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Options for revising the annexes to the Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone: annex IX

Reactive Nitrogen

Report by the co-Chairs of the Task Force on Reactive Nitrogen

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I. Introductory remarks

1. This report, prepared in cooperation with the secretariat to the Convention on Long-range Transboundary Air Pollution, describes the results of the sixth meeting of the Task Force on Reactive Nitrogen, held on 11 and 12 May 2011 in Rome. The background documents and presentations made during the meeting and the reports presented can be accessed at: www.clrtap-tfrn.org. The results of the sixth meeting of the Expert Panel on the Mitigation of Agricultural Nitrogen, the third meeting of the Expert Panel on Nitrogen and Food and the sixth meeting of the Expert Panel on Nitrogen Budgets are also presented here. An updated version of the draft revised annex IX to the Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol), based on document ECE/EB.AIR/WG.5/2011/3, is presented in the annex.

A. Attendance

2. Forty-one experts from the following Parties to the Convention attended the workshop and the meeting of the Task Force: Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Ireland, Italy, Norway, Poland, Netherlands, Russian Federation, Spain, Sweden, Switzerland and United Kingdom of Great Britain and Northern Ireland.

3. Also present were representatives from the Working Group on Strategies and Review and the Working Group on Effects, as well as experts from the International Cooperative Programme on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping); the Joint Expert Group on Dynamic Modelling; the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) Centre for Integrated Assessment Modelling (CIAM) at the International Institute for Applied Systems Analysis (IIASA); the Expert Group on Techno-economic Issues; the Food and Agriculture Organization of the United Nations (FAO); the European Commission Directorate-General for the Environment; and Fertilizers Europe (EFMA). A member of the United Nations Economic Commission for Europe (UNECE) secretariat also attended.

B. Organization of work

4. The Task Force was co-chaired by Mr. O. Oenema (Netherlands) and Mr. M. Sutton (United Kingdom). It was hosted by Italy, with support from the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA).

5. A representative of ENEA opened the sixth meeting of the Task Force and outlined the work of ENEA on environmental activities, including links to the work of the Convention and the Task Force on Reactive Nitrogen.

6. The Task Force welcomed the attendance of the UNECE secretariat at the meeting. The secretariat outlined the requests from the Working Group on Strategies and Review to the Task Force on the further elaboration of options for annex IX and supporting documents, and highlighted the adoption of the Long-Term Strategy of the Convention, its current focus and updates on information requirements regarding workplans for task forces and other groups.

7. The Task Force worked in plenary, discussing feedback and information requested by the Working Group on Strategies and Review at its forty-eighth session, the output of

the preceding expert panel meetings and other Task Force related activities (such as nitrogen and climate and *The European Nitrogen Assessment*).

II. Activities related to the revision of the Gothenburg Protocol

8. The Dutch co-Chair informed the Task Force about the conclusions of the forty-eighth session of the Working Group on Strategies and Review with respect to revision of the Gothenburg Protocol and the associated documents.

9. The Task Force noted:

(a) That the Working Group requested additional flexibility within annex IX, and that this additional flexibility would be designed by the Working Group;

(b) That the Working Group requested a further update of the Guidance Document on Control Techniques for Preventing and Abating Emissions of Ammonia (ECE/EB.AIR/WG.5/2007/13) (Guidance Document) so as to ensure consistency between the annex IX options and the Guidance Document. The Task Force agreed that consistency between the annex IX options and the Guidance Document could be improved through further improving the Guidance Document, but noted that full consistency was difficult to achieve as long as annex IX was under negotiation by the Working Group;

(c) The request of the Working Group to continue the collection and assessment of information from Parties about the cost-effectiveness and applicability of the measures set out in annex IX;

(d) That comments from the European Union had been requested, but had not been available at the time of meeting.

10. The Task Force agreed to submit a further revised version of the Guidance Document to the forty-ninth session of the Working Group, taking account of comments received from experts and Parties.

