

TABLE OF CONTENTS

<i>Chapter</i>	<i>Page</i>
LIST OF TABLES	xvii
LIST OF FIGURES	xx
CHAPTER 1. INTRODUCTION	1-1
CHAPTER 2. PHYSICAL AND CHEMICAL NATURE OF PHOTO- CHEMICAL OXIDANTS	2-1
A. INTRODUCTION	2-1
B. GENERAL DISCUSSION	2-1
C. PHYSICAL PROPERTIES	2-2
1. Ozone	2-2
2. Peroxyacetyl Nitrate	2-3
D. OXIDANT FORMATION PROCESSES	2-3
1. Nitrogen Dioxide Photolytic Cycle	2-3
2. Hydrocarbon Interaction with Nitrogen Dioxide Photolysis	2-6
3. Hydrocarbon Reactivity	2-8
4. Nitric Oxide and Nitrogen Dioxide	2-10
E. METEOROLOGICAL EFFECTS	2-11
1. General	2-11
2. Sunlight	2-11
3. Temperature	2-13
F. REACTANT CONCENTRATION STUDIES	2-13
1. Environmental Chamber Studies	2-13
2. Atmospheric Studies	2-15
G. FUTURE RESEARCH	2-17
H. SUMMARY	2-19
I. REFERENCES	2-19
CHAPTER 3. ATMOSPHERIC PHOTOCHEMICAL OXIDANT CONCENTRATIONS	3-1
A. INTRODUCTION	3-1
B. CONCENTRATIONS OF OXIDANTS IN URBAN ATMOSPHERES	
1. General Discussion	3-1
2. Oxidant Concentration Patterns	3-2
3. Seasonal and Diurnal Variations	3-4
4. Oxidant Measurement Parameters	3-6

<i>Chapter</i>	<i>Page</i>
a. Sulfur Dioxide	3-6
b. Nitrogen Dioxide	3-6
c. Nitric Oxide	3-7
C. CONCENTRATIONS OF OZONE IN URBAN ATMOSPHERE	3-7
1. Adjusted Oxidant	3-7
2. Ozone Concentration Patterns	3-11
D. CONCENTRATIONS OF PEROXYACETYL NITRATE IN THE URBAN ATMOSPHERE	3-11
E. METEOROLOGICAL FACTORS	3-14
1. General Discussion	3-14
2. Transport	3-15
3. Monitoring Station Location	3-17
F. SUMMARY	3-17
G. REFERENCES	3-18
CHAPTER 4. NATURAL SOURCES OF OZONE	4-1
A. INTRODUCTION	4-1
B. NATURAL SOURCES OF OZONE	4-1
C. OZONE TRANSFER	4-1
D. SUMMARY	4-3
E. REFERENCES	4-4
CHAPTER 5. MEASUREMENT OF OXIDANTS, OZONE, AND PEROX- YACETYL NITRATE IN AMBIENT AIR	5-1
A. INTRODUCTION	5-1
B. REFERENCE METHOD FOR MEASUREMENT OF TOTAL OX- IDANTS	5-1
C. METHODS FOR MEASUREMENT OF TOTAL OXIDANTS	5-2
1. Continuous Methods Utilizing Potassium Iodide	5-2
a. Colorimetric	5-2
b. Coulometric	5-3
c. Colorimetric versus Coulometric Methods	5-3
2. Other Methods—Intermittent Sampling	5-5
a. Ferrous Ammonium Sulfate	5-5
b. Alkaline Potassium Iodide	5-5
c. Phenolphthalin	5-5
D. METHODS SPECIFICALLY FOR MEASUREMENT OF OZONE ...	5-5
1. Chemiluminescence	5-5
2. Ultraviolet Photometry	5-6
3. Trans-butene-2 Gas Phase Titration	5-6
4. Rubber Cracking	5-6
5. Other Chemical Methods	5-6
E. METHODS FOR DETERMINATION OF PEROXYACETYL NI- TRATE	5-6
1. Long-Path Infrared Spectroscopy	5-6
2. Gas Chromatography	5-7

