UNITED NATIONS **E**

Economic and Social Council

Distr.
GENERAL

ECE/EB.AIR/WG.5/2007/1
1 February 2007

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

EXECUTIVE BODY FOR THE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Working Group on Strategies and Review

Thirty-ninth session
Geneva, 18–20 April 2007
Item 3 of the provisional agenda

REVIEW OF THE 1999 GOTHENBURG PROTOCOL

Draft report by the secretariat

1. The Executive Body at its twenty-third session initiated the first review of the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone in accordance with article 10 of the Protocol following the Protocol's entry into force in 2005 (ECE/EB.AIR/87, para. 51(b)). It decided that the review should be completed at its twenty-fifth session in 2007 and invited all bodies of the Convention to plan their work to this end. This document outlines the legal requirements for the review (section I) and gives an overview of the various technical elements that might be considered by the Parties in their review. It concludes by suggesting three possible options for action following the review. The text makes reference to documents prepared by Convention bodies and programme centres for the review process, which provide more detailed information should this be needed.

2. The current draft document has been prepared for consideration by the Working Group on Strategies and Review at its thirty-ninth session. The document is expected to be revised and

updated for presentation to the twenty-sixth session of the Working Group on Effects, the thirty-first session of the Steering Body to EMEP[1] and the fortieth session of the Working Group on Strategies and Review in autumn 2007. A final revised text will be presented to the twenty-fifth session of the Executive Body in December 2007.

3. While all subsidiary bodies and programme centres were invited to contribute to the draft text, not all have responded to the secretariat's request for contributions. In places, therefore, this document contains text based on information from other documents or presents an outline of the information required; the secretariat has marked such sections accordingly and requests that the appropriate bodies and programme centres provide the necessary revisions for the next revised version.

4. The deadline for submission of revised text for inclusion in the report to the Working Group on Effects, the Steering Body to EMEP and the Working Group on Strategies and Review is 2 June 2007.

I. LEGAL REQUIREMENTS FOR THE REVIEW

5. Article 10 of the Gothenburg Protocol requires that Parties keep under review the obligations of the Protocol and broadly specifies the modalities of such reviews. Paragraphs 2 (a) and (b) of the article are of importance in determining the content and structure of the review report, while paragraph 2 (c) deals with procedural matters for the review.

6. Paragraph 2 (c) of article 10 stipulates that the procedures, methods and timing for reviews shall be specified by the Parties at a session of the Executive Body. It also requires that the first such review should start no later that one year after the entry into force of the Protocol. In accordance with this requirement, the Executive Body initiated the review at its twenty-third session in December 2005, following the Protocol's entry into force on 17 May 2005. It also indicated the time frame for completion of the review – by its twenty-fifth session in December 2007 – and invited all Convention bodies to plan their work for the review.

[1] Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

7. Paragraph 2 (a) of article 10 specifies the subject of the review. According to its subparagraph (i), the Parties' obligations in relation to their calculated and internationally optimized allocations of emission reductions, referred to in article 7, paragraph 5, should be reviewed. Article 7, paragraph 5 requires Parties to arrange for the preparation of revised information on calculated and internationally optimized allocations of emission reductions for the States within the geographical scope of EMEP, using integrated assessment models, including atmospheric transport models or alternative assessment methods approved by the Executive Body. In other words, the Parties' emission ceilings (specified in annex II of the Protocol) should be reviewed in light of the revised information on calculated and internationally optimized emission reduction allocations.

8. Paragraph 2 (a) (ii) of article 10 requires the review of the adequacy of the obligations and the progress made towards achieving the objective of the Protocol. The relevant obligations to be reviewed here could include those under article 3, paragraph 1 on the achievement of emission ceilings; article 3, paragraphs 2 and 3 on the application of emission limit values to new and existing stationary sources; article 3, paragraph 4 on the evaluation of limit values for new and existing boilers and process heaters (see paragraph 13 below); article 3, paragraph 5 on the application of limit values for fuels and new mobile sources; article 3, paragraph 8 (a) on the application of measures to control ammonia emissions; and article 3, paragraph 7 on the application of measures to products. The results of the in-depth review of the Gothenburg Protocol by the Implementation Committee, scheduled for 2006 and 2007, should provide an assessment of the degree of implementation of most of these articles by the individual Parties to the Protocol.

