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LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Working Group on Effects
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Item 6 (c) of the provisional agenda

HEALTH RISKS OF HEAVY METALS AND PERSISTENT ORGANIC POLLUTANTS
FROM LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Summary of the preliminary assessment ^{*/}

I. BACKGROUND

1. The Working Group on Effects at its eighteenth session (EB.AIR/WG.1/1999/2, paras. 44 - 48) and the Executive Body for the Convention at its seventeenth session (ECE/EB.AIR/68, paras. 49 - 52) noted the impressive results of the Task Force on the Health Aspects of Air Pollution in assessing possible health risks from particulate matter from long-range transboundary air pollution, and expressed their appreciation to the European Centre for Environment and Health of the World Health Organization (WHO/ECEH) for its important coordinating role. They recommended that future activities of the Task Force should also address the possible health effects of selected heavy metals and persistent organic pollutants, with heavy metals being a short-term priority.

*/ Prepared by the joint Task Force on the Health Aspects of Air Pollution of the World Health Organization/European Centre for Environment and Health (WHO/ECEH) and the Executive Body.

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2. The third meeting of the Task Force on the Health Aspects of Air Pollution was held from 8 to 10 May 2000 in Bilthoven (Netherlands), with the participation of 18 experts representing 12 countries, the European Commission and WHO/Regional Office for Europe. Pursuant to the decision of the Executive Body at its seventeenth session and the approved 2000 work-plan for the implementation of the Convention (ECE/EB.AIR/68, annex IV, section 3.8), the Task Force was requested to provide:

(a) A preliminary assessment of the available information on population exposure to cadmium, lead and mercury, in particular from long-range transport, and of the potential health effects;

(b) A preliminary selection of Apriority@ persistent organic pollutants (POPs) based on the potential health effects of the compounds and on the potential contribution of long-range transport to exposure.

3. The present document summarizes the discussions of the Task Force and its conclusions and recommendations concerning both topics.

II. HEAVY METALS

A. Introduction

4. The Protocol on Heavy Metals, adopted in 1998, aims at reducing emissions of cadmium (Cd), lead (Pb) and mercury (Hg). It describes the measures and best available techniques for controlling emissions from the major sources, and indicates programmes, strategies and policies to achieve the limit values for the heavy metals specified in the Protocol. The objective of the Protocol is to minimize the effects on human health and the environment. However, human health issues have so far been barely addressed in the substantiation of the Protocol.

5. The Task Force on the Health Aspects of Air Pollution was expected to: (i) review the available data on concentrations of cadmium, lead and mercury in air; (ii) assess the relevance of the various routes of human exposure, in particular the contribution of long-range transport of air pollutants; and (iii) evaluate the human health risk of exposure to cadmium, lead and mercury from long-range transport; as a basis for drafting a chapter reviewing the health risks of heavy metals from the long-range transport of air pollution, for a substantive report on the "Occurrence, movement, and effects of selected heavy metals", to be prepared by the Working Group on Effects.

6. The working document on AHealth Risk of Heavy Metals from Long-range Transboundary Air Pollution@, prepared by Mr. M. Jakubowski, a consultant to the ECE secretariat, provided the initial basis for the discussion. The existing reviews performed by the International Programme on Chemical Safety or World Health Organization were used as a basis for health hazard evaluation. Other materials used as sources of information are listed in section C below.

7. The discussions were held in plenary sessions and in two working sub-groups, one

considering the health hazards of the metals, and the other population exposure, and the contribution of long-range transport. The following text summarizes the general conclusions concerning all metals considered, the related follow-up actions, and the specific conclusions concerning each of the pollutants discussed.

B. Conclusions and recommendations

1. General conclusions

8. The Task Force considered dietary intake of each of the three metals to be the principal route of population exposure relevant to long-range transboundary air pollution. Therefore, food contamination by the metals from long-range transport is the main issue of the assessment.

9. The Task Force decided to establish an editorial group to draft the relevant chapter for the substantive report on heavy metals. With regard to the chapter's structure, it was recommended to consider the use of a flow chart of: (i) sources (including long-range transport); (ii) environmental media; (iii) critical foodstuffs; (iv) exposure; and (v) intake by humans; as the outline for the exposure chain. It was also recommended to extend the overview of available knowledge on limit values, e.g. by including the information from the manuals for calculating critical loads.

