

Chapter 1

Introduction

Human beings need a regular supply of food and water and an essentially continuous supply of air. The requirements for air and water are relatively constant (10–20 m³ and 1–2 litres per day, respectively). That all people should have free access to air and water of acceptable quality is a fundamental human right. Recognizing the need of humans for clean air, in 1987 the WHO Regional Office for Europe published *Air quality guidelines for Europe* (1), containing health risk assessments of 28 chemical air contaminants.

These guidelines can be seen as a contribution to target 10 of HEALTH21, the health for all policy framework for the WHO European Region as formulated in 1999 (2). This target states that by the year 2015, people in the Region should live in a safer physical environment, with exposure to contaminants hazardous to health at levels not exceeding internationally agreed standards. The achievement of this target will require the introduction of effective legislative, administrative and technical measures for the surveillance and control of both outdoor and indoor air pollution, in order to comply with criteria to safeguard human health. Unfortunately, this ambitious objective is not likely to be met in the next few years in many areas of Europe. Improvement in epidemiological research over the 1990s and greater sensitivity of the present studies have revealed that people's health may be affected by exposures to much lower levels of some common air pollutants than believed even a few years ago. While the no-risk situation is not likely to be achieved, a minimization of the risk should be the objective of air quality management, and this is probably a major conceptual development of the last few years.

Various chemicals are emitted into the air from both natural and man-made (anthropogenic) sources. The quantities may range from hundreds to millions of tonnes annually. Natural air pollution stems from various biotic and abiotic sources such as plants, radiological decomposition, forest fires, volcanoes and other geothermal sources, and emissions from land and water. These result in a natural background concentration that varies according to local sources or specific weather conditions. Anthropogenic air pollution has existed at least since people learned to use fire, but it has increased rapidly since industrialization began. The increase in air pollution resulting from the expanding use of fossil energy sources and the growth in the manufacture and use of chemicals has been accompanied by mounting public awareness of and concern about its detrimental effects on health and the environment. Moreover, knowledge of the nature, quantity, physicochemical behaviour and effects of air pollutants has greatly increased in recent years. Nevertheless, more needs to be known. Certain aspects of the health effects of air pollutants require further assessment; these include newer scientific areas such as developmental toxicity. The proposed guideline values will undoubtedly be changed as future studies lead to new information.

The impact of air pollution is broad. In humans, the pulmonary deposition and absorption of inhaled chemicals can have direct consequences for health. Nevertheless, public health can also be indirectly affected by deposition of air pollutants in environmental media and uptake by plants and animals, resulting in chemicals entering the food chain or being present in drinking-water and thereby constituting additional sources of human exposure. Furthermore, the direct effects of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including their self-regulation ability, thereby affecting the quality of life.

In recent decades, major efforts have been made to reduce air pollution in the European Region. The emission of the main air pollutants has declined significantly. The most pronounced effect is observed for sulfur dioxide: its total emission was reduced by about 50% in the period 1980–1995. Reduction of emission of nitrogen oxides was smaller and was observed only after 1990: total emission declined by about 15% in the period from 1990 to 1995 (3). The reduction of sulfur dioxide emission is reflected by declining concentrations in ambient air in urban areas. Trends in concentrations of other pollutants in urban air, such as nitrogen dioxide or particulate matter, are less clear and it is envisaged that these pollutants still constitute a risk to human health (4).

Many countries of the European Region encounter similar air pollution problems, partly because pollution sources are similar, and in any case air pollution does not respect national frontiers. The subject of the transboundary long-range transport of air pollution has received increasing attention in Europe over the last decade. International efforts to combat emissions are undertaken, for instance within the framework of the Convention on Long-range Transboundary Air Pollution established by the United Nations Economic Commission for Europe (5, 6).

The task of reducing levels of exposure to air pollutants is a complex one. It begins with an analysis to determine which chemicals are present in the air, at what levels, and whether likely levels of exposure are hazardous to human health and the environment. It must then be decided whether an unacceptable risk is present. When a problem is identified, mitigation strategies should be developed and implemented so as to prevent excessive risk to public health in the most efficient and cost-effective way.

