The Update and Revision of the 1987 WHO Air Quality Guidelines
(WHO European Centre for Environment and Health)

Mise à jour et révision des valeurs guides de l'OMS de 1987

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1. Background

The WHO Regional Office for Europe has been involved for many years in the assessment of air pollution and public health. Since the creation of the WHO European Centre for Environment and Health in 1991, the Bilthoven division has been responsible for work on air pollution and health.

In 1987, the WHO Regional Office for Europe published the first set of « Air Quality Guidelines for Europe » covering 28 air pollutants (WHO, 1987) ; these are briefly summarized in Table 1. In 1992, it was agreed that the WHO European Centre for Environment and Health would undertake the update of these 1987 guidelines because enough evidence had become available to change some of the guideline values presently recommended, and to add new guideline values for a number of additional air pollutants.

The updating process itself started in 1993 and is foreseen to continue through 1995/96. For this first update, experts have decided during a first planning meeting to include six additional pollutants and four groups of pollutants. Table 2 lists those pollutants for which an update is envisaged, those for which the levels should be remain the same as in the 1987 publication, and those additional pollutants, or groups of pollutants, for which new guideline values should be set. The update will be carried out by various experts preparing draft chapters, and working groups reviewing these chapters and reaching agreement on the proposed guideline values. The work is done in close cooperation with the International Programme on Chemical Safety (IPCS) and the Commission of the European Union (EU) who is currently in the process of developing a new Air Quality Framework Directive.

It is foreseen to publish the new edition of the « Air Quality Guidelines for Europe » in 1996. This publication may take the format of a loose-leaf binder so that periodic updates of individual sections or new sections covering new pollutants can follow easily thereafter. Altogether, the updating process is foreseen to continue on a regular basis.

2. Work accomplished to date

Up to now, several meetings have been held, experts participating in the review process have been identified, chapter authors have been designated, the different expert groups have been set up, and a preliminary schedule for the entire review process have been drawn up. The following sections summarize the main points of discussion as well as the conclusions and recommendations of the meetings already held, and briefly describe the current status of work.

2.1. First planning meeting

A first planning meeting, attended by seven national and international experts and five WHO experts, took place in January 1993 and laid down the main lines along which the update should proceed. Experts discussed the criteria for inclusion of substances or mixture in the update, the strategies for derivation of guidelines, the modalities of a rolling update, and the format of publication. Also, the list of pollutants presented in Table 2 was agreed upon, and all pollutants were grouped into three priority classes, as also indicated in the table. The

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Table 1
Summary of the 1987 WHO « Air Quality Guidelines for Europe » (AQGs).

Substance	AQG	Averaging Time	Comments
INORGANIC SUBSTANCES (cont.)			
Acrylonitrile	none		carcinogen [1] ; 1 $\mu g/m^3$ presents a 2×10^{-5} lifetime risk
Benzene	none		carcinogen [1] ; 1 $\mu g/m^3$ presents a 4×10^{-6} lifetime risk
Carbon disulfide	100 $\mu g/m^3$	24 hours	
1,2-dichloroethane	0,7 mg/m^3	24 hours	
Dichloromethane	3 mg/m^3	24 hours	
Formaldehyde	100 $\mu g/m^3$	30 minutes	
Polynuclear aromatic hydrocarbons (PAH)	none		carcinogen [1] ; 1 ng/m^3 presents a 9×10^{-5} lifetime risk
Styrene	800 $\mu g/m^3$	24 hours	
Tetrachloroethylene	5 mg/m^3	24 hours	
Toluene	8 mg/m^3	24 hours	
Trichloroethylene	1 mg/m^3	24 hours	
Vinyl chloride	none		carcinogen [1] ; 1 $\mu g/m^3$ presents a 1×10^{-6} lifetime risk
INORGANIC SUBSTANCES			
Arsenic	none		carcinogen [1] ; 1 $\mu g/m^3$ presents a 3×10^{-3} lifetime risk
Asbestos	none		carcinogen [1] ; 1 fiber/m^3 presents a 10^{-6}- 10^{-5} lifetime risk of developing lung cancer, and a 10^{-5}-10^{-4} lifetime risk of developing mesothelioma
Cadmium	1-5 ng/m^3 10-20 ng/m^3	1 year (rural areas) 1 year (urban areas)	
Carbon monoxide	100 mg/m^3 60 mg/m^3 30 mg/m^3 10 mg/m^3	15 minutes 30 minutes 1 hour 8 hours	
Chromium	none		carcinogen [1] ; 1 $\mu g/m^3$ presents a 4×10^{-2} lifetime risk
Hydrogen sulfide	150 $\mu g/m^3$	24 hours	
Lead	0.5-1.0 $\mu g/m^3$	1 year	
Manganese	1 $\mu g/m^3$	1 year	