10. The following plan was agreed for the preparation of the chapter:

(a) WHO/ECEH in collaboration with nominated experts would prepare the initial outline, to be considered and further elaborated at a meeting of the editorial group tentatively planned for September - October 2000;

(b) A draft of the chapter would be circulated to the Task Force for review by the beginning of January 2001; comments should be sent to WHO-ECEH before 1 March 2001;

(c) The final version of the chapter should be available by mid-May 2001.

11. It was recommended to coordinate the preparation of the chapter with Ms. G. Mills, Chairperson of ICP Vegetation, responsible for collating of substantive report.

12. The Task Force agreed to provide WHO/ECEH with all relevant information for the review, in particular on items requiring, in the view of the meeting, better assessment.

2. Lead

13. The target site for lead toxicity is cognitive impairment, associated with blood lead levels (PbB) above 100 µg/l. At present there are insufficient data to verify these effects below 100 µg/l of PbB. The Task Force reaffirmed that children were the most sensitive subgroup of the general population. It also noted the possibility of combined effects with simultaneous exposure to cadmium and/or antagonism in the presence of zinc.

14. Lead may be associated with adverse effects on male reproductive function and on blood pressure in both sexes. However, data are insufficient to confirm these effects at low levels of exposure.

15. Average blood lead levels in Europe are about 20-50 µg/l. Probabilistic models predict that more than 95% of the general population fall below the 100 µg/l level, as recommended by WHO. Available data indicate that the exposure to lead in Europe and North America is declining.

16. In adults the majority of blood lead is derived from food (over 80%), while in children air, water and soil contribute significantly (approximately 40%) to overall exposure. Children may have high exposure from ingestion of soil and dust.

17. Local emissions of Pb to the atmosphere can lead to very high exposure levels in populations living close to emission sources.

18. Long-range transboundary air pollution contributes to the background concentrations of lead in the atmosphere, the deposition on soil and the contamination of food. According to a rough qualitative assessment, the exposure through air and soil leads to exposures well below the level of health concern. The contribution of food and drinking water contaminated by Pb directly or indirectly (through soil) may be more significant. However, the contribution of long-range transboundary air pollution to food contamination is unknown, and needs further assessment.

19. Considering the above facts, Pb exposure seems to be predominantly due to local atmospheric emissions and other local sources. An assessment is required regarding the importance of long-range transboundary air pollution as a source of contamination of soils and (via surface water) of drinking water.

20. An assessment is also required on:

(a) The effects of acidification on the (increased) mobilization of Pb in general, and in private drinking water wells in particular;

(b) The relationship between the content of Pb in soils and (surface) water and the resulting Pb content in food (see also the Manual for calculating critical loads of heavy metals for terrestrial ecosystems; p. 80, table 18);

(c) The most important food categories and the Pb uptake for these categories.

3. Cadmium

21. It is well established that exposure to cadmium adversely affects kidney functions. The margin of safety between the present total daily intake of cadmium and the intake which can result in a slight increase in early signs of kidney dysfunction is very narrow, particularly in smokers.

22. Other endpoints might also be of importance. For example, preliminary data suggest evidence for potential adverse effects on male reproductive function. To perform a comprehensive health impact assessment of cadmium, these data need further consideration.

23. Although the International Agency for Research on Cancer (IARC) categorized cadmium as a human carcinogen, some concern was raised regarding possible confounding exposures, including

arsenic. This may have influenced the outcome of the classification process. Consequently, a quantitative risk estimate of cadmium carcinogenicity cannot be derived.

24. Concern was expressed that the WHO provisional tolerable daily intake (TDI) was set on the basis of a healthy, young population, but a typical population may also include a substantial subset beyond 50 years of age with concurrent disease that may impair kidney function.

25. The Task Force noted the possibility of combined effects with simultaneous exposure to lead and/or antagonism in the presence of zinc.

26. Population exposure levels, as indicated by the Cd concentrations in blood or in renal cortex, have shown a tendency to decrease over recent decades. However, an explanation for this finding has not yet been agreed.