11. The co-Chair of the Expert Group on Techno-Economic Issues, Mr T. Pigniatelli (Italy), reported on the experiences of the Group in revising technical annexes and guidance documents under the Convention. Updating cost estimates, providing accurate definitions and including all necessary parameters was important. It had also proved useful to collate comments from Parties into official documents and to provide translation into Russian.

12. The co-Chair of the Expert Panel on the Mitigation of Agricultural Nitrogen missions reported on the progress in the work on the Guidance Document. The Task Force agreed to:

(a) Add a short section in the beginning of the Guidance Document to highlight the links with the options for annex IX;

(b) Revise the sections on animal feeding strategies and low-emission animal housing, with a view to increase consistency with the annex IX;

(c) Include additional information on costs of ammonia abatement in the Guidance Document, drawing on the findings from the fifth meeting of the Task Force (ECE/EB.AIR/WG.5/2011/6) and information since received from Parties and experts;

(d) Set a deadline for further comments on the Guidance Document to be provided by 31 May 2011 to allow revision of the document in advance of the forty-ninth session of the Working Group.

13. The Task Force noted that accurate estimates of the economic cost of the measures in annex IX were a crucial factor for ratification of the revision of the Gothenburg Protocol,

especially for the countries in Eastern Europe, Caucasus and Central Asia. Improving the links between expert information from those countries and information used by the greenhouse gas and air pollution interactions and synergies (GAINS) model would be advantageous, and the Task Force agreed to foster closer links with the newly formed Coordinating Group on the promotion of actions towards implementation of the Convention in Eastern Europe, the Caucasus and Central Asia (Coordinating Group for Eastern Europe, the Caucasus and Central Asia). The representative of the Russian Federation (Ms. N. Kozlova) had already attended the first of those meetings and would continue to do so when possible. The UNECE secretariat agreed to provide contact details for Task Force members to improve collaboration.

14. Drawing on the comments of some parties and experts, and on the recommendations of the Expert Panel on the Mitigation of Agricultural Nitrogen meeting and discussion, the Task Force agreed a few modifications to the annex IX options. The modifications were justified on the grounds of an improved consistency between the measures, improved applicability of the measures as well as improved linkages between annex IX and the Guidance Document. (The modifications are described by the co-Chairs in section IX below.)

15. The Task Force discussed the context of national nitrogen budgeting proposed in annex IX., noting that such budgets necessarily cover nitrogen in an integrated way, considering all source sectors, while the scope of the current annex IX was limited to the agricultural sector. To address this inconsistency, the Task Force proposed that, subject to modification and agreement by the parties, the text relating to national nitrogen budgets be moved to the main text of the Protocol, where it could refer to nitrogen in all sectors (not just agriculture). The Task Force agreed to provide an updated text and guidance on the calculation of national nitrogen budgets as an informal document to the forty-ninth session of the Working Group.

16. Considering the request from the Working Group for flexibility in annex IX, the Task Force agreed a ranked list of priority measures for ammonia emission reduction. The priorities were established on the basis of: (a) availability and applicability of the measures across the UNECE region; (b) being cost neutral or have a low cost to farmers, especially when taking account of their co-benefits; (c) focusing on sectors where the application of measures provided a significant contribution to ammonia emissions reduction; and (d) the need for long-term capacity-building. The priorities were as follows (with the highest priority first):

1. Low-emission application of manures and fertilizers to land, including:

(a) Low emission application of slurry and solid manure from cattle, pigs and poultry. Available measures included immediate or fast incorporation into the soil, trailing hose, trailing shoe and other band spreading and injection methods, and slurry dilution via irrigation;

(b) Low-emission application of urea fertilizers. Available measures included immediate or fast incorporation into the soil, coated pellets, urease inhibitors and fertilizer substitution;

2. Animal feeding strategies to reduce nitrogen excretion. Available measures included: (a) low-protein phase feeding on pig and poultry farms; and (b) low-protein supplement feeding of cattle during housing, and improved nitrogen and grazing management of grazed grassland targeted to improve nitrogen use efficiency;

