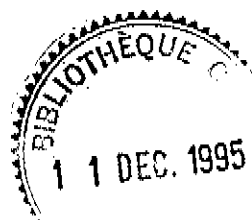




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UPDATING AND REVISION OF THE AIR QUALITY GUIDELINES FOR EUROPE

Report on a WHO Working Group on
PCBs, PCDDs and PCDFs

Maastricht, Netherlands
8-10 May 1995

1995

EUR/HFA targets 19 and 21

TARGET 19

ENVIRONMENTAL HEALTH MANAGEMENT

By the year 2000, there should be effective management systems and resources in all Member States for putting policies on environment and health into practice

TARGET 21

AIR QUALITY

By the year 2000, air quality in all countries should be improved to a point at which recognized air pollutants do not pose a threat to public health.

ABSTRACT

Within the framework of the updating and revision of the *Air Quality Guidelines for Europe*, the Working Group on PCBs, PCDDs and PCDFs met in Maastricht, Netherlands, on 8 - 10 May 1995. The group consisted of nine experts from five countries, as well as WHO staff. Two working papers, one dealing with polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) and the other one dealing with polychlorinated biphenyls (PCBs), were discussed. Although direct inhalation exposure was not a major route of uptake of these compounds, ambient levels may significantly contribute to total human exposure. Efforts to reduce current levels should be continued. A number of recommendations relating both to research and risk assessment and risk management needs were agreed upon.

Keywords

AIR QUALITY
ENVIRONMENTAL EXPOSURE
POLYCHLORINATED BIPHENYLS - adverse effects
POLYCHLORINATED BIPHENYLS - toxicity
DIOXINS - adverse effects
DIOXINS - toxicity
BENZOFURANS - adverse effects
BENZOFURANS - toxicity
(4) EC
(7) IPCS

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Introduction

Since the publication of the *Air Quality Guidelines for Europe* in 1987, new scientific data have been gathered and new developments in risk assessment methodologies have taken place, requiring updating and/or revision of the guidelines. To initiate the updating procedure, which is being conducted in collaboration with the European Commission (EC) and the International Programme on Chemical Safety (IPCS), a planning meeting was held at the Bilthoven Division of the WHO European Centre for Environment and Health (WHO ECEH) from 11 to 13 January 1993. This meeting, which set the framework for the updating and revision process, recommended the setting up of a number of specialized working groups to assess the effects of specific pollutants/groups of pollutants. In September 1993, a Working Group on Methodology and Format met in Bilthoven and developed guidance material for the specialized working groups on issues related to the methods to be applied in the assessment of specific pollutants/groups of pollutants as well as with the format of presentation.

This Working Group recommended that a Working Group on PCBs, PCDDs and PCDFs meet to deal with health aspects of exposure to airborne polychlorinated biphenyls (PCBs), as well as polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Professor Dr Ulf Ahlborg, Institute of Environmental Medicine, Karolinska Institute, Stockholm, prepared the draft chapters dealing with the afore-mentioned compounds.

Based on financial support by the Federal Ministry for the Environment, Nature Protection and Nuclear Safety of the Federal Republic of Germany, the meeting of the working group was held at the Department of Health Risk Analysis and Toxicology, University of Limburg in Maastricht, Netherlands, from 8 to 10 May 1995. The aim of the meeting was to finalize the draft chapters and to derive, by consensus, health-based air quality guideline values for the compounds reviewed. The meeting was attended by nine experts from five countries, as well as by members of IPCS and the WHO ECEH. Dr Erik Dybing was elected Chairman and Dr Ulf G. Ahlborg Rapporteur. Dr Maged Younes was the Scientific Secretary.

PCBs: evaluation of risks to human health

Exposure evaluation

PCB analysis should be performed by congener-specific methods. The method of quantifying total PCBs, by comparing the sample peak pattern with that of a commercial mixture, is accurate only when the sample under investigation has been directly contaminated by a commercial mixture. However, because of substantial differences in PCB patterns between biological samples and technical products, this method leads to errors in quantification of biological samples and also to differences between laboratories due to the use of different standard mixtures.

On the basis of the problems and differences in quantifying total PCBs, data on the levels of PCBs in samples have to be interpreted with great care. Comparisons can only be made between data from either the same laboratory, using the same validated technique and the same standards over a longer period, or between laboratories when very strict inter-laboratory controls have been made. Indications of trends can only be obtained when taking these considerations into account.