9. Paragraph 2 (a) (ii) of article 10 also requires the review of progress made towards achieving the objective of the Protocol – that is, to control and reduce emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds caused by anthropogenic activity so as to ensure that, in the long term and in a stepwise approach, and taking into account advances in scientific knowledge, atmospheric depositions or concentrations of these substances do not exceed the critical loads and levels as described in annex I of the Protocol.

10. In view of the above, the review of the Protocol should include the following elements:

(a) A review of the emission ceilings in annex II;

(b) A review of the adequacy of the obligations listed in paragraph 5 above;

(c) A review of the progress towards achieving the objective of the Protocol as set out in article 2.

11. The results of the review should indicate (a) whether, in view of the latest scientific knowledge, the emission ceilings in annex II and the obligations of the Protocol are adequate for achieving the objective of the Protocol; and (b) what progress has been made towards achieving the objective.

12. Paragraph 2 (b) of article 10 requires that reviews take into account the best available scientific information on the effects of acidification, eutrophication and photochemical pollution, including assessments of all relevant health effects, critical levels and loads; the development and refinement of integrated assessment models; technological developments; changing economic conditions; progress made on the databases on emissions and abatement techniques (especially those related to ammonia and volatile organic compounds); and the fulfilment of the obligations regarding emission levels.

13. In addition to the above review requirements, article 3, paragraph 4 of the Protocol specifies that limit values for new and existing boilers and process heaters with a rated thermal input exceeding 50 MW_{th} and new heavy-duty vehicles shall be evaluated by Parties at a session of the Executive Body with a view to amending annexes IV, V and VIII no later than two years after the date of entry into force of the Protocol. Section V below deals with this issue and makes proposals for amending the annexes.

II. EMISSIONS, ATMOSPHERIC CONCENTRATIONS AND DEPOSITION LEVELS

14. EMEP continues to improve the extent and quality of reporting through development of an emissions review process and through its monitoring strategy that was adopted in 2005. This section describes the reductions in emissions reported by Parties in 2006 for their 2004 emissions as well as the levels of pollutants measured across the EMEP region.

15. [The following information on emissions is taken from that provided by the EMEP Meteorological Synthesizing Centre–West for the 2006 review of strategies and policies. Information is still required from the EMEP Chemical Coordinating Centre on the measured levels of pollutants in the EMEP region indicating the trends from 1990.]

16. Emissions of sulphur dioxide (SO_2) in Europe continued to show a clear downward trend. The total emission for all Parties to the Convention within the geographical scope of EMEP was estimated to be 14,896 Gg (SO_2) in 2004, which represents a decrease of 65% since 1990. This implies that, over the whole EMEP area, the emission target for SO_2 set by the Gothenburg Protocol for 2010 was already reached in 2004. However, there are significant differences in the achievements of individual Parties. While about half of the Parties to the Convention have

already reached their targets set by the Gothenburg Protocol, the other half still need to reduce their emissions.

17. For emissions of nitrogen oxides (NO_x) the situation is not as satisfactory. Total emissions of all Parties within the EMEP area fell to 17,741Gg (NO_2) in 2004, only 30% less than the 1990 levels. While 40% of Parties to the Convention have reached their targets set by the Gothenburg Protocol for 2010, a further 15% decrease in the total emission from the EMEP region is needed to reach the overall 2010 target.

18. Estimated ammonia emissions in the EMEP region have fallen by 22% from the 1990 levels; in 2004 they totalled 6,774 Gg (NH_3). These figures imply that 65% of all Parties to the Convention have already reached the goal of the Gothenburg Protocol and that the total ammonia emission in the EMEP area is now close to the Protocol target set for 2010.