3. Low emission techniques for all new stores for cattle and pig slurries and poultry manure. Available measures include covers on all new slurry tanks, use of floating

covers or slurry bags, prohibition of the building of new open slurry lagoons and keeping stored poultry manure dry;

4. Strategies to improve nitrogen use efficiencies and reduce nitrogen surpluses. The priority target was to establish nitrogen balances on demonstration farms or through on-farm demonstration, as a basis to monitor improvements in nitrogen use efficiency. That priority would develop capacity across the UNECE region for wider use of nitrogen budgeting approaches after 2020;

5. Low emission techniques in new and largely rebuilt pig and poultry housing. Available measures included improved building designs, reducing the area of manure exposed to the air, keeping poultry litter dry and chemical scrubbing of exhaust air.

17. The Task Force noted that, for each of those priorities, the options for annex IX allowed flexibility by: (a) specifying a range of possible quantitative targets for which several techniques were available; (b) specifying exemptions for small farms through the use of farm-size and equipment-size thresholds with varying degrees of ambition; and (c) allowing relaxation in the implementation date for countries with economies in transition.

18. The Task Force noted that packages of priority measures might be more cost-effective than selecting one or two of the priority measures. For example, covering manure storages made little sense if the manure was applied subsequently without low-emission manure application techniques.

19. The representative of CIAM provided an update on the incorporation of new cost data regarding ammonia emission abatement in GAINS. A consistent revision had been done using the data from the fifth meeting of the Task Force. Full documentation had been provided — including a paper in a book to be published from the proceedings of the fifth meeting and an interim report, with detailed tables to explain the parameters used at each stage. Those would be made available to Task Force members.

20. The Task Force noted that the threshold for farm sizes differed between annex IX and GAINS (set at 5 and 15 livestock units, respectively). The threshold for farm sizes in GAINS was based on data availability, while the threshold in annex IX was based on shares in total ammonia emissions. The reasons for those differences should be further discussed in documentation for the forty-ninth session of the Working Group. The Task Force invited CIAM to clearly explain the methodology and the measures included when reporting ammonia emissions reductions and economic cost by sector.

21. A representative of Germany gave a presentation on the economic costs of ammonia emission abatement measures applied in Germany, as a function of farm size. Costs of emissions abatement for pig slurry ranged from €0.1–€1 per kilogram (kg) of ammonia (NH₃-N) saved. Costs of air purification in livestock buildings were relatively expensive, ranging from €4–€8 per kg of ammonia-N saved. Combining simple measures could provide a significant reduction (i.e., a 40% reduction) at low costs, i.e., around €1 per kg nitrogen (N) abated. It was noted that the final outputs were related to economies of scale, performance of techniques, allocation of the costs and reference emission levels, and that all of those had to be well understood.

22. A representative of France presented the results of a consultation exercise to provide cost information for ammonia emission abatement in France. Technical experts, scientists and providers of agricultural and technical products and techniques had been consulted. It was not a simple task, given the time constraints and the complexity of cost assessments of a wide range of techniques. Results had been compiled into a report with overall mean costs expressed in euros per kg NH₃-N abated, for 65 techniques. That information had been provided to the Task Force in February and updated in April 2011.

23. A representative of Spain presented requirements for the assessment of economic costs of measures. He explained the use of templates to allow the collection of information regarding cost per place per technique.

III. Nitrogen budgets

24. The co-Chair of the Expert Panel on Nitrogen Budgets informed the Task Force about the Panel's fourth and fifth meetings, held on 29 October 2010 in Paris and on 12 April 2011 in Edinburgh (United Kingdom), respectively. For their work, collaboration had been sought with EUROSTAT, the Organization for Economic Cooperation and Development and FAO. Good progress had been made and a better understanding achieved of the various issues related to the availability and accuracy of nitrogen budget data. A spreadsheet model template had been made available to aid with calculations, and that was being developed into a web-based platform. The Task Force invited the Expert Panel to develop guidance documents on national nitrogen budgets and farm nitrogen budgets. In the longer term, the panel might also look at dynamic versions of the national budgets — a first attempt of such work had been presented at the Nitrogen and Global Change conference in Edinburgh in April 2011.

