

Environmental ENGINEERING



ENVIRONMENTAL HEALTH and SAFETY
for Municipal Infrastructure, Land Use and Planning, and Industry

SIXTH EDITION

Nelson L. NEMEROW, Franklin J. AGARDY, Patrick SULLIVAN, and Joseph A. SALVATO



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ENVIRONMENTAL ENGINEERING, SIXTH EDITION

Environmental Health and Safety for
Municipal Infrastructure, Land Use
and Planning, and Industry

EDITED BY NELSON L. NEMEROW, FRANKLIN J. AGARDY,
PATRICK SULLIVAN, JOSEPH A. SALVATO



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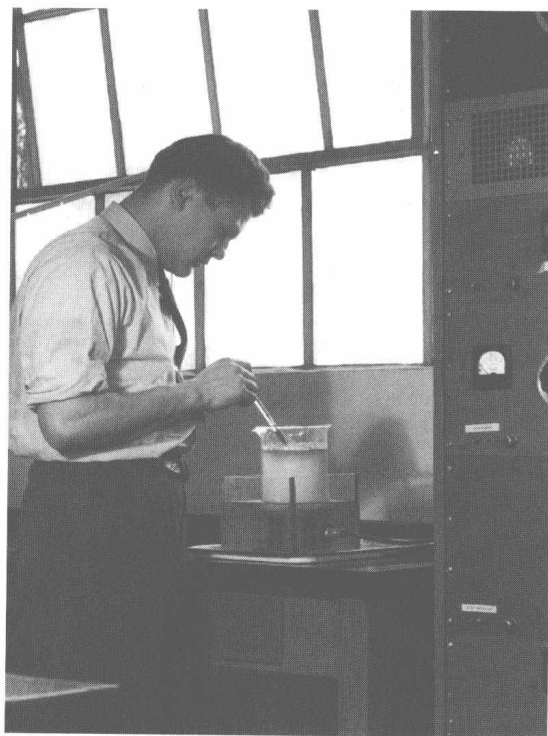
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Doctors Agardy and Sullivan would like to dedicate this sixth edition of *Environmental Engineering* to Nelson L. Nemerow who passed away in December of 2006. Dr. Nemerow was born on April 16, 1923 and spent most of his productive years as an educator and prolific author. He spent many years teaching at Syracuse University, the University of Miami, North Carolina State, Florida International, and Florida Atlantic University. He authored some 25 books dedicated to advancing the art of waste disposal and utilization. His passion was waste minimization and the title of one of his most recent publications, *Zero Pollution for Industry*, summed up more than fifty years of teaching and consulting. A devoted husband and father, he divided his time between residences in Florida and Southern California. Nelson served in the United States Merchant Marine during World War II. His commitment to excellence was second to none.



PREFACE

Today's scientists, engineers, public health workers and physicians face challenges which were predicted, but certainly not expected to emerge this soon and to the magnitude presently occurring. The problems and proposed solutions in this volume cover a broad spectrum of issues including industrial and domestic solid wastes, air pollution and associated global warming, noise pollution and housing.

Many engineering elements go into developing solutions to these problems including the need for more detailed mapping and surveying, developing improved housing codes, including the development of more eco-friendly building materials and greater emphasis on conservation. Issues such as site planning and associated environmental assessments now play a major role in virtually all proposed developments.

New technologies and approaches are constantly evolving and are being implemented in greater scale than ever before. Old landfills are being mined for fuel (gasses), new landfills are designed to prevent waste materials from migrating to groundwater, and new approaches to waste incineration focus on energy recovery and conversion of waste materials into usable materials.

In many developed communities, noise pollution has been identified as a major problem and one sees more and more barriers constructed to suppress noise. Going a step further, home construction codes have led to the development of materials for construction which are not only more eco-friendly but act as a much improved barrier to both noise and heat transfer.

As the earth's population grows, problems of food, water, land, housing, sanitation, medical care and global warming, to name a few, continue to place new challenges on the engineering community. The question always uppermost in our minds is "Are we able to cope?" The answer lies in the knowledge of engineers and the resources necessary to not only meet these challenges, but to address them head on and develop appropriate solutions. This text should help engineers and scientists meet these challenges.

FRANKLIN J. AGARDY
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CHAPTER 1

INDUSTRIAL SOLID WASTES UTILIZATION AND DISPOSAL

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INTRODUCTION

There are a lot of definitions for the word *industry*. The most generic definition is, “An organized manmade activity that provides goods and services essential for maintaining and developing human life.” As much as there is diversity in human needs and activities, there is also a great diversity in industry. North America Industrial Classification System (NAICS) has classified industries into the following industrial sectors according to their activities:

- Agriculture, forestry, fishing, and hunting
- Mining
- Utilities
- Construction
- Manufacturing
- Wholesale trade
- Retail trade
- Transportation and warehousing
- Information
- Finance and insurance
- Real estate and rental and leasing
- Professional, scientific, and technical services
- Management of companies and enterprises