19. For non-methane volatile organic compounds, emissions in 2004 were 15,247 Gg, a decrease of 38% from 1990 levels. The Protocol goals require a further 2% to 6% reduction by 2010, which indicates some Parties still need to take action.

III. EFFECTS ON HUMAN HEALTH, NATURAL ECOSYSTEMS, MATERIALS AND CROPS

20. [The text in this section was prepared by the secretariat from information provided by the International Cooperative Programmes (ICPs) and in consultation with members of the Bureau of the Working Group on Effects.]

21. The Working Group on Effects, its ICPs and the Task Force on Health provide the necessary information on effects on human health and the environment to assess the effectiveness of abatement measures. This section summarizes the results of work related to the review of the Protocol. More detailed information is available in a report prepared by the Working Group.

22. Monitoring and assessment of the effects of sulphur and nitrogen on ecosystems has showed some recovery in acidification but continuing risks of eutrophication. Sulphur deposition observed by ICP Forests and ICP Integrated Monitoring had decreased significantly by 2003, while nitrogen deposition had remained fairly constant. Review of the data confirmed that deposition and acidified soils destabilized forest ecosystems and tree nutrition, and that ground vegetation species composition was linked to nitrogen deposition. Observations at ICP Waters and ICP Integrated Monitoring sites showed that surface waters have become less acidic and are less toxic to biota. Even so, while no trends were detected for nitrate concentrations in surface

waters, it is known that nitrogen continues to accumulate in most catchment soils, so there is risk of future biodiversity change. Furthermore, the recovery achieved by sulphur emission decreases could be offset by the net acidifying effect of nitrogen processes and leached nitrate caused by nitrogen deposition.

23. Critical loads for acidification and eutrophication for all of Europe were updated in 2006 by the Coordination Centre for Effects (CCE) of ICP Modelling and Mapping. Risks for eutrophication were estimated as higher, more widespread and more spatially variable than those for acidification. In 2010, critical loads of acidification and eutrophication will still be exceeded for 8% and 46% of the European ecosystem area respectively. The exceedance area for acidification declines by 12% from that in 2000, but that for eutrophication hardly changes. The Protocol's long-term aim of closing the gap of critical load and level exceedances should be based on sustainable health and environmental endpoints; integrated assessment modelling should account for the regional distribution of the sensitivity of ecosystems.

24. The dynamic modelling of ecosystems recovery from acidification achieved a major breakthrough in 2004. A Europe-wide dynamic acidification modelling framework is now ready to use target loads to assess damage and recovery times. Dynamic models to address nitrogen and carbon cycles and eutrophication are available for scenario analysis but require further testing prior to regional application. According to models, acidified forest and surface water sites in many regions in Europe would need many decades for chemical and biological recovery even if the Protocol were fully implemented. In addition, ecosystems may not recover to their original status.

25. Declining concentrations of acidifying air pollutants resulted in decreased observed corrosion of materials at the ICP Materials sites in 1987–1997. The corrosion rate of carbon steel decreased further in 1997–2003, though the rates for zinc and limestone increased slightly. The levels of nitric acid could partly explain the different corrosion rates. Exceedances of acceptable levels of corrosion for cultural heritage materials were frequent.

26. New critical levels of ozone for crops and trees have been derived using an ozone flux method and can be used in integrated assessment modelling. The new method links ozone effects to the plant uptake through stomata on leaf surfaces. Preliminary mapping indicates widespread exceedances with different spatial patterns from the concentration-based method used for the Protocol. ICP Vegetation has reported continued damage to vegetation due to ozone across 17 European countries between 1992 and 2006. Trends observed reflect the spatial and temporal variation in ozone concentration, with no marked decline or increase evident.

