Environmental Health Criteria 7

PHOTOCHEMICAL OXIDANTS

World Health Organization

INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

ENVIRONMENTAL HEALTH CRITERIA 7

PHOTOCHEMICAL OXIDANTS

This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of either the World Health Organization or the United Nations Environment Programme.

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NOTE TO READERS OF THE CRITERIA DOCUMENTS

While every effort has been made to present information in the criteria documents as accurately as possible without unduly delaying their publication, mistakes might have occurred and are likely to occur in the future. In the interest of all users of the environmental health criteria documents, readers are kindly requested to communicate any errors found to the Division of Environmental Health, World Health Organization, Geneva, Switzerland, in order that they may be included in corrigenda which will appear in subsequent volumes.

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In addition, experts in any particular field dealt with in the criteria documents are kindly requested to make available to the WHO Secretariat any important published information that may have inadvertently been omitted and which may change the evaluation of health risks from exposure to the environmental agent under examination, so that the information may be considered in the event of updating and re-evaluating the conclusions contained in the criteria documents.

WHO TASK GROUP ON ENVIRONMENTAL HEALTH CRITERIA FOR PHOTOCHEMICAL OXIDANTS

Tokyo, 30 August-3 September 1976

Participants

Members

Dr K. Biersteker, Medical Research Division, Municipal Health Department, Rotterdam, Netherlands *(Chairman)*

Professor K. A. Bustueva, Department of Community Hygiene, Central Institute for Advanced Medical Training, Moscow, USSR *(Vice-Chairman)*

Dr R. G. Derwent, Environmental and Medical Sciences Division, Atomic Energy Research Establishment, Harwell, England *(Rapporteur)*

Dr D. E. Gardner, Biomedical Research Branch, Clinical Studies Division, Health Effects Research Laboratory, Environmental Protection Agency, Research Triangle Park, NC, USA

Dr J. Jager, Centre of General and Environmental Hygiene, Institute of Hygiene and Epidemiology, Prague, Czechoslovakia

Dr G. von Nieding, Laboratory for Respiration and Circulation, Bethanien Hospital, Moers, Federal Republic of Germany

Mr E. A. Schuck, US Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, NV, USA

Professor N. Yamaki, Faculty of Engineering, Saitama University, Saitama, Japan

Observers

Dr J. Kagawa, Department of Medicine, Tokai University, Kanagawa, Japan

Professor K. Maeda, Department of Medicine, Tokyo University, Tokyo,

Japan

Dr T. Nakajima, Division of Environmental Health Research, Osaka Prefectural Institute of Public Health, Osaka, Japan

Dr T. Okita, Department of Community Environmental Sciences, The Institute of Public Health, Tokyo, Japan

Dr H. Watanabe, Hyogo Prefectural Institute of Public Health, Kobe, Japan

Dr N. Yamate, First Section of Environmental Chemistry, National Institute of Hygienic Sciences, Tokyo, Japan

Secretariat

Dr G. Freeman, Department of Medical Sciences, Stanford Research Institute, Menlo Park, CA, USA *(Temporary Adviser)*

Dr Y. Hasegawa, Medical Officer, Control of Environmental Pollution and Hazards, World Health Organization, Geneva, Switzerland *(Secretary)*

Mr G. Ozolins, Scientist, Control of Environmental Pollution and Hazards, World Health Organization, Geneva, Switzerland

Professor C. M. Shy, Institute for Environmental Studies and Department of Epidemiology, School of Public Health, University of North Carolina, Chapel Hill, NC, USA *(Temporary Adviser)*

Dr T. Suzuki, The Institute of Public Health, Tokyo, Japan *(Temporary Adviser)*

Professor T. Toyama, Department of Preventive Medicine, Keio University, Tokyo, Japan *(Temporary Adviser)*

ENVIRONMENTAL HEALTH CRITERIA FOR PHOTOCHEMICAL OXIDANTS

A WHO Task Group on Environmental Health Criteria for Photochemical Oxidants met in Tokyo from 30 August to 3 September 1976. Dr Y. Hasegawa, Medical Officer, Control of Environmental Pollution and Hazards, Division of Environmental Health, WHO, opened the meeting on behalf of the Director-General and expressed the appreciation of the Organization to the Government of Japan for acting as host to the meeting. The Task Group reviewed and revised the second draft criteria document and made an evaluation of the health risks from exposure to photochemical oxidants.

The first and second drafts of the criteria document were prepared by Professor Carl M. Shy of the Department of Epidemiology, School of Public Health, University of North Carolina, Chapel Hill, NC, USA, and Dr Donald E. Gardner, Chief, Biomedical Research Branch, Clinical Studies Division, Health Effects Research Laboratory, US Environmental Protection Agency, Research Triangle Park, NC, USA. The comments upon which the second draft was based were received from the national focal points for the WHO Environmental Health Criteria Programme in Bulgaria, Canada, Czechoslovakia, the Federal Republic of Germany, Japan, New Zealand, Poland, Sweden, the USA, and the USSR; and from the Food and Agriculture Organization of the United Nations (FAO), Rome, the World Meteorological Organization (WMO), Geneva, and the International Union of Pure and Applied Chemistry (IUPAC). The collaboration of these national institutions and international organizations is gratefully acknowledged.