<i>Chapter</i>	<i>Page</i>
F. SUMMARY	5-7
G. REFERENCES	5-7
CHAPTER 6. EFFECTS OF PHOTOCHEMICAL OXIDANTS ON VEGETATION AND CERTAIN MICROORGANISMS	6-1
A. INTRODUCTION	6-1
B. SYMPTOMS OF THE EFFECTS OF PHOTOCHEMICAL AIR POLLUTANTS ON VEGETATION	6-2
C. FACTORS AFFECTING RESPONSE OF VEGETATION TO PHOTOCHEMICAL AIR POLLUTANTS	6-3
1. Genetic Factors	6-3
2. Environmental Factors	6-4
3. Other Factors	6-5
4. Discussion	6-6
D. PROBLEMS IN DIAGNOSIS AND ASSESSMENT OF THE ECONOMIC IMPACT OF PHOTOCHEMICAL AIR POLLUTION ON VEGETATION	6-6
E. DOSE-INJURY RELATIONSHIPS OF PHOTOCHEMICAL AIR POLLUTION AND VEGETATION	6-7
F. EFFECTS OF PHOTOCHEMICAL OXIDANTS ON MICROORGANISMS	6-12
G. EFFECTS OF OZONE ON MICROORGANISMS	6-12
H. SUMMARY	6-18
I. REFERENCES	6-20
CHAPTER 7. THE EFFECT OF OZONE ON MATERIALS	7-1
A. INTRODUCTION	7-1
B. MECHANISMS OF OZONE ATTACK	7-1
C. THE EFFECT OF OZONE ON RUBBER	7-1
D. THE EFFECT OF OZONE ON FABRICS AND DYES	7-4
1. Damage to Textile Fabrics	7-4
2. Fading of Dyes	7-4
E. THE NEED FOR FUTURE RESEARCH	7-6
F. SUMMARY	7-6
G. REFERENCES	7-7
CHAPTER 8. TOXICOLOGICAL APPRAISAL OF PHOTOCHEMICAL OXIDANTS	8-1
A. INTRODUCTION	8-1
B. OZONE	8-1
1. Animal Data	8-1
a. Acute Toxicity	8-1
b. Effects of Prolonged Exposure to Ozone	8-10
c. Interaction with Other Agents	8-12
d. Mechanisms of Ozone Toxicity in Animals	8-15
e. Summary	8-16

<i>Chapter</i>	<i>Page</i>
2. Human Data	8-18
a. Occupational Exposures to Ozone	8-18
b. Human Experimentation	8-19
c. Summary of Human Exposure to Ozone	8-24
C. OXIDANTS	8-25
1. Animal Data	8-25
a. Direct Effects of Photochemical Oxidants	8-25
b. Indirect Effects of Photochemical Oxidants	8-33
c. Summary	8-34
D. PEROXYACYL NITRATES	8-35
1. Animal Data	8-35
Lethality	8-35
2. Human Data	8-35
Effects on Pulmonary Function	8-35
3. Discussion	8-35
E. SENSORY IRRITATION	8-35
1. Animal Data	8-35
Effects of Air Pollutants on the Eye	8-35
2. Human Data	8-38
a. Olfactory Effects	8-38
b. Experimental Studies of Eye Irritation	8-38
3. Discussion	8-39
F. SUMMARY	8-40
G. REFERENCES	8-42
CHAPTER 9. EPIDEMIOLOGICAL APPRAISAL OF PHOTOCHEMICAL OXIDANTS	9-1
A. INTRODUCTION	9-1
B. ACUTE EFFECTS OF PHOTOCHEMICAL OXIDANTS	9-1
1. Daily Mortality in Relation to Variations in Oxidant Levels	9-1
a. Mortality Among Residents Age 65 Years and Older	9-1
b. Mortality and Heat Waves	9-1
c. Mortality of Nursing Home Residents	9-4
d. Two-Community Study	9-4
e. Mortality from Cardiac and Respiratory Diseases	9-5
f. Discussion	9-6
2. Hospital Admissions in Relation to Oxidant Levels	9-7
a. Los Angeles County Hospital Admissions, 1954	9-7
b. Hospital Admissions in the Los Angeles Metropolitan Area	9-7
c. Discussion	9-8
3. Aggravation of Respiratory Diseases by Oxidant Pollution	9-8
a. Aggravation of Asthma	9-8
b. Aggravation of Emphysema and Chronic Bronchitis	9-8
c. Discussion	9-12
4. Impairment of Performance Associated with Oxidant Pollution	9-12
a. Athletic Performance	9-12
b. Automobile Accidents	9-13
c. Ventilatory Performance	9-13