27. European-wide effects can now be estimated using a new pan-European land cover database, merged from land cover maps of the CORINE (Coordination of Information on the Environment) programme and the Stockholm Environment Institute. The land cover map has now harmonized the work of the Working Group on Effects and EMEP, since the same map is being used to calculate ecosystem-specific critical loads and to estimate effects of ozone on vegetation.

28. The Task Force on Health reassessed the effects of ozone and particulate matter (PM) on human health. Calculations using the sum of maximum daily 8-hour means above ozone concentration of 35 parts per billion (SOMO35) show that ozone contributes annually to over 20,000 premature deaths across Europe. Exposure levels and health impacts were not expected to change significantly in the future, though the number and magnitude of ozone peak concentrations have declined markedly over the last decade. The long-range transport of PM contributes significantly to a wide range of acute and chronic health problems in Europe. An increased risk of all-cause mortality by 6% for 10 $\mu g/m^3$ of fine particulate matter ($PM_{2.5}$) leads to a reduction in life expectancy of 8.6 months on average in the European Union.

IV. NATIONAL EMISSION CEILINGS

29. [In the absence of other information, the following text was taken from the draft report of the Task Force on Integrated Assessment Modelling.]

30. The emissions ceilings listed in tables I–IV in annex II to the Protocol were negotiated on the basis of indicative values calculated by the RAINS model. Since 1999 the Centre for Integrated Assessment Modelling (CIAM) has continued to develop the RAINS model in the light of improved scientific knowledge and understanding. In 2004, a group of peer reviewers concluded that RAINS was fit for its purpose of supporting the review and revision of national emission ceilings, provided that uncertainties were sufficiently taken into account. Recommendations were also made to extend the model to the local and hemispheric scales as well as integrating consideration of abatement measures for greenhouse gases.

31. As RAINS had a possible bias towards add-on technical solutions, it was recommended that more attention be paid to non-technical measures and structural changes in agriculture, transport and energy use. A systematic compilation of biases by the Working Group on Effects programmes (impact estimates) and by EMEP (emission estimates and dispersion modelling) was also recommended. Parties to the Convention were asked to check and improve their data supply. CIAM was asked to increase further the transparency of RAINS by making input data and the model available via its website and to give users the possibility to provide feedback. All recommendations have been taken on board in the workplan of the Convention.

32. Work has started to include the local scale (the EU City-Delta project), the hemispheric scale (the Task Force on Hemispheric Transport of Air Pollution) and the inclusion of measures in the fields of energy, transport and agricultural policies. Uncertainties and possible biases have become a recurring item at meetings of the Task Force on Integrated Assessment Modelling as well as meetings on emission inventories, atmospheric modelling and the modelling of effects. Bilateral consultations held by CIAM with 21 parties led to an improved database of emission projections that is consistent with national statistics on energy, agriculture and transport, and with other international reports (e.g. to the United Nations Framework Convention on Climate Change).

33. Technical changes resulting from recent developments of the EMEP dispersion model are now incorporated into the RAINS model:

(a) EMEP has replaced the Lagrangian dispersion model used in 1999 by a Eulerian unified model. The grid size of the model has been reduced from 150*150 km to 50*50 km. These changes result in increased average calculated depositions on sensitive ecosystems and an increase in the calculated share of unprotected ecosystems.

(b) The EMEP model is now able to calculate ecosystem-specific deposition. Using these more realistic values indicates that forests receive more deposition than meadows and lakes. This leads to an increase in the proportion of unprotected ecosystems.

34. Revisions of the maps of critical loads for acidity and for eutrophication have been included in RAINS, though there are no major overall changes to the maps. However, the critical levels for ozone have been revised to incorporate scientific findings that suggest that for vegetation a flux-based approach should be used to define the critical level.

35. If the “negotiating scenario” used in 1999 were recalculated, the above changes would inevitably lead to a different result. However, it is expected that the major polluters would still need to decrease their emissions significantly; it is easy to argue that the Gothenburg emission ceilings were “no regret” values and were a positive step towards achieving the objective of the Protocol (see section X). However, the number of changes made to the model and its input data suggest that new calculations are needed to re-evaluate fully the negotiated emission ceilings to decide if they should be revised.