Analyses of air pollution problems are exceedingly complicated. Some are national in scope (such as the definition of actual levels of exposure of the population, the determination of acceptable risk, and the identification of the most efficient control strategies), while others are of a more basic character and are applicable in all countries (such as analysis of the relationships between chemical exposure levels, and doses and their effects). The latter form the basis of these guidelines.

The most direct and important source of air pollution affecting the health of many people is tobacco smoke. Even those who do not smoke may inhale the smoke produced by others (“passive smoking”). Indoor pollution in general and occupational exposure in particular also contribute substantially to overall human exposure: indoor concentrations of nitrogen dioxide, carbon monoxide, respirable particles, formaldehyde and radon are often higher than outdoor concentrations (7).

Outdoor air pollution can originate from a single point source, which may affect only a relatively small area. More often, outdoor air pollution is caused by a mixture of pollutants from a variety of diffuse sources, such as traffic and heating, and from point sources. Finally, in addition to those emitted by local sources, pollutants transported over medium and long distances contribute further to the overall level of air pollution.

The relative contribution of emission sources to human exposure to air pollution may vary according to regional and lifestyle factors. Although, as far as some pollutants are concerned, indoor air pollution will be of greater importance than outdoor pollution, this does not diminish the importance of outdoor pollution. In terms of the amounts of substances released,

the latter is far more important and may have deleterious effects on animals, plants and materials as well as adverse effects on human health. Pollutants produced outdoors may penetrate into the indoor environment and may affect human health by exposure both indoors and outdoors.

Nature of the guidelines

The primary aim of these guidelines is to provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and wellbeing. In the present context, guidelines are not restricted to a numerical value below which exposure for a given period of time does not constitute a significant health risk; they also include any kind of recommendation or guidance in the relevant field.

The guidelines are intended to provide background information and guidance to governments in making risk management decisions, particularly in setting standards, but their use is not restricted to this. They also provide information for all who deal with air pollution. The guidelines may be used in planning processes and various kinds of management decisions at community or regional level.

When guideline values are indicated, this does not necessarily mean that they should be used as the starting point for producing general countrywide standards, monitored by a comprehensive network of control stations. In the case of some pollutants, guideline values may be of use mainly for carrying out local control measures around point sources. To aid in this process, information on major sources of pollutants has been provided.

It should be emphasized that when numerical air quality guideline values are given, these values are not standards in themselves. Before transforming them into legally binding standards, the guideline values must be considered in the context of prevailing exposure levels, technical feasibility, source control measures, abatement strategies, and social, economic and cultural conditions (see Chapter 4). In certain circumstances there may be valid reasons to pursue policies that will result in pollutant concentrations above or below the guideline values.

Although these guidelines are considered to protect human health, they are by no means a “green light” for pollution. It should be stressed that attempts should be made to keep air pollution levels as low as practically achievable.

Ambient air pollutants can cause a range of significant effects that require attention: irritation, odour annoyance, and acute and long-term toxic effects. Numerical air quality guidelines either indicate levels combined with exposure times at which no adverse effect is expected in terms of noncarcinogenic endpoints, or they provide an estimate of lifetime cancer risk arising from those substances that are proven human carcinogens or carcinogens with at least limited evidence of human carcinogenicity. It should be noted that the risk estimates for carcinogens do not indicate a safe level, but they are presented so that the carcinogenic potencies of different carcinogens can be compared and an assessment of overall risk made.

It is believed that inhalation of an air pollutant in concentrations and for exposure times below a guideline value will not have adverse effects on health and, in the case of odorous compounds, will not create a nuisance of indirect health significance. This is in line with the definition of health: a state of complete physical, mental and social wellbeing and not merely

the absence of disease or infirmity (8). Nevertheless, compliance with recommendations regarding guideline values does not guarantee the absolute exclusion of effects at levels below such values. For example, highly sensitive groups such as those impaired by concurrent disease or other physiological limitations may be affected at or near concentrations referred to in the guideline values. Health effects at or below guideline values may also result from combined exposure to various chemicals or from exposure to the same chemical by multiple routes.