IV. Food consumption: effects on health and nitrogen pollution

25. The co-Chair of the Expert Panel on Nitrogen and Food gave an update on the work related to food consumption and nitrogen emissions. The aim of the work was (a) to achieve a better understanding of that relationship; (b) to derive indicators for various food categories; and (c) to quantify the effect of changes in food consumption patterns, using scenario analysis. A draft report would be available for review in October/November with the anticipated final delivery date in January 2012. The Task Force invited the Expert Panel to make a plan for the next three years.

26. A representative of the Netherlands summarized the major findings of the study 'The Protein Puzzle: the consumption and production of meat, dairy and fish in the European Union'.¹ The study showed that more animal protein was consumed than was recommended from a health perspective, but with significant differences between EU member States. The consumption of especially pork and poultry had increased significantly since 1960 across Europe. Wealth appeared to be the main driver of consumption, but the type of meat varied by country. The mean N use efficiency in the 27 States of the EU (EU-27) in 2005 was 20% for milk, 8% for beef, 25% for pork, 38% for poultry and 28% for egg production.

27. A representative of Germany provided an overview of the gaseous emissions from the food chain, including greenhouse gas (GHG) emissions and those from land-use-change. Land-use change appeared to be a large component of GHG emissions relating to food production, especially that for beef and sheep. Food accounted for 20% of the GHG footprint of the United Kingdom and that increased to 30% if land-use-change was included. Life-cycle assessments had concluded that decreasing livestock production in the United Kingdom by 50% would decrease N emissions in a 1 to 1 ratio (i.e., it would also result in a decrease of 50% in N emissions) and release one third of the agricultural land.

28. A representative of FAO presented the results of the global study on livestock, environment and nitrogen use efficiency in animal food chains. Livestock production

¹ Available at <http://www.pbl.nl/node/54504>.

systems were important for food security and sustaining livelihoods in many areas of the world, but also contributed to environmental pollution. The Task Force noted that the emissions from livestock production systems could be lowered through improving management. The latter might be achieved through a combination of education, training, demonstrations, payments for environmental services, incentives, clarifying property rights, bringing intensive systems closer to villages, encouraging manure use, improving market access, etc. Holistic approaches to the problem were needed and, if systems were handled properly, then food security and decreasing GHG emissions could go hand in hand.

29. A representative of Italy provided information about meat consumption across Europe. Many of the northern and western countries ate more animal protein than recommended. The proportion of meat to vegetables was higher in Northern Europe than in the Mediterranean countries. However, meat consumption had increased considerably in Mediterranean countries since 1961, and the diet in the Mediterranean was considered now less healthy than in 1960. It was noted that water, energy, and land were all required in larger quantities for producing meat than for legumes.

30. A representative of Italy provided information about the Mediterranean Diet Foundation, which had been established to research the Mediterranean diet and provide education on its benefits. The Foundation would be involved in the World Exposition in Milan (Italy) in 2015, which would have the theme of “Feeding the planet — energy for life”. The links between human health and animal protein consumption and the environmental costs of animal protein consumption had not yet attracted the attention of policymakers to the extent that actions had been implemented (as in the case of air pollution). It was noted that making those links explicit — including the potential costs of health problems — could be useful for policymakers. However, it was noted that food choice was strongly connected to consumer preferences, culture and economy, and that changes in human diets were not easily made.

V. The European Nitrogen Assessment

31. The British co-Chair provided a brief overview of *The European Nitrogen Assessment: Sources, Effects and Policy Perspectives*,² the first continental-scale assessment of the nitrogen problem, which had been launched at the Nitrogen and Global Change conference in Edinburgh on 11 April 2011. The volume contained 26 chapters, a technical summary and a summary for policymakers.

VI. Nitrogen and climate

32. The British co-Chair provided a short update on progress relating to nitrogen and climate issues. The report of the Task Force on Nitrogen and Climate had been provided to the Executive Body for the Convention in December 2010. The Task Force noted that efforts were being made to establish links with the Intergovernmental Panel on Climate Change (IPCC) to explore possibilities for using the report on nitrogen and climate as an input to the fifth Assessment Report of the IPCC.