V. EMISSION LIMIT VALUES

36. [Members of the Expert Group on Techno-economic Issues provided some of the following text. The remainder was prepared by the secretariat.]

37. This section summarizes, in paragraphs 38–40, the work of the Expert Group on Techno-economic Issues on the evaluation of limit values in annexes IV, V and VIII and the annex amendment requirements of article 3, paragraph 4 of the Protocol (see para. 13 above). It also draws attention to the need to amend other annexes to the Protocol. The Expert Group provides further information in its report to the Working Group on Strategies and Review.

38. The Expert Group noted that annexes IV and V identify emission limit values (ELVs) for SO_2 and NO_x for large combustion plants that were different from those established by EU directive 2001/80/EC. The Expert Group also noted that relevant information on best available techniques (BAT) could be found in the Integrated Pollution Prevention and Control (IPPC) BAT reference (BREF) document (directive 96/61/EC). It suggested that this could be used for the assessment of other ELVs. Furthermore, EU directive 2003/17/EC would lower the ELV for large combustion plants to 10 mg/kg from 1 January 2009.

39. Concerning heavy-duty vehicles and annex VIII to the Protocol, the Expert Group drew attention to the preparatory work in progress on EURO VI standards and noted that a proposed EU directive was expected in 2007. The development and implementation of this directive should be followed closely and, if appropriate, reflected in a revised annex VIII. For stationary engines, Parties may wish to consider the need to revise ELVs with regard to state-of-the-art engines and reduction techniques.

40. Also in annex VIII to the Protocol, sulphur content limit values are defined as 350 mg/kg for compression-ignition and 50 mg/kg for positive-ignition engines. These values could be revised downwards since Parties that are EU Member States already follow directive 1998/70/EC, which since 1 January 2005 has limited petrol and diesel fuels to a maximum of 50 mg/kg.

41. Further consideration of revisions to annexes may now be appropriate. For example, the Expert Group has compiled removal efficiencies and abatement costs for some activities (refineries and cement), which may help with decisions on amendments. As only a limited number of activities are covered in the Protocol, Parties may wish to consider the need for adding others with significant emissions. Parties may also wish to consider reflecting other national or international legislation – for example, revising annex VIII for off-road engines to reflect EU directive 2003/44/EC for recreational craft and directive 2002/88/EC for emissions from internal combustion engines installed in non-road mobile machinery.

42. Some Parties have drawn particular attention to annexes that should receive immediate attention. For example, table IV of annex V, which lists limit values for NO_x emissions for new stationary engines, has created difficulties for several countries in their ratification process.

Finland has offered to begin work on proposing revisions to table IV that would apply the same ELVs to all engines, from small unit spark ignition engines and compression engines up to large engine plants.

43. Parties may also wish to give special attention to the problems of the level of detail of the technical annexes. Some Parties to the Convention have indicated that, while they are able to meet the overall emission ceilings specified in annex II, they are having trouble ratifying the Protocol because of the stringent requirements of some of the annexes. Some delegations have suggested that a two-tier approach may encourage better implementation of the Protocol.

VI. THE ROLE OF HEMISPHERIC TRANSPORT

44. The Executive Body established the Task Force on Hemispheric Transport of Air Pollution, under decision 2004/4, to address the technical issues involved in understanding and estimating the transport of air pollution across the northern hemisphere. The Task Force is due to complete its work in 2009 but is drawing up an interim report for consideration in the review of the Protocol.

