

MODERN INDUSTRIAL HYGIENE

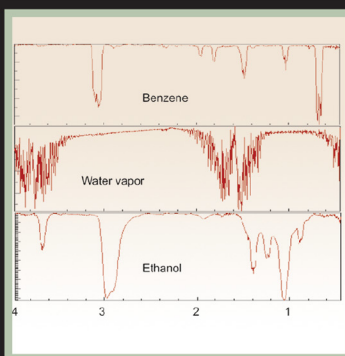
Volume 1

Recognition and Evaluation of Chemical Agents

Recognition and Evaluation of Chemical Agents



$$95\% \text{tile} = \bar{x} + 1.65\sigma$$
$$95\% \text{ UCL} = \bar{x} + 1.65 \sigma / \sqrt{n}$$
$$\text{UCL} = \bar{x} + t_{(\alpha, n-1)} s / n^{0.5}$$
$$95\% \text{ UTL} = \bar{x} + k_{(P, \alpha, n-1)}$$
$$= MC + 1.65 (CV) (\dots)$$



Recognition and Evaluation of Chemical Agents

Recognition and Evaluation of Chemical Agents

2nd Edition

Jimmy L. Perkins

This is a preview. [Click here to purchase the full publication.](#)

MODERN INDUSTRIAL HYGIENE

Volume 1, 2nd Edition

Recognition and Evaluation of Chemical Agents

Jimmy L. Perkins

University of Texas Health Science Center – Houston

School of Public Health

San Antonio Regional Campus

ACGIH®

Cincinnati, Ohio, U.S.A.

This is a preview. [Click here to purchase the full publication.](#)

Copyright © 2008 by ACGIH®

ISBN: 978-1-882417-75-9

All rights reserved. No part of this work covered by the copyright hereon may be reproduced or used in any form or by any means — graphic, electronic, or mechanical including photocopying, recording, taping, or information storage and retrieval systems — without written permission of the publisher.

Printed in the United States of America

ACGIH®

1330 Kemper Meadow Drive

Cincinnati, Ohio 45240-4148

U.S.A.

Telephone: (513) 742-2020

Fax: (513) 742-3355

E-mail: publishing@acgih.org

<http://www.acgih.org>

CONTENTS

Contributors	v
Foreword	vii
Preface	ix
Acknowledgments	xiii

I. INDUSTRIAL HYGIENE – THE DISCIPLINE

1. What Is an Industrial Hygienist?	1
2. Industrial Hygiene – Historical Perspective	11
3. Principles and Focus of Industrial/Occupational Hygiene	41

II. DISEASE AGENTS OF THE WORKPLACE

4. Disease Agents of the Workplace	63
5. Common Industrial Processes and Their Associated Agents	103
6. Exposure Routes	149

III. TOOLS FOR ASSESSING THE WORKPLACE

7. Approximating the Truth	173
8. The Physical Nature of Gases and Vapors	193
9. Basic Aerosol Physics	221
10. Occupational Exposure Limits and Threshold Limit Values	239
11. Federal Legislation and Regulation Relative to Industrial Hygiene	287

IV. THE FRAMEWORK FOR ASSESSING THE WORKPLACE

12. Gathering Information about the Workplace	319
13. Qualitative Surveying – The Walkthrough	335
14. Quantitative Surveying – Exposure Assessment	357

15. Quantitative Surveying – Application of Mathematical Modeling to Estimate Air Contaminant Exposure (Mark Nicas)	377
16. Quantitative Surveying – Statistical Modeling of Occupational Exposures	407
17. Quantitative Surveying – Application of Variance Component Models to Exposure Assessment (Elaine Symanski)	453
18. Quantitative Surveying – Forming the Strategy	487

V. AIR SAMPLING AND LABORATORY ANALYSIS

19. Laboratory Analytical Techniques	509
20. Pumps and Their Calibration	539
21. Gases and Vapors – Solid Media	581
Appendix – Adsorption Theory	616
22. Gases and Vapors – Bags, Rigid Containers, and Impingers	631
23. Gases and Vapors – Passive Monitoring	647
24. Aerosols	677
25. Interpreting Analytical Methods and Selecting a Laboratory	745

VI. REAL TIME ANALYSIS

26. An Overview of Direct-Reading Instrumentation	771
27. Instruments for Gases and Vapors	793
28. Instruments for Aerosols	851
29. Detector Tubes	877
30. Calibration of Direct-Reading Instrumentation	897

Appendices – Equations Derived From Mass Balance Considerations

Appendix A – Physical-Chemical Constants	945
Appendix B – Vapor Pressure Constants and Temperature Ranges	965
Appendix C – Three Dimensional Solubility Parameters (J/cm^3) ^{0.5}	985
Appendix D – Answers to Study Questions	993