Substance	AQG	Averaging Time	Comments
INORGANIC SUBSTANCES (cont.)			
Mercury	1 µg/m³	1 year	
Nickel	none		carcinogen [1] ; 1 µg/m³ presents a 4×10^{-4} lifetime risk
Nitrogen dioxide	400 µg/m³ 150 µg/m³	1 hour 24 hours	
	95 µg/m³ 30 µg/m³	4 hours 1 year	to protect the natural environment - " -
Total nitrogen deposition	3 g/m²	1 year	- " -
Ozone & other photochemical oxidants	150-200 µg/m³ 100-120 µg/m³	1 hour 8 hours	
Ozone	200 µg/m³ 65 µg/m³ 60 µg/m³	1 hour 24 hours 100 days (growing season)	to protect the natural environment - " - - " -
Peroxyacetyl nitrate	300 µg/m³ 80 µg/m³	1 hour 8 hours	- " - - " -
Radon	none [≥ 100 Bq/m³]	[1 year]	carcinogen [1] ; 1 Bq/m³ presents a 0.7-2.1 $\times 10^{-4}$ lifetime risk ; [recommended level for remedial action in buildings]
Sulfur dioxide	500 µg/m³ 350 µg/m³	10 minutes 1 hour	
	100 µg/m³ 30 µg/m³	24 hours 1 year	to protect the natural environment - " -
Sulfur dioxide & black smoke	125 µg/m³ 50 µg/m³	24 hours 1 year	
Sulfur dioxide & TSP	120 µg/m³	24 hours	
Vanadium	1 µg/m³	24 hours	

(1) A linear one-hit extrapolation model has been used to calculate the lifetime cancer risks.

individual main conclusions and recommendations from this first planning meeting were as follows :

1. It was agreed that a second edition of the WHO Air Quality Guidelines for Europe should be produced.

2. It was recommended that in the second edition increased emphasis should be placed upon discussion and identification of major sources of pollutants.

3. It was recommended that the introductory chapters of the Air Quality Guidelines be expanded to include discussions of different means of setting standards.

4. It was recommended that defining Air Quality Guidelines should not be a « once only » task and that a regular updating program was needed.

5. It was concluded that the second edition could not easily be produced in precisely the same format as the first edition. The format of publication should allow updating as necessary, e.g. a loose leaf format.

Table 2

Air Pollutants to be Included in the First Revision of the 1987 WHO « Air Quality Guidelines for Europe ».