Exposure via food and water

Food is the main source of human intake of PCBs while intake through drinking water is negligible.

Total PCB

In a recent estimate of intake of total PCBs in Sweden, 0.05 $\mu\text{g PCB/kg b.w. and day}$ was calculated, with 50% contribution from fish. This is markedly lower than an earlier Finnish estimate of 0.24 $\mu\text{g/kg b.w. and day}$, and might reflect the decreasing trends in PCB levels in Nordic food. In Germany, decreasing intakes of PCBs have also been observed and the present intake is estimated to be somewhat below 1 $\mu\text{g PCB/kg b.w. and day}$.

TEQ

Recent data from the Nordic countries indicate that the average intake of dioxin-like PCBs today may be slightly above 1 $\text{pg TEQ/kg b.w. and day}$. If the contributions of PCDDs and PCDFs (using the NATO/CCMS I-TEFs) are also taken into account, the intake would range between 2 and 6 $\text{pg TEQ/kg b.w. and day}$ for many European countries and the United States. For certain risk groups, such as fishermen from the Baltic sea and Inuits in the Arctic with extremely high intake of contaminated fatty fish, the intake may be up to 4 times higher.

Exposure via air

PCB levels in air have been shown to be higher in indoor air than in ambient air. The inhalation exposure, assuming an indoor air level of 3 ng PCB/m^3 in an uncontaminated building, an inhaled volume of 20 m^3 of air per day for adults, would be approximately 0.001 $\mu\text{g PCB/kg b.w. and day}$. In contaminated buildings, concentrations above 300 ng PCB/m^3 have been found, which corresponds to a dose of at least 0.1 $\mu\text{g PCB/kg b.w. and day}$. In buildings using PCB-containing sealants, levels up to 7500 ng/m^3 have been found (corresponding to a dose of 2.5 $\mu\text{g/kg b.w. and day}$). In ambient air there is a wide variation in the measurements from nonindustrialized (e.g. 0.003 ng/m^3) to industrial/urban areas (e.g. 3 ng/m^3). The levels of dioxin-like PCBs cannot be estimated due to limited congener-specific analytical data.

Health risk evaluation

Total PCB

In 1990, the Joint FAO/WHO Expert Committee on Food Additives concluded that, due to the limitations of the available data, it was impossible to establish a precise numerical value for a tolerable intake of total PCBs for humans. In 1987, IARC concluded that available studies suggested an association between human cancer and exposure to PCBs. Overall, PCBs were classified as probably carcinogenic to humans (group 2A). However, several national governments are employing tolerable daily intakes (TDI) for PCBs for the purpose of risk management; for example, Germany is presently applying a TDI of 1 $\mu\text{g/kg b.w.}$

Neurobehavioural and hormonal effects have been observed in infants exposed to background concentrations of PCBs, prenatally and/or through breastfeeding. However, the clinical significance of these observations is unclear.

The contribution from inhalation exposure will at an average be approximately 1% of the dietary intake but may in certain extreme situations (areas close to sources or contaminated indoor air) approach the dietary intake.

TEQ

Dioxin-like PCBs can be converted to TEQs using the WHO/IPCS interim TEFs and subsequently be assessed using the TDI for TCDD. In 1992, WHO established a tolerable daily intake for TCDD at 10 pg/kg b.w. day. This was based on the TCDD-induced liver cancer in rats for which a NOAEL was 1 ng/kg b.w. and day, corresponding to a liver concentration of 540 ng/kg on a wet weight basis. Due to toxicokinetic differences between humans and rats, this would correspond to a daily intake in humans of 100 pg/kg b.w. and day, to which value an uncertainty factor of 10 to cover interindividual variation was applied. Although not explicitly stated, the TDI can be looked upon as applicable to the total intake of TEQs derived from PCDDs and PCDFs and other dioxin-like compounds that act by the same mechanisms and cause similar types of toxicity.

For the average consumer, the daily intake of dioxin-like PCBs determined as TEQs would range between 10 and 30% of the TDI. When the contribution from PCDDs and PCDFs is taken into account, the intake would increase to between 20 and 60%. However, there are groups with specific dietary habits (e.g. high intake of contaminated food) or occupational exposure that may exceed the TDI for PCDDs and PCDFs.