45. [A summary of the Task Force report will be presented here that draws upon the conclusions and recommendations of the Task Force's 2007 report. The summary will address the key tasks of "understanding the hemispheric transport of air pollutants" and "quantifying the transcontinental influence", and the conclusions presented will be without prejudice to further work to be performed for the 2009 assessment. The Task Force is expected to present its consensus view on whether intercontinental transport of ozone, fine particles and the like and their precursors (including nitrogen oxides, methane, carbon monoxide, sulphur dioxide and organic compounds) is significant in terms of current policy objectives, and what the key uncertainties are.]

VII. RELATION TO CLIMATE CHANGE ISSUES

46. [This section requires further elaboration by the Task Force on Integrated Assessment Modelling.]

47. The report of the Task Force on Integrated Assessment Modelling draws attention to the synergies between air pollution and climate change. There are close links between sources, abatement measures and atmospheric transport and chemistry; there are synergistic and antagonistic effects in abatement measures, changes in source-receptor matrices due to climate change, and changing critical loads due to changed precipitation patterns. There are also links with the carbon and nitrogen cycles.

48. The Centre for Integrated Assessment Modelling has developed the GAINS model to explore such synergies and the possibilities for developing integrated strategies. Results have shown that when air pollution and greenhouse gas emissions are considered together, there are larger abatement potentials and lower costs. Even so, there are possibilities of antagonistic effects such as the air pollution effects stemming from the use of biofuels.

VIII. PARTICULATE MATTER

49. [In the absence of other information, this text was derived from the draft report of the Task Force on Integrated Assessment Modelling. The Expert Group on Particulate Matter may wish to further elaborate.]

50. While the Protocol does not aim to address the problems of particulate matter (PM) pollution, it was recognized at the time of its adoption that steps taken to cut emissions of the Protocol pollutants were likely to result in decreases of PM concentrations. The recent reports by the World Health Organization that fine particles can have very significant adverse effects on human health have prompted the Executive Body to establish the Expert Group on Particulate Matter to consider the issue of PM and how it might be addressed through a future protocol. The Expert Group will provide a final report to the Executive Body in December 2007, which may be considered in the review of the Protocol. Major conclusions are briefly summarized below.

51. Particulate matter may be emitted directly from sources (primary PM) or can result from chemical reaction in the atmosphere of two or more pollutants (secondary PM). While the chemical composition of PM may markedly affect its impact on health, there are few results showing the composition of PM, and none are likely to be available soon. Consequently, effects of PM have been correlated with size fraction and mass in the air.

52. Calculations have shown that current $PM_{2.5}$ (< 2.5 μm) concentrations lead to life expectancy decreases as noted in paragraph 28 above. Current existing legislation on the emissions of primary PM and PM precursors is expected to reduce the impacts by about one third by 2020. Further reduction could be achieved by the implementation of available abatement measures, as a substantial part of PM concentrations may be allocated to anthropogenic sources.

53. Concentrations of anthropogenic $PM_{2.5}$, in particular secondary inorganic aerosols, have considerable transboundary origin, about 60% on average. Natural sources such as Sahara sand storms can cause large PM concentrations, but these are mainly limited to specific meteorological episodes.

54. Exposure assessment has to take account that concentrations of $PM_{2.5}$ in urban areas can be 4–5 $\mu g/m^3$ higher than in rural locations. The differences vary and depend on factors like city

size, topography and meteorology. The EMEP model cannot explicitly account for these urban increments due to its 50×50 km grid size. The results from the City-Delta project were used to estimate urban increments in the RAINS model; however, the methodology was found to be sensitive to target domain definition and emission data quality.

55. In evaluating abatement measures for PM precursors by integrated assessment modelling, the potential for reducing exposure by reducing primary PM emissions must be taken into account. Moreover, local PM controls for combustion sources, especially traffic, seem to be very effective, especially in cities with relatively high levels above background concentrations. Some local measures (such as speed limits, parking policies and road pricing) are more cost-effective than more expensive Europe-wide measures.