A. Appropriate updates and revisions will be considered for the following pollutants originally included in the 1987 « Air Quality Guidelines for Europe » (with exception of those substances indicated below which are to be reprinted from the 1987 book) :

Number	Pollutant	Priority class
1	carbon monoxide (CO)	I
2	nitrogen oxides (NO_x)/nitrogen dioxide (NO_2)	I
3	ozone (O_3) & other photochemical oxidants	I
4	sulfur dioxide (SO_2)	I
5	particulate matin (PM)[1]	I
6	lead (Pb)	I
7	cadmium (Cd)	I
8	manganese (Mn)	I
9	mercury (Hg)	I
10	arsenic (As)	I
11	chromium VI (Cr)	I
12	nickel (Ni)	II
13	radon (Rn)	I
14	toluene	I
15	benzene	I
16	styrene	II
17	trichloroethylene	I
18	tetrachloroethylene	II
19	dichloromethane	II
20	formaldehyde (HCHO)	I
21	polyaromatic hydrocarbons (PAH) [1]	I
22	asbestos and other mineral fibers [2]	II
23	vanadium (V) [to be reprinted]	III
24	hydrogen sulfide (H_2S) [to be reprinted]	III
25	carbon disulfide (CS_2) [to be reprinted]	III
26	vinyl chloride [to be reprinted]	III
27	acrylonitrile [to be reprinted]	III
28	1,2-dichloroethane [to be reprinted]	III

B. Appropriate chapters, including unit risk values and/or guideline values, are to be prepared for the following additional air pollutants :

Number	Pollutant	Priority class
29	platinum (Pt)	II
30	1,3-butadiene	II
31	PCDD/F	II
32	polychlorinated biphenyls (PCBs)	II
33	environmental tobacco smoke (ETS)	I
34	fluorides	II

C. In addition to the above, WHO Interactive Groups (coordinated with non-WHO efforts and sponsored, e.g., by CEC, US EPA, the Dutch National Institute of Public Health and Environmental Protection) will be convened to prepare special chapters for inclusion in the updated WHO « Air Quality Guidelines for Europe » regarding the following topics/substances :

Number	Pollutant	Priority class
35	total volatile organic compound (TVOCs) - from indoor air perspective	II
36	pollutants of global concern (e.g., CFCs, HFCs, CO_2, CH_4, etc.) in relationship to direct and indirect health effects	III
37	organic compounds associated with use of emerging fuels/fuel additives (e.g., alcohols, ethers, aldehydes)	II
38	new technology metals, e.g. thallium, gallium etc.	III

(1) The PM evaluation is to include some consideration of the possible need for separate guideline values for diesel, acid aerosols, PAH, and silicates (wind blown dusts).

(2) The asbestos update is to be expanded to also include an evaluation of man-made mineral fibers.

6. It was concluded that the revision should, in the first place focus on Europe and similar areas ; however, it was expected that the Air Quality Guidelines would play a useful role in other areas.

7. It was recommended that working groups be set up to draft the revised version of the Air Quality Guidelines.

8. It was agreed that criteria for inclusion of substances or mixtures of substances should include :

(a) whether a substance or mixture poses a widespread problem in terms of sources,

(b) whether the potential for exposure is large, taking also into account indoor exposure,

(c) whether important new health effects data has become available since the last edition,

(d) whether monitoring is feasible,

(e) whether significant non-health (e.g., ecotoxic) effects could occur.

9. It was recommended that guidance on exposure-effect and exposure-response relationships (and where appropriate dose-effect and dose-response relationships) be provided as far as possible.

10. It was recommended that seven working groups and three interactive groups be established.

11. In each working group working papers would be prepared by experts prior to meetings of the groups.

12. It was recommended that the « Methodology and Format » Working Group should provide guidance to the other Working Groups by writing an appropriate general chapter on :

(a) types of health effects : acute, sub-chronic and chronic ;

(b) threshold and non-threshold effects for carcinogens and non-carcinogens ;

(c) effects at different levels of exposure (and/or dose) and how these should be discussed and illustrated ;

(d) the significance of observed effects of exposure to pollutants, including a discussion on annoyance, adverse and acceptable effects ;

(e) the choice of appropriate averaging times for guidelines in relation to observed exposure-response relationships ;

(f) the realistic estimation of population exposure ;

(g) the need for the incorporation of confidence limits into unit risk estimates ;

(h) recent developments in physiologically-based pharmaco-kinetic/pharmaco-dynamic modeling ;

(i) the value of the pollutants in question as indicators of air quality ;

(j) how to combine risk estimates for predicting effects of mixtures of pollutants and combined exposures.