27. Food is the dominant route of population exposure to Cd in non-smokers (tobacco smoking can at least double Cd intake). A limited number of food items are responsible for a large fraction of the total intake. In Sweden, potatoes provide 42%, and wheat a further 41% of Cd intake through food. However, the data on other food items were not available to the Task Force. The available knowledge on the Cd content in current "food baskets" needs to be reflected in the final contribution to the substantive report.

28. The main sources of Cd to arable land are phosphate fertilizers, municipal sewage sludge and industrial emissions. Atmospheric deposition adds a small fraction to the upper levels of soil or to surface water (0.1-0.2% as a rough mean for Europe). The mean addition of Cd from fertilizers to top soils is in the same range as the atmospheric deposition. Substantial parts of the atmospheric input (20 to 75%) come from long-range transboundary air pollution.

29. Cd content in arable land accumulates at an annual rate of 0.1 to 0.2%. If the current inputs remain unchanged, the critical input of Cd to soil can be exceeded in the long term.

30. Further assessment is required on:

(a) Relationships between the soil content of Cd, uptake in indicator plants/receptors and human exposure;

(b) The influence of soil parameters, such as pH, on Cd retention in soil.

31. Representatives from individual countries were requested to identify national information on the relationship between the Cd content in "domestic food baskets" and population exposure to Cd. This would lead to recommendations on the monitoring of key items in the food basket.

4. Mercury

32. The Task Force recognized the two primary targets of exposure to mercury: (i) the

central nervous system (CNS) affected by elemental Hg vapours and methylmercury; and (ii) the kidneys, affected by inorganic mercury compounds. It was noted, however, that CNS effects occurred at lower levels of exposure; hence action levels for total mercury (including methylmercury) would also help protect against kidney effects.

33. Concomitant exposure to selenium and/or zinc may antagonize the effects caused by mercury.

34. Mercury concentrations in hair in the general population indicate that overall exposure levels are below levels of concern. The Hg content in hair is significantly higher in fish consumers, than in non-fish eaters. Hair concentrations of Hg in specific subgroups consuming high amounts of fish and/or marine mammals indicate that they have a high exposure to methylmercury.

35. Hg contents of fish often exceed 0.5 mg/kg, which is the recommended limit in many countries, and sometimes exceed 1.0 mg/kg. These levels can lead to exceedance of TDIs or reference doses (RfDs) established by WHO, the United States Environmental Protection Agency (US/EPA), the United States Agency for Toxic Substances and Disease Registry (ATSDR) and the Federal Environmental Agency of Germany (UBA), particularly for subsistence consumers.

36. Long-range transboundary air pollution is a significant contributor to Hg concentrations in the environment, due to the high mobility of Hg. On a global scale, 50% of Hg deposition is of anthropogenic origin. Therefore, long-range transboundary air pollution may significantly contribute to the Hg intake by fish and, subsequently, to population exposure.

37. Improved assessment is required on:

- (a) The relationship between Hg deposition and the Hg content of fish;
- (b) The important factors determining the fate and cycling of Hg in freshwater and the marine environment. Multiple factors may be involved, e.g. by the increased Hg content of lake-perch/pike in comparison to sea-perch/pike. Long-range transboundary air pollution deposition and acidification were suggested as factors affecting the Hg fate in waters.

C. Bibliography

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III. PERSISTENT ORGANIC POLLUTANTS

A. Introduction

38. Persistent organic pollutants (POPs) are organic compounds of anthropogenic origin which resist photolytic, biological or chemical degradation, leading to bioaccumulation in the food chain. They can be transported over long distances in the atmosphere resulting in widespread distribution across the earth, including regions where they have never been used. Due to their toxic characteristics they pose a threat to humans and the environment. Therefore, the international community has in recent years called for urgent global action to reduce and eliminate the release of POPs.

39. The Protocol on Persistent Organic Pollutants covers aldrin, chlordane, chlordecone, DDT, dieldrin, endrin, heptachlor, hexabromobiphenyl, hexachlorobenzene (HCB), hexachlorocyclohexane (HCH), mirex, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins/furans (PCDDs/ PCDFs), and toxaphene. The Protocol describes the technical measures to eliminate or restrict the production or use of these substances, and it identifies the implementation requirements to achieve that goal.

