toxicology, and infectious disease, a brief discussion on normal physiology is included. Finally, it will be necessary to understand the role of professional environmental health practitioners, the skills that they need, and how they address the expanding field of environmental problems.

### THE ECOSYSTEM

The Earth is divided into the lithosphere, or land masses, and the hydrosphere, or the oceans, lakes, streams, and underground waters. The hydrosphere includes the entire aquatic environment. Our world, both lithosphere and hydrosphere, is shaped by varying life forms. Permanent forms of life create organic matter and, in combination with inorganic materials, help establish soil. Plants cover the land and reduce the potential for soil erosion — the nature and rate of erosion affects



the redistribution of materials on the surface of the Earth. Organisms assimilate vast quantities of certain elements and molecules, such as carbon and oxygen. Animals, through respiration, release carbon dioxide into the atmosphere — carbon dioxide affects the heat transmission of the atmosphere. Organisms affect the environment and in turn are affected by it.

Two environments, biotic (living environment or community) and abiotic (nonliving environment), combine to form an ecosystem. An ecosystem can also be subdivided by more specific criteria into the following four categories: abiotic, the nutrient minerals that are synthesized into living protoplasm; autotrophic, the producer organisms (largely the green plants), which assimilate the nutrient minerals using energy and combine them into living organic substances; heterotrophic, the consumers, usually the animals that ingest or eat organic matter and release energy; and the heterotrophic reducers, bacteria or fungi, which return the complex organic compounds to their original abiotic state and release the remaining chemical energy. The biotic group in the ecosystem complex is essentially comprised of the autotrophs, or producer organisms that synthesize organic substances, and the heterotrophs, or consumer or reducer organisms that decompose labile organic substances. The ecosystem is important when considering the food chain, which is in effect a transfer of energy from plants through a series of organisms that eat and, in turn, are eaten. Eventually, decay will start the process all over again.

The ecological niche is the combination of function and habitat of each of the approximately 1.5 million species of animals and a half million species of plants on the Earth. There are many interactions between species in the ecosystem, yet a balance is dictated by nature. The law of limiting factors states that a minimum quantity of essentials, such as nutrients, light, heat, moisture, and space, must be available within the ecosystem for survival of the organisms. In some instances where these limiting factors apply or where pesticides or other environmental elements are introduced into the ecosystem, the organism alters itself in order to exist within the new environment. This change is called mutation. Unfortunately, mutation becomes a serious concern in the area of pest control as well as in disease, because the new organism may be highly resistant to effective control and may therefore cause disease and physical destruction of plants and animals. The ecosystem is always in a dynamic, rather than static, balance — changes in one part of the ecosystem will cause changes in another.

## **The Biosphere**

The biosphere is that part of the Earth in which life exists. However, this definition is not complete, since spores may commonly be found in areas that are too dry, too cold, or too hot to support organisms that metabolize. The biosphere contains the liquid water necessary for life; it receives an ample supply of energy from an external source, which is ultimately the sun, and within it liquid, solid, and