13. It was recommended that the chapter format used in the 1987 edition be broadly retained.

After this planning meeting, the different Working Groups and Interactive Groups were set up. Table 3 details the responsibilities of these groups, and indicates the list of pollutants to be adressed by each group.

2.2. Meeting of the « Methodology and Format » working group

A first meeting of the « Methodology and Format » Group was arranged and took place in September 1993. This meeting was attended by 12 national and international experts and four WHO experts, who discussed the types of health effects to be addressed, the strategies for derivation of guidelines, the methods of risk assessment, and the explanations needed in the new edition in order to come to a clear and transparent publication from which it is understandable as to how the guideline values were derived. The Working Group came to the following main conclusions and recommendations.

1. It was concluded that the following categories of health effects are worth considering : annoyance, non-carcinogenic effects, carcinogenic effects.

2. It was recommended that the terms « threshold » and « non-threshold » be abandoned and « non-carcinogenic » and « carcinogenic » be used instead.

3. It was concluded that the non-carcinogenic group could be divided into (a) those air pollutants for which significant knowledge exists, and expert judgement and experience could safely be used in establishing a guideline value, and (b) those for which much less knowledge exists, and standard methods and large uncertainty factors may be needed.

4. It was strongly recommended that clear explanations be provided as to how the guideline values have been derived. This was seen as particularly important when complex statistical techniques are being employed.

5. It was recommended that, in preparing chapters dealing with individual pollutants, the relevant chapters of the first edition be taken as a starting point and be amended as necessary.

6. It was recommended that the term « protection factor » be replaced by « uncertainty factor ».

7. It was recommended that guidance regarding the exposure-response relationship for individual pollutants and mixtures be provided as appropriate.

Table 3
Overview of 7 Working Groups and 3 Interactive Groups.

N°	Working Group Title	Major Tasks
WORKING GROUPS :		
I	Methodology and Format	This group is composed of senior experts in the field who would advise on how the following more specialized groups should tackle assignments, and on the format of the second edition of the Air Quality Guidelines. The Groups should especially provide advice on methods of risk assessment.
II	Major or « Traditional » Air Pollutants	This Group may need to be split into : Subgroup IIa to deal with CO, O_3, and NO_x ; and Subgroup IIb to deal with SO_2 and particulates. It was recommended that SO_2 and particulate matter be considered both separately and in combination. The Group will also consider diesel emissions, PAH compounds, acid aerosols and silicates (wind blown dust).
III	Inorganic Air Pollutants	This group will consider Pb, Cr(VI), Cd, Mn, Hg, and As as first priorities, and Ni and Pt as second priorities. The Group will also address fluorides, and whether future contributions should deal with T1, Ga, and other new technology metals. The group will reprint the 1987 account of V, H_2S and CS_2.
IV	Organic Air Pollutants	This group will consider toluene, trichloroethylene, tetrachloroethylene, benzene, and formaldehyde as first priorities, and 1,3 butadiene, dichloromethane, and styrene as second priorities. This group will reprint the 1987 account of acrylonitrile, vinyl chloride and 1,2 dichloroethane.
V	Particular Indoor Air Pollutants	This group will consider Rn, asbestos and other mineral fibres, and ETS.
VI	PCBs and Dioxins	
VII	Ecotoxicity	This group will select from the list of compounds and mixtures defined by the planning group, those for which ecotoxic effects should be evaluated. Particular attention should be paid to (a) direct phytotoxic effects of ozone and other photochemical oxidants, NO_2, SO_2, (b) acid deposition, (c) heavy metals, and (d) persistent organic compounds. The Group will collaborate with groups from the UN ECE.
INTERACTIVE GROUPS :		
VIII	Total Volatile Organic Compounds	This Group will collaborate with a group in the CEC.
IX	Compounds Generated by the Use of Alternative Fuels	The alternative fuels assessed should include alcohols, ethers and aldehydes, especially acetaldehyde and formaldehyde. This group will collaborate with the US EPA.
X	Direct and Indirect Effects of Global Air Pollution	This group will collaborate with the Dutch National Institute of Public Health and Environmental Protection and the US EPA.