40. It is the objective of the Protocol to prevent adverse effects on human health and the environment. However, issues related to the health aspects of POPs have not yet been sufficiently addressed. To this end the Task Force on the Health Aspects of Air Pollution was expected to: (i) select priority POPs from those included in the current Protocol for action; and (ii) identify and plan future actions that it could take to address the health effects from the long-range transport of the selected POPs.

41. The AReview of selected persistent organic pollutants^a prepared by Ritter *et al.*, 1995, for the International Programme on Chemical Safety was circulated in advance of the meeting as the basis for the discussion. Other material used during the discussion as a source of information is listed in section C below.

B. Conclusions and recommendations

42. Noting that aldrin , chlordane, chlordecone, dieldrin, endrin, hexabromobiphenyls, mirex and toxaphene should be eliminated following the ratification of the Protocol on Persistent Organic Pollutants, the Task Force considered these compounds of low priority for further evaluation of the health effects from long-range transboundary air pollution.

43. The Task Force also noted the following compounds listed in the Protocol for which additional information would be required within two years after ratification of the Protocol: DDT, HCB, HCHs, heptachlor, terphenyls, pentachlorophenol, ugilec. (For pentachlorophenol no deadline was fixed.)

44. The Task Force identified the following priority compounds with respect to acquiring the additional information including an evaluation of the health effects from long-range transboundary air pollution: (i) pentachlorophenol (PCP); (ii) HCH and DDT; (iii) terphenyls and ugilec (starting with a quick hazard assessment); and (iv) HCB and heptachlor.

45. In the case of PCP, particular attention should be given to the potential effects of anisole, which is formed during atmospheric transformation of PCP.

46. Regarding DDT (in use for malaria control) the Task Force is of the opinion that the compound can be proposed for elimination as soon as alternatives (efficacy and costs) are available. In addition, attention was drawn to the presence of DDT in dicofol.

47. Although γ -HCH (lindane) is the isomer used, β -HCH is the isomer most frequently found. The Task Force recommends that the origin of the presence of β -HCH in the environment, food, etc. needs further attention.

48. In addition to the compounds listed above, the Task Force identified the following POPs as candidates for further evaluation of the health effects from long-range transboundary air pollution:

(a) PCDDs/PCDFs, because of the revised WHO TDI (from 10 to 1-4 pg/kg bw/day);

(b) PCBs. As the toxicity of coplanar PCBs is similar to the toxicity of the PCDDs/PCDFs, they should be included in the sum of the PCDDs/PCDFs, which will result in an increase of exposure to these compounds. In addition, there is recent information on subtle neurobehavioural, hormonal and immunotoxic effects at low doses of non-planar PCBs;

(c) PAHs. The available information on PAHs is based on a huge amount of data on benzo(a)pyrene but limited data on other PAHs. The first action should be a quick hazard assessment and an assessment of the contribution of long-range transboundary air pollution to human exposure to PAHs.

49. In addition to other POPs that might be identified as candidates for future inclusion in the Protocol by the expert group on POPs (first meeting to be held 6-8 November 2000, The Hague), the Task Force identified the following POPs for future evaluation:

- (a) Polybrominated diphenylethers (flame retardants);
- (b) Polybrominated dibenzodioxins and -furans;
- (c) Short-chain chlorinated paraffins.

Because of a lack of information the first action for these three groups of compounds should be a quick hazard assessment.

50. The Task Force also raised a number of general issues which deserve further attention:

(a) Unborn children are considered a (sub)population at particular risk. With respect to POPs, the body burden of pregnant women is usually the result of previous (some decades ago) exposure. Therefore, previous exposure deserves particular attention in exposure assessment;

(b) People in arctic areas and other populations consuming large amounts of fish and/or sea mammals are in general highly exposed to POPs, and should thus be considered as a particular (sub)population at risk;

(c) The risk of concomitant exposure from long-range transport to compounds other than POPs but also exerting developmental effects, such as methylmercury or lead, should be addressed.

C. Bibliography

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