² The *Assessment* is available free online at <http://www.nine-esf.org/ENA-Book>.

VII. Viewpoints on integrated nitrogen issues and management

33. A representative of Poland provided information on Polish farms and ammonia abatement issues. Farm size was a key issue in Poland; 65% of Polish farms had less than 10 cows. In the case of pig farming, only 27% of farms had more than 20 sows. Concerns were expressed about the exchange of ammonia between countries. The Task Force noted that exchange of ammonia between countries was taken into account in the GAINS model.

34. A representative of Denmark provided information on the mandatory nitrogen accounting for farms in Denmark. The nitrogen accounting had contributed to a total reduction of ammonia from dairy cattle of 34% since 1985. At the same time, the nitrogen accounting had contributed to a reduction of nitrogen leaching of 50%. Nitrogen excretion rates per animal category were updated every year. Various ammonia emission abatement techniques had been implemented and the ammonia loss per kg nitrogen excreted was one of the lowest in the EU-27 now.

35. The representative of the Russian Federation provided information about the formation of a Russian Reactive Nitrogen Network, with planned research and information exchange. Some documents on best practice would be generated. In some cases, translation of European Commission reference documents on Best Available Techniques (BREFs) would be made. A major issue was that the nitrogen issue was spread across many organizations, which were not connected, making integration difficult. At the first session of the Coordinating Group for Eastern Europe, the Caucasus and Central Asia, a presentation on agricultural reactive nitrogen abatement was made. Work on nitrogen balances had begun, using a Russian translation of the Guidelines.

36. A representative of the Netherlands provided information on an “Integrated Nitrogen Ceilings Approach: how to manage excess nitrogen”, a system which was being developed in the Netherlands for assessing effects of certain policy choices on emission ceilings.

37. The Chair of the Joint Expert Group on Dynamic Modelling gave an overview of the Group’s work and presented the results of several case studies. The Group was created to provide a time dimension to work on critical loads, from which the concept of Target Load Functions (TLFs) had been created. It was suggested that although TLFs were not currently incorporated into GAINS, perhaps they could be. The focus of the Group had developed with need — i.e., there had been a shift from work on sulphur compounds to work on nitrogen in recent years. The Group worked on natural and semi-natural ecosystems.

38. The Chair of ICP Modelling and Mapping provided an overview of the achievements of the Working Group on Effects, including conclusions for each of the main pollutants. Reduced nitrogen was becoming more important as far as effects were concerned. Several scenarios showed a considerable decrease in eutrophication, but significant eutrophication was still predicted with even the most extreme policy scenarios. In the case of Maximum Feasible Reduction, there were still impacts. In the case of acidification, areas which were impacted were reduced and nitrogen was becoming the main acidifying compound. Ozone still continued to be of concern for natural vegetation and crops, including for Northern Europe, but Maximum Feasible Reductions in the pollutant would mean an improvement.

39. The British Task Force co-Chair provided a short presentation on a low-cost approach to managing nitrogen waste from biogas streams on behalf of a representative from the United States. Nitrogen was recovered from the biowaste as ammonium bicarbonate, which was currently prohibited in the UNECE region. The Task Force noted that the route for discussions about exemptions should be through the focal point of the United States. Key in the discussions were “renewable” and “recycling” aspects of the

process; the process and its performance had to be described very carefully to avoid loopholes.