8. It was recommended that attention be paid to the importance of differential exposure by various routes.

9. It was recommended that the « unit risk » approach be retained, at least, as a default option.

10. It was recommended that more feel for the imprecision of estimated unit risk be provided, including an assessment of all sources of error and bias and their likely magnitudes.

11. It was concluded that, although it is important to consider the effects of exposure to mixtures of pollutants, this will only be possible for a small number of cases.

12. It was agreed that, in addition to defining guideline values, health consequences of exceedances of these values should be indicated. Based on this information, countries could establish action or alert levels if they wished, as part of their own risk management system.

13. It was recommended that authors of individual chapters explain clearly the basis for decisions regarding averaging times chosen.

14. It was concluded that setting standards depended on risk management strategies and this lay outside the competence of the group. It was further felt that the overwhelming importance of legislative and country-specific factors would make the task of recommending general means of moving from guidelines to standards all but impossible.

15. It was recommended that WHO take steps to better communicate the intended purpose of the Air Quality Guidelines.

Since then, individual chapter authors have been designated and a preliminary schedule for the submission of draft chapters and for proposed review meetings as been drawn up, which is presented in Table 4. Also, individual authors have started to contribute sections to be considered in the general chapters, such as the « Introduction » and « Scope and Purpose ».

3. Future work

Currently authors are busy writing their respective chapters. The first draft chapters are due in early summer of this year and the first review meeting of the Working Group on « Ecotoxicity » will take place in September of this year, closely followed by others.

Once all draft chapters are finalized, all review meetings have been held, and proposals for new guideline values have been agreed upon by experts, a final WHO consultation meeting will be held, involving a larger circle of national and international experts and policy makers. Thereafter, the draft guidelines will be ready for publication.

Acknowledgements

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References

– WHO Regional Office for Europe (1987). *Air Quality Guidelines for Europe.* World Health Organization, Regional Office for Europe, Copenhagen, Denmark.

Table 4
Overview of the Proposed Review Schedule (1).

Working Group Name	« Draft » Chapter Expected	Review Meeting Proposed
Major or « Traditional » Air Pollutants	31.08.1994	11.-14.10.1994
Inorganic Air Pollutants	31.08.1994	24.-28.10.1994
Organic Air Pollutants	not yet decided	fall 1994
Particular Indoor Air Pollutants	31.12.1994	February/March 1995
PCBs and Dioxins	31.12.1994	February/March 1995
Ecotoxicity	30.06.1994	21.-23.09.1994

(1) N.B. These dates may be subject to change dependent on the progress being made with the work.

Table 5
Glossary of Chemical Substances.

Chemical symbol	Name of chemical substance	Chemical symbol	Name of chemical substance
As	Arsenic	NO_x	Oxides of nitrogen
Cd	Cadmium	O_3	Ozone
CO	Carbon monoxide	PAH	Polycyclic aromatic hydrocarbons
Cr (VI)	Hexavalent chromium	Pb	Lead
CS_2	Carbon disulfide	PCB	Polychlorinated biphenyls
ETS	Environmental tobacco smoke	PM	Particulate matter
Ga	Gallium	Pt	Platinum
H_2S	Hydrogen sulfide	Rn	Radon
HCHO	Formaldehyde	SO_2	Sulfur dioxide
Hg	Mercury	T1	Thallium
Mn	Manganese	TVOC	Total volatile organic compounds
Ni	Nickel	V	Vanadium
NO_2	Nitrogen dioxide		