It is important to note that guidelines have been established for single chemicals. Mixtures of chemicals can have additive, synergistic or antagonistic effects. In general, our knowledge of these interactions is rudimentary. One exception can be found in a WHO publication on summer and winter smog (9), which deals with commonly recurring mixtures of air pollutants.

In preparing this second edition of the guidelines, emphasis has been placed on providing data on the exposure–response relationships of the pollutants considered. It is expected that this will provide a basis for estimating the risk to health posed by monitored concentrations of these pollutants.

Although health effects were the major consideration in establishing the guidelines, evidence of the effects of pollutants on terrestrial vegetation was also considered and guideline values were recommended for a few substances (see Part III). These ecological guidelines have been established because, in the long term, only a healthy total environment can guarantee human health and wellbeing. Ecological effects on life-forms other than humans and plants have not been discussed since they are outside the scope of this book.

The guidelines do not differentiate between indoor and outdoor exposure (with the exception of exposure to mercury) because, although the sites of exposure influence the type and concentration of air pollutants, they do not directly affect the basic exposure–effect relationships. Occupational exposure has been considered in the evaluation process, but it was not a main focus of attention as these guidelines relate to the general population. However, it should be noted that occupational exposure may add to the effects of environmental exposure. The guidelines do not apply to very high short-term concentrations that may result from accidents or natural disasters.

The health effects of tobacco smoking have not been assessed here, the carcinogenic effects of smoking having already been evaluated by IARC in 1986 (10). Neither have the effects of air pollutants on climate been considered, since too many uncertainties remain to allow a satisfactory evaluation of possible adverse health and environmental effects. Possible changes of climate, however, should be investigated very seriously by the appropriate bodies because their overall consequences, for example the “greenhouse effect”, may go beyond direct adverse effects on human health or ecosystems.

Procedures used in the updating and revision process

The first step in the process of updating and revising the guidelines was the selection of pollutants. Air pollutants of special environmental and health significance to countries of the European Region were identified and selected by a WHO planning group in 1993 (11) on the basis of the following criteria:

- (a) whether substances or mixtures posed a widespread problem in terms of sources;

- (b) the ubiquity and abundance of the pollutants where the potential for exposure was large, taking account of both outdoor and indoor exposure;
- (c) whether significant new information on health effects had become available since the publication of the first edition of the guidelines;
- (d) the feasibility of monitoring;
- (e) whether significant non-health (e.g. ecotoxic) effects could occur; and
- (f) whether a positive trend in ambient levels was evident.

During the deliberations of the planning group, compounds that had not been dealt with in the first edition of the guidelines were also considered, including butadiene, fluoride, compounds associated with global warming and with alterations in global air pollution (and possibly with secondary health effects), and compounds associated with the development of alternative fuels and new fuel additives. Other factors affecting selection included the timetable of the project, and the fact that only those substances for which sufficient documentation was available could be considered.

The existence of relevant WHO Environmental Health Criteria documents was of great value in this respect. On the basis of these considerations, the following 35 pollutants were selected to be included in this second edition of the guidelines:

Organic air pollutants

Acrylonitrile¹
Benzene
Butadiene
Carbon disulfide¹
Carbon monoxide
1,2-Dichloroethane¹
Dichloromethane
Formaldehyde
Polycyclic aromatic hydrocarbons (PAHs)
Polychlorinated biphenyls (PCBs)
Polychlorinated dibenzodioxins and dibenzofurans (PCDDs/PCDFs)
Styrene
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl chloride¹

Indoor air pollutants

Environmental tobacco smoke
Man-made vitreous fibres
Radon

Inorganic air pollutants

Arsenic
Asbestos¹
Cadmium
Chromium
Fluoride
Hydrogen sulfide¹
Lead
Manganese
Mercury
Nickel
Platinum
Vanadium¹

Classical air pollutants

Nitrogen dioxide
Ozone and other photochemical oxidants
Particulate matter
Sulfur dioxide

¹ 1987 evaluation retained, not re-evaluated.