The Secretariat also wishes to acknowledge the most valuable collaboration in the final phases of the preparation of this document, of Professor Shy, Dr Gardner, Dr R. G. Derwent of the Environmental and Medical Sciences Division, Atomic Energy Research Establishment, Harwell, England, and Professor K. Schaffner of the Institute of Radiation Chemistry at the Max-Planck-Institute for Carbon Research, Mulheim an der Ruhr, Federal Republic of Germany.

This document is based primarily on original publications listed in the reference section. Much valuable information may also be found in other published criteria documents (US Department of Health, Education and Welfare, 1970; North Atlantic Treaty Organization, 1974; National Academy of Sciences, 1977).

Because biological knowledge concerning many components of photochemical air pollution is limited, the Task Group agreed that a definition of photochemical oxidants should be given early in the criteria document.

Photochemical oxidants can be formed as the result of the sunlight-induced oxidation of precursor pollutants emitted into the atmosphere. These precursor compounds include the oxides of nitrogen and a variety of hydrocarbons with different chemical reactivities with respect to the formation of photochemical oxidants. The principal oxidants are ozone, nitrogen dioxide, and the peroxyacylnitrates. However, until recently, measurement methods specific for each of these oxidants were not available and the most commonly employed methods were affected, to some extent, by interference from other atmospheric pollutants. Thus, when such studies are being considered, it is important to know whether some correction has been made for this interference, particularly in studies related to health effects in man.

Although many other ingredients have been identified in photochemical air pollution, there is little information available at the moment concerning their biological significance, and they have not been referred to in this document. The biological significance of nitrogen dioxide has been reviewed and evaluated in another WHO environmental health criteria document (World Health Organization, 1977).

Details of the WHO Environmental Health Criteria Programme including some terms frequently used in the documents may be found in the general introduction to the Environmental Health Criteria Programme published together with the environmental health criteria document on mercury (Environmental Health Criteria 1--Mercury, Geneva, World Health Organization, 1976).[a]

The following conversion factors have been used in the present document[b]:

carbon monoxide (CO)	1 ppm = 1150 µg/m^3
nitric oxide (NO)	1 ppm = 1230 µg/m^3
nitrogen dioxide (NO_2)	1 ppm = 1880 µg/m^3
nitrous oxide (N_2O)	1 ppm = 1800 µg/m^3
ozone (O_3)	1 ppm = 2000 µg/m^3
peroxyacetylnitrate (PAN)	1 ppm = 5000 µg/m^3
sulfur dioxide (SO_2)	1 ppm = 2600 µg/m^3

[a] Reprints available from the Division of Environmental Health, World Health Organization, 1211 Geneva 27, Switzerland.

[b] When converting values expressed in ppm to μg/m^3, the numbers have been rounded up to 2 or, exceptionally 3 significant figures and, in most cases, concentrations higher than 10 000 μg/m^3, have been expressed in mg/m^3.

1. SUMMARY AND RECOMMENDATIONS FOR FURTHER RESEARCH AND OTHER ACTION

1.1 Summary

1.1.1 Chemistry and analytical methods

In the context of this report, photochemical oxidants are understood to include ozone, nitrogen dioxide, and peroxyacylnitrates. Many other compounds have been proposed as components of photochemical air pollution but, as little information is available concerning their biological significance, these substances have not been discussed in this document. As nitrogen dioxide is an important air pollutant in its own right, it is the subject of a separate document (World Health Organization, 1977). Thus this report deals mainly with ozone and "oxidants" as measured by the neutral buffered potassium iodide method (NBKI).

Ozone and peroxyacylnitrates can be measured specifically by chemiluminescent reactions and by gas chromatography in conjunction with electron-capture detectors. These methods are highly sensitive and are not subject to interference from other atmospheric pollutants. To obtain the most reproducible data, sampling manifolds should be made entirely of teflon or glass as oxidants in the inlet stream may react with plastics or metal.

The terms "oxidant" or "total oxidant" are used to describe the oxidizing property of sampled air as determined by its reaction with neutral phosphate-buffered potassium iodide. Nitrogen dioxide in sampled air enhances the reaction with potassium iodide, while sulfur dioxide inhibits it. The terms "corrected oxidant" or "adjusted oxidant" indicate that measurements have been corrected for the presence of nitrogen dioxide and sulfur dioxide. Interference from these substances is not entirely eliminated by the current systems used for removing them from the inlet stream. The accuracy of the analytical procedure for oxidant measurements also depends on the pH of the buffer solution, reagent concentrations, and other variables.

1.1.2 Sources of photochemical oxidants and their precursors

Ozone, a natural constituent of the stratosphere formed by the photolysis of molecular oxygen, can be transported by atmospheric