Index	1048
-------	------

CONTRIBUTORS

Mark Nicas, PhD, MPH, CIH

School of Public Health
University of California
Berkeley, CA
Chapter 15

Elaine Symanski, PhD

University of Texas
Health Science Center
School of Public Health
Houston, TX
Chapter 17

This is a preview. [Click here to purchase the full publication.](#)

FOREWORD

Each time I teach my course *Risk Recognition, Evaluation and Control in the Workplace for Physical, Chemical, Biological and Radiological Hazards (Comprehensive Industrial Hygiene Review)*, the students ask: “Is there a textbook that goes with this course?” At present, and even more so in the future, the best answer may well be *Modern Industrial Hygiene* by Professor Jimmy Perkins. This book, Volume I, is the first of four books that, when completed, will address the *complete* subjects that make up the science and the art of industrial hygiene.

This first volume covers the subjects of, for example:

- What is industrial hygiene?
- The history of industrial hygiene;
- Toxic chemicals in the workplace;
- Occupational exposure limits;
- Exposure routes;
- The physical nature of gases, vapors and aerosols; and
- Methods and strategies of qualitative exposure assessment.

Some of the most current and complex information can be found in three subject areas. These are [1] processes and their chemical hazards, [2] sampling strategies and statistics, and [3] field and laboratory analytical chemistry, as follows:

- Industrial processes and their toxic chemicals, which chapter includes: abrasive blasting; boilers and furnaces; confined spaces; diesel engines; electroplating; grinding, polishing and buffing; laboratories; machining and cutting oils; metal surface treatments; painting; plastics; and welding and allied processes;
- Statistical approaches to the treatment of field and laboratory data, which chapters focus on mathematical modeling, including: emission rate modeling; dilution and mixing; analysis of distributions; variability and confidence intervals; analysis of

variance and covariance; and determinants of exposure, all of which, taken together can guide the industrial hygienist in preparing strategies for quantitative surveying of the workplace

- Methods of sampling, analysis and monitoring of gases and vapors, which chapters focus on: laboratory analysis; sampling of gases, vapors and aerosols; real time monitoring of air contaminants; and quality control and quality assurance in analytical laboratories.

Volume 2 in the *Modern Industrial Hygiene* series was published by ACGIH in 2003. It deals with “Biological Aspects” which includes the subject of ergonomics. Volume 3 will deal with “Control of Chemical Agents.” Volume 4 will deal with “Physical Agents” including noise, vibration, pressure, heat and cold, and ionizing and non-ionizing radiation. It is important to note that the four volumes in this series are, and will be, a tour-de-force for Professor Perkins. Although he has had authors and assistance with many of the chapters, all of the material was either edited or has been written by him. Professor Perkins’ mastery of the body of knowledge that *is industrial hygiene* will be a benchmark for us all.

PREFACE

Most Industrial or Occupational Hygienists, being scientists, probably remember working the math or chemistry problems that were part of their textbooks. The questions at the end of chapters in biology texts could be particularly troublesome as they were often open-ended and sometimes subjective. No doubt we agonized over these; nonetheless, many were thought provoking. The questions and problems were an important part of the learning process. They emphasized the most important material, an increasingly important process as the sea of information continues to expand. They also forced us to use the tools that we had just read about; many times the uses that the questions forced were not the uses that we envisioned upon first reading the material. Thus, the learning process was further advanced one very important step.

But the learning process continues even after a formal degree program. Many hygienists would undoubtedly say that on-the-job-training is ultimately far more extensive than that gained while in university. So what tools are available to the hygienist during this advanced stage of the learning process? Often the tools that were learned in college become more refined in one's mind as the professional career continues. In other words, in the classroom we learn the concept in a general sort of way. We think that we know how to apply it, and we usually think that we have a firm understanding of it. After all we passed the exam! But along comes reality and experience, both of which cause us to question the perceptions that we formed in the classroom. Because of contrary field observations, we may even question the basic tenets of the concept or the underpinnings of some long-held notion or axiom. It is at these moments, common for some, rare for many, but nevertheless experienced by everyone, that we need a thorough review of the axiom and the events that led to its becoming a part of the lore of hygiene.

It is the above process, occurring continuously throughout one's lifetime that constitutes learning, or more aptly understanding. The formal student must observe information from various angles in order to gain, not an understanding, for that usually comes with maturity and repeated application, but rather an appreciation for the multifaceted nature of information. The student gains this appreciation by viewing the information in different contexts. A good teacher provides one context, a good textbook the second, and a good set of questions forces the third. Heretofore, the hygiene student has not had access to a general textbook written from this perspective and containing questions and problems and their answers.

The practicing hygienist continues to learn by refining his or her understanding through

This is a preview. [Click here to purchase the full publication.](#)