VIII. Future work

40. The future work of the Task Force, set out below, has been split into core/ongoing work and new items — with a view to the next year and the next three years — as requested by the secretariat (with new and/or longer-term activities are highlighted in italics):

(a) Continue the work on nitrogen emission abatement from agricultural sources, develop technical and scientific information on an integrated approach to mitigation of agricultural nitrogen emissions with particular reference to the revision of the Gothenburg Protocol and, in particular:

- (i) Finalize the update of the Guidance Document;
- (ii) Continue to liaise with CIAM to examine the costs and benefits of ammonia emissions abatement measures;
- (iii) *Work on updating the Framework Code on Good Agricultural Practice for Reducing Ammonia; inform the deliberations of the Working Group on Strategies and Review on revisions to annex IX to the Gothenburg Protocol; and take account of the relevant BREFs;*
- (iv) *Develop multi-pollutant approaches;*

(b) Continue providing technical information on making and using nitrogen budgets and estimating nitrogen emissions:

- (i) At the national scale and for various system boundaries;
- (ii) *Looking specifically at the farm scale;*

(c) Continue developing and providing technical and scientific information to support the revision of the Gothenburg Protocol in relation to the whole nitrogen cycle;

(d) Continue collecting and assessing information from the national focal points regarding their experiences, including any difficulties that they have in developing and implementing an integrated approach;

(e) Provide technical information on the effects of human diets on nitrogen use and emissions;

(f) Liaise with countries in Eastern Europe, the Caucasus and Central Asia in the development of approaches for managing reactive nitrogen in industry and agriculture in order to:

- (i) *Investigate the barriers to implementation of the Gothenburg Protocol;*
- (ii) *Improve collaboration with the newly formed Coordinating Group for Eastern Europe, the Caucasus and Central Asia;*

(g) Continue improving coordination of activities across and outside the Convention, and collaborate with subsidiary bodies under the Convention to complement the work of the subsidiary bodies of the Convention, in particular:

- (i) Working with ICP Modelling and Mapping, focusing on critical loads and dynamic modelling of nitrogen effects, including the development of indicators through the use of nitrogen budget approaches and links between nitrogen and climate;

- (ii) With the Task Force on Emission Inventories and Projections, continue to ensure consistency between development of emission estimates and the estimation of efficiencies of agricultural emissions abatement; *hold a joint workshop in spring 2012 on agricultural emissions and projections*;
- (iii) With the Task Force on Integrated Assessment Modelling, participate in relevant meetings, in particular providing advice to avoid pollutant swapping, and on effects of human behaviour, including dietary choices;
- (h) Further disseminate the results from the *European Nitrogen Assessment* and consider the longer-term perspective in relation to the potential of linking air pollution, water pollution and other environmental threats;
- (i) Consider the vision and future possibilities for integrating nitrogen management within the Convention and in relation to other UNECE and international conventions; *prepare an informal document on this topic*;
- (j) Hold the Task Force's seventh meeting, tentatively scheduled to be held in May 2012, and submit its report.

IX. Annex IX

41. At its forty-eighth session, the Working Group on Strategies and Review welcomed the work carried out by the Task Force on Reactive Nitrogen on updating technical annex IX to the Gothenburg Protocol, the Guidance Document and the assessments of the economic costs of the provisions of annex IX. It requested the Task Force to further update estimates of costs and strengthen the coherence between annex IX and the Guidance Document for the forty-ninth session of the Working Group in September 2011.

42. At the Task Force's sixth meeting, the draft revised annex IX, as presented in document ECE/EB.AIR/WG.5/2011/3 was slightly revised, in response to queries by a number of parties and also in response to the request by the Working Group on Strategies and Review to strengthen the coherence between annex IX and the Guidance Document (see annex).

43. The following description of the options for revision of annex IX to the Gothenburg Protocol is provided by the co-Chairs of the Task Force as a basis to stimulate discussion by the Working Group on the combination of the options.