In addition to the 35 pollutants listed above, this second edition expands on the ecological effects presented in the first edition in an enlarged section examining the ecotoxic effects of sulfur dioxide (including sulfur and total acid deposition), nitrogen dioxide (and other nitrogen compounds, including ammonia) and ozone.

To carry out the evaluation process, the planning group established a number of working groups on:

- methodology and format
- ecotoxic effects
- classical air pollutants
- inorganic air pollutants
- certain indoor air pollutants
- polychlorinated biphenyls, dioxins and furans
- volatile organic pollutants.

The dates of the meetings of these working groups and the membership are listed in Annex I.

Before the meeting of each working group, scientific background documents providing in-depth reviews of each pollutant were prepared as a basis for discussion. Guidelines were established on the basis of these discussions. After each meeting, a text on each pollutant or pollutant group was drafted on the basis of the amended background documents, incorporating the working group's conclusions and recommendations. The draft report of the working group was then circulated to all participants for their comments and corrections. A final consultation group was then convened to critically review the documents for clarity of presentation, adequacy of description of the rationale supporting each guideline and consistency in the application of criteria, and with a view to possibly considering newly emerged information. The process concluded with a review of the recommendations and conclusions of all the working groups.

It was appreciated, during preparation of this second edition, that the wider range of pollutants being considered and the considerably expanded database available for some pollutants would lead to a significant lengthening of the text. It was therefore decided to limit the published edition of the guidelines (WHO Regional Publications, European Series, No. 91) to summaries of the evaluation on which the guidelines are based. The full background information and its evaluation will become progressively available on the Regional Office's web site.

As in the first edition, detailed referencing of the relevant literature has been provided with indications of the periods covered by the reviews of individual pollutants. Every effort has been made to ensure that the material provided is as up-to-date as possible, although the extended period of preparation of this second edition has inevitably meant that some sections refer to more recently published material than others.

During the preparation of the second edition, the Directorate-General for Environment, Nuclear Safety and Civil Protection (DGXI) of the European Commission developed a Framework Directive and a number of daughter directives dealing with individual pollutants. It was agreed with the Commission that the final drafts of the revised WHO guideline documents would provide a starting point for discussions by the Commission's working groups aiming at setting legally binding limit values for air quality in the European Union.

References

1. *Air quality guidelines for Europe*. Copenhagen, WHO Regional Office for Europe, 1987 (WHO Regional Publications, European Series, No. 23).

2. *HEALTH21. The health for all policy framework for the WHO European Region.* Copenhagen, WHO Regional Office for Europe, 1999 (European Health for All Series, No. 6).
3. *Europe's environment: the second assessment.* Copenhagen, European Environment Agency, 1998.
4. *Overview of the environment and health in Europe in the 1990s: Third Ministerial Conference on Environment and Health, London, 16–18 June 1999.* Copenhagen, WHO Regional Office for Europe, 1998 (document EUR/ICP/EHCO 02 02 05/6).
5. *Convention on Long-range Transboundary Air Pollution. Strategies and policies for air pollution abatement. 1994 major review.* New York, United Nations, 1995 (ECE/EB.AIR/44).
6. *Convention on Long-range Transboundary Air Pollution. Major review of strategies and policies for air pollution abatement.* New York, United Nations, 1998 (EB.AIR/1998/3, Add.1).
7. WHO EUROPEAN CENTRE FOR ENVIRONMENT AND HEALTH. *Concern for Europe's tomorrow. Health and the environment in the WHO European Region.* Stuttgart, Wissenschaftliche Verlagsgesellschaft, 1995.
8. *Constitution of the World Health Organization.* Geneva, World Health Organization, 1985.
9. *Acute effects on health of smog episodes.* Copenhagen, WHO Regional Office for Europe, 1992 (WHO Regional Publications, European Series, No. 43).
10. *Tobacco smoking.* Lyon, International Agency for Research on Cancer, 1986 (IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Vol. 38).
11. *Update and revision of the air quality guidelines for Europe. Report of a WHO planning meeting.* Copenhagen, WHO Regional Office for Europe, 1994 (document EUR/ICP/CEH 230).