IX. NORTH AMERICA

56. [The following outline for this section was received from the United States:

(a) Background

i. Gothenburg and bilateral agreement

(b) Acid rain

i. Current status

ii. Projections for the future

(c) Ozone

i. Current status

ii. Projections for the future

(d) Particulate matter (North American efforts could also be discussed in the PM section above)]

X. PROGRESS TOWARDS ACHIEVING THE OBJECTIVE OF THE PROTOCOL

57. The objective of the Protocol is to control and reduce emissions of the prescribed pollutants to ensure that, in the long term, critical loads and levels are not exceeded within the

EMEP region. When the Protocol was adopted, the Executive Body was provided with calculations showing the benefits of implementing the Protocol in terms of decreased exceedances of critical loads using the then available critical load maps and modelled deposition data.

58. *Acidification.* From measurements and from calculations made with reported emissions it is clear that the deposition of acidifying substances in Europe has declined since the 1980s, and positive effects on the chemical composition of soils and lakes have been measured. However, there have been changes to the EMEP model, in particular improved resolution and ecosystem-specific deposition values. New deposition estimates and revised critical loads values show that protection of ecosystems will be less than expected in 2010, even with full implementation of the Protocol. Dynamic models also demonstrate that time delays will be encountered before recovery takes place in many areas. Even so, the Protocol will achieve its goal of moving towards full protection, but the shortfall in protection expected from the 1999 estimates further emphasizes the need for additional measures.

59. *Eutrophication*. Deposition of both oxidized and reduced nitrogen remains a widespread problem for European biodiversity. Even estimates made at the time of adoption of the Protocol indicated that critical loads for nitrogen would still be exceeded over a majority of ecosystem areas in Europe. With the revised estimates of deposition made by EMEP, and with revised (lower) critical loads for nitrogen agreed by the Working Group on Effects, the impacts of nitrogen are considered to be even greater than previously thought. The Protocol, while still achieving some protection in some areas of Europe, will not address the widespread problems of excess nitrogen deposition.

60. *Ground-level ozone.* Although VOC emissions in Europe have declined in the past decade by more than 25%, no clear downward trend in ozone effects has been observed. While the frequency of very high ozone episodes may have fallen, “background” levels show a steady tendency to increase. As a result, excesses over the thresholds used for defining critical levels of ozone (annex I to the Protocol) are still significant in many parts of Europe. New scientific research has shown that an “ozone flux approach” is biologically a more realistic description of the effects of ozone exposure to vegetation than the critical levels defined in the Protocol. Applying this method would mean that ozone effects to vegetation become more widespread over Europe and not merely a Mediterranean problem. Human health impacts of ozone were earlier estimated with an indicator (AOT60) that integrated the duration and absolute level of ozone exposure (similar to the critical level for vegetation). Systematic review has indicated that this would not provide protection against a number of severe health effects. A new proposed indicator (SOMO35) suggests that ozone impacts on health would continue to be widespread in Europe. There is a need to evaluate fully the effects of ozone on both human health and

vegetation, but it is clear that, even with full implementation of the Protocol, critical levels will be exceeded and ozone effects on human health as well as damage to plants will still be widespread and significant.

XI. CONCLUSIONS

61. Depending on the views of the Parties, they may arrive at one of the following possible conclusions:

(a) An optimistic conclusion might be that the emission ceilings and the obligations of the Protocol are adequate and on the way to being fully implemented, which would lead to achieving the objective of the Protocol. If this conclusion is reached, a possible further step could be a revision of the Protocol in view of increased ambition levels. In addition, in recognition of the fact that that some Parties to the Convention are having difficulties with ratification of the Protocol, consideration could be given to the impediments such countries face in implementing existing Protocol obligations.

(b) A second possibility is that, although on their way to being fully implemented, the obligations of the Protocol will not lead to achieving its objective and therefore need to be revised.

(c) It is also possible that the latest scientific knowledge confirms the adequacy of the Protocol's obligations, but that, due to an insufficient degree of implementation, progress towards achieving its objective is slow. In this case, revision of the Protocol might not be necessary, but stronger implementation measures might be needed.