Based on the recent WHO human milk exposure study, the intake of PCDDs and PCDFs in nursing infants in industrialized countries ranged from about 20 pg TEQ/kg b.w. and day in less industrialized areas up to about 130 pg TEQ/kg b.w. and day in highly industrialized areas. This indicates intakes that are 2 to 13 times higher than the TDI. When the contribution from dioxin-like PCBs is taken into account, the intakes may be up to two times higher. However, WHO noted that this should not be applied to nursing infants because the concept of TDI relates to a dose ingested throughout a lifetime. The quantity of PCDDs and PCDFs ingested over a 6-month breastfeeding period would be less than 5% of the quantity ingested over a lifetime.

Recommended guidelines

WHO has not developed a TDI for total PCB exposure. Due to the multiplicity of mechanisms underlying PCB-induced health effects, there may not be a scientifically sound rationale to set such a TDI. Average ambient air concentrations of PCBs are estimated to be 3 ng/m³ in urban areas, which corresponds to a daily intake of 1 ng/kg b.w. or 1 to 2% of the daily intake from food. Although this air concentration is only a minor contributor to human exposure, it is a major contributor to contamination of the food chain. It would also be possible to perform such calculations using TEQs from dioxin-like PCBs in ambient air. At present no such analytical data have been published.

Although indoor air levels of PCBs generally are very low, in certain instances, levels up to 7.5 µg/m³ have been detected. For people living or working in such buildings, the exposure of PCBs via air could contribute significantly to the overall PCB exposure.

Due to the uncertainties regarding the indirect contribution of PCBs in ambient air to the total human exposure, measures should be undertaken to reduce atmospheric emissions from known sources.

In addition to air emissions, other important sources for the environmental contamination include leakages from electrical equipment, contaminated waste sites and chemical products. However, the relative contribution of these various sources to human exposure, directly or indirectly, is not well characterized. For risk reduction, it is important to control known sources as well as to identify new sources.

PCBs: Recommendations

1. Proper procedures should be used for the disposal of PCBs in closed systems.
2. Intercalibration studies on the analysis of PCBs should be carried out.
3. There is a need for development and validation of models for emission and deposition of PCBs.
4. Studies assessing the utility of indicator PCBs for assessment of total PCB exposure should be initiated.
5. There is a need for the development and validation of specific, sensitive and simple bioassays for screening purposes.
6. Risk assessment models should be developed to determine the health impact of complex environmental mixtures such as PCBs and related compounds.
7. Assessment of human health impact of nondioxin-like PCBs needs to be strengthened.
8. Presently unknown sources of PCBs need to be identified.
9. The quantitative importance of de novo synthesis of PCBs should be established..
10. Congener-specific data for PCB concentrations in air are needed.

PCDDs and PCDFs: Evaluation of risks to human health

Exposure evaluation

Food is the main source of human intake of PCDDs and PCDFs while intake through drinking-water is negligible. Calculated as TEQs, the average intake in European countries has been estimated to range between 1.5 and 2 pg/kg b.w. and day. Recent data from the Nordic countries indicate that this figure today may be slightly less than 1 pg/kg b.w. and day. For the US, intake estimates are in the range of 1 to 3 pg TEQ/kg b.w. and day.

If the contributions of dioxin-like PCBs (using the WHO/IPCS TEFs for PCBs) are also taken into account, the intake would be in the range of 2 to 6 pg TEQ/kg b.w. and day. For certain risk groups, for example, fishermen from the Baltic sea and Inuits in the Arctic, intakes may be considerably higher.

Inhalation exposure to PCDDs and PCDFs is generally low. Assuming an ambient air level of 0.1 pg TEQ/m³ and an inhaled volume of 20 m³ of air per day for adults, inhalation would amount to about 0.03 pg TEQ/kg b.w. and day. However, certain industrial and urban areas as well as areas close to major sources, may have up to 20 times higher air concentrations. The contribution to the total TEQs of dioxin-like PCBs from ambient air cannot be calculated due to lack of congener-specific data.

Under special circumstances, such as indoor air highly contaminated from PCB-containing coated particle boards, the inhalation exposure to PCDDs and PCDFs may be up to 1 pg TEQ/kg b.w. and day.

Although present concentrations of PCDDs and PCDFs in ambient air do not present a health hazard by direct human exposure, these concentrations will lead to deposition of PCDDs and PCDFs followed by uptake through the food chain.