<i>Chapter</i>	<i>Page</i>
d. Discussion	9-14
5. Eye Irritation in Relation to Variations in Oxidant Levels	9-14
a. Panel Studies	9-14
b. Student Nurse Study	9-16
c. Evaluation of Filters for Removing Eye Irritants from Polluted Air	9-16
d. Photochemical Oxidant and Eye Irritation in Locations Other Than California	9-18
e. Discussion	9-19
C. CHRONIC EFFECTS OF PHOTOCHEMICAL OXIDANTS	9-20
1. Mortality in Areas of High and Low Oxidant Pollution	9-21
a. Lung Cancer Mortality	9-21
b. Chronic Respiratory Disease Mortality	9-22
c. Discussion	9-23
2. General Morbidity in Areas of High and Low Oxidant Pollution	9-23
a. State of California Health Survey	9-23
b. Chronic Respiratory Disease Survey of Telephone Workers ...	9-26
c. Discussion	9-27
3. Effects of Photochemical Oxidant Pollution on Community Satisfaction	9-27
a. State of California General Health Survey	9-27
b. Survey of Los Angeles Physicians	9-29
c. Discussion	9-30
D. SUMMARY	9-30
1. Review of Results from Cited Studies	9-30
2. Future Research Needs	9-31
3. Discussion	9-32
E. REFERENCES	9-32
CHAPTER 10. SUMMARY AND CONCLUSIONS	10-1
A. INTRODUCTION	10-1
B. NATURE OF PHOTOCHEMICAL OXIDANTS	10-1
C. ATMOSPHERIC PHOTOCHEMICAL OXIDANT CONCENTRA- TIONS	10-1
D. NATURAL SOURCES OF OZONE	10-2
E. MEASUREMENT OF PHOTOCHEMICAL OXIDANTS	10-2
F. EFFECTS OF PHOTOCHEMICAL OXIDANTS ON VEGETATION AND MICROORGANISMS	10-3
G. EFFECT OF OZONE ON MATERIALS	10-4
H. TOXICOLOGICAL STUDIES OF PHOTOCHEMICAL OXIDANTS	10-5
1. Effects of Ozone in Animals	10-5
2. Effects of Ozone in Humans	10-5
3. Effects of Peroxyacetyl Nitrate	10-6
4. Effects of Mixtures Containing Photochemical Oxidants on Animals	10-6
5. Effects of Mixtures Containing Photochemical Oxidants on Humans	10-7

<i>Chapter</i>	<i>Page</i>
I. EPIDEMIOLOGICAL STUDIES OF PHOTOCHEMICAL OXIDANTS	10-7
J. AREAS FOR FUTURE RESEARCH	10-8
1. Environmental Aspects of Photochemical Oxidants	10-8
2. Toxicity of Ozone, Photochemical Oxidants, and Peroxyacyl Nitrates	10-8
3. Epidemiology of Photochemical Oxidants	10-9
K. CONCLUSIONS	10-9
1. Human Exposure	10-9
a. Ozone	10-9
b. Oxidants	10-10
2. Other Exposures	10-10
a. Photochemical Oxidants	10-10
b. Ozone Effects on Susceptible Materials	10-10
L. RESUME	10-10
APPENDIX. CONVERSION BETWEEN VOLUME AND MASS UNITS OF CONCENTRATION	A-1
SUBJECT INDEX	I-1