Health risk evaluation

WHO has established a tolerable daily intake for TCDD at 10 pg/kg b.w. day. This was based on TCDD-induced liver cancer in rats for which a NOAEL was 1 ng/kg b.w., corresponding to a liver concentration of 540 ng/kg on a wet weight basis. Due to toxicokinetic differences between humans and rats, this would correspond to a daily intake in humans of 100 pg/kg b.w. to which value an uncertainty factor of 10 to cover interindividual variation was applied. Although not explicitly stated, the TDI can be looked upon as applicable to the total intake of TEQs, both via the oral and inhalation route, derived from PCDDs and PCDFs and other dioxin-like compounds that act by the same mechanisms and cause similar types of toxicity. WHO and IPCS are currently planning a reevaluation in 1996 of the present TDI based on new data.

For the average consumer, the daily intake by all routes of exposure to PCDDs and PCDFs calculated as TEQs would be between 10 and 30% of the current TDI. When the contribution from dioxin-like PCBs is taken into account, the intake would increase to between 20 and 60% of the TDI. However, there are groups with specific dietary habits (e.g. high intake of contaminated food) or occupational exposure that may have exposures in excess of the TDI for PCDDs and PCDFs.

The intake of PCDDs and PCDFs in nursing infants in industrialized countries has been calculated to range from about 20 pg TEQ/kg b.w. and day in less industrialized areas to about 130 pg TEQ/kg b.w. and day in more industrialized areas. This indicates intakes that are 2 to 13 times higher than the TDI. When the contribution from dioxin-like PCBs is taken into account, the intakes may be up to twice these figures. However, WHO has noted that the TDI should not be applied to nursing infants because the concept of TDI relates to a dose ingested throughout a lifetime. The quantity of PCDDs and PCDFs ingested over a 6-month breastfeeding period would be less than 5% of the quantity ingested over a lifetime.

The TEQ contribution from inhalation exposure will at an average be approximately 1% of the dietary intake but may in certain extreme situations (areas close to point emission sources or contaminated indoor air) approach the dietary intake.

Recommended guidelines

Urban ambient air concentrations of PCDDs and PCDFs are estimated to be about 0.1 pg TEQ/m³; however, large variations have been measured. Although such an air concentration is only a minor contributor to human exposure, it is a major contributor to contamination of the food chain. It is difficult, however, to calculate indirect exposure from contamination of food via deposition from ambient air. Mathematical models are being used in the absence of experimental data, but they require validation. Air concentrations of 0.3 pg/m³ or higher are indications of local emission sources that need to be identified and controlled.

Although indoor air levels of PCDDs and PCDFs generally are very low, in certain instances levels up to 3 pg TEQ/m³ have been detected. Such levels will constitute an exposure up to 10% of the current TDI of 10 pg/kg b.w.

Due to the uncertainties regarding the indirect contribution of PCDDs and PCDFs in ambient air to the total human exposure, measures should be undertaken to reduce further emissions to air from known sources. For risk reduction, it is important to control known sources, i.e. both combustion processes and chemicals, as well as to identify new sources.

PCDDs and PCDFs: Recommendations

1. The revaluation of the present TDI for PCDDs and PCDFs, should take into account the importance of species variation in toxicodynamics as well as toxicokinetics.
2. Further knowledge of sources and their relative impact is necessary. There is also a need to develop source-specific emission standards. In addition, environmental recycling should be taken into account. For a reduction of food contamination via air, it is more effective to establish guideline levels based on the deposition of PCDDs and PCDFs than for ambient air concentrations. Models for the calculation of deposition guideline levels and a standardization of measurements need to be developed.
4. More information on historical sources and their importance in relationship to present sources is required.
6. There is a need for standardized protocols for sampling and analytical procedures.
7. There is a need for more knowledge of possible transformation reactions occurring during long-range air transport.
8. The occurrence and the importance of related polyhalogenated hydrocarbons in relation to human health need to be elucidated.
9. Rapid, inexpensive and validated test methods for biological responses should be developed for screening purposes.

*Annex 1***Working papers**

ICP/EHAZ 94.05/MT10/01	List of Working Papers
ICP/EHAZ 94.05/MT10/02	Scope and Purpose
ICP/EHAZ 94.05/MT10/03	Provisional Agenda
ICP/EHAZ 94.05/MT10/04	Provisional Programme
ICP/EHAZ 94.05/MT10/05	Provisional List of Participants
ICP/EHAZ 94.05/MT10/06	Draft chapter on polychlorinated dibenzo-p-dioxins and dibenzofurans, by Dr Ulf G. Ahlborg
ICP/EHAZ 94.05/MT10/07	Draft chapter on polychlorinated biphenyls, by Dr Ulf G. Ahlborg

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