44. The revisions relate to the following provisions:

(a) *B. Nitrogen management (provisions 8, 9, 10)*. Firstly, the description of the provision has been simplified with a view also of providing back-up information in the Guidance Document and increasing the coherence between annex IX and the Guidance Document. Secondly, the target levels have been lowered, as various experts indicated that the practical applicability of the highest ambition levels was too limited. Thirdly, the introduction of farm-level nitrogen balances on demonstration farms has a mandatory character but on practical farms a voluntary character. The voluntary character on practical farms has been justified on the grounds that experts from a number of countries have indicated that a mandatory implementation would be less feasible/applicable within the set target implementation dates. Fourthly, the provision on national nitrogen budgets will have to be implemented for the agricultural sector only. Further, we recommend the implementation of national nitrogen budgets for all sectors, but this provision should be included elsewhere in the Gothenburg Protocol, as annex IX refers to the agricultural sector only;

(b) *C. Livestock feeding strategies (provision 11)*. Firstly, the description of the provision has been simplified with a view also of providing back-up information in the Guidance Document and increasing the coherence between annex IX and the Guidance Document. Secondly, the feeding strategies have been specified now to housed animals only, because experts have indicated that the practical applicability of feeding strategies to grazing animals is limited;

(c) *D. Animal housing (provision 12)*. A typographical error has been removed: “poultry” has been replaced by “layer”;

(d) *E. Manure storage outside animal houses (provision 14)*. The description of the provision has been revised with a view to increasing the coherence between annex IX and the Guidance Document.

Annex

**Draft revised annex IX
Measures for the control of emissions of ammonia from
agricultural sources^a**

1. [The Parties that are subject to obligations in article 3, paragraph 8 (a), shall take the measures set out in this annex. – ~~delete~~] **[This annex describes the minimum measures for the control of ammonia emissions. These minimum measures can be reached by using, as a guidance, the techniques for preventing and reducing ammonia emissions, according to the specifications listed in Guidance Document V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto (hereafter referred to as the Guidance Document).]**

[2. Data on animals are converted into livestock units (LU) using the following coefficients: Cattle: under 1 year old: 0.4; 1 year or over but under 2 years: 0.7; 2 years old and over: Male animals: 1.0; Dairy cows: 1.0; Other cows and heifers: 0.8. Sheep and goats (all ages): 0.1; Pigs: Piglets having a live weight of under 20 kilograms (kg) per 100 head: 2.7; Breeding sows weighing 50 kg and over: 0.5; and Other pigs: 0.3.]

[3.] [2. Each Party shall take due account - ~~delete~~] [When taking the minimum measures for the control of ammonia emissions, due account shall be taken] of the need to reduce losses from the whole nitrogen cycle. [Efforts shall be made to develop strategies for increasing nitrogen-use efficiency in crop and animal production. A high nitrogen-use efficiency is indicative for low nitrogen losses, low risk of pollution swapping and a high economic return on farm expenditure on nitrogen.]

[4. The timescales for the application of the minimum measures for the control of ammonia emissions set out in this annex are:

(a) {Two years after the date of entry into force of the present Protocol for that Party (options A, B); 31 December 2017 (option C)}; or

(b) For a Party that is a country with an economy in transition, {five years after the date of entry into force of the present Protocol for that Party (options A, B); 31 December 2019 (option C)}.¹]

[5. Where measures are used to meet the requirements of this annex, other than those listed as Category 1 in the Guidance Document, these shall be reported, including justification of the verification procedures used to estimate the abatement efficiencies specified, according to the principles set out in the Guidance Document.]

A. Advisory code of good agricultural practice

[6.] [3. Within one year from the date of entry into force of the present Protocol for it, a Party shall establish, publish and disseminate an - ~~delete~~] [An] advisory code of good agricultural practice to control ammonia emissions [shall be established, published and disseminated, based on the Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions, adopted by the Executive Body at its thirty-third

^a Proposed new text is in square brackets and bold.

session (EB.AIR/WG.5/2001/7) and any amendment thereto.] The [advisory] code shall take into account the specific conditions within the territory of the Party and shall include provisions on the following items:

- (a) Nitrogen management, taking into account the full nitrogen cycle;
- (b) Livestock feeding strategies;
- (c) Low-emission manure spreading [techniques - ~~delete~~] [approaches];
- (d) Low-emission manure storage systems;
- (e) [Low-emission manure processing and composting systems;]
- (f) Low-emission animal housing systems;
- (g) Possibilities for limiting ammonia emissions from the use of mineral fertilizers.

[Parties should give a title to the code with a view to avoiding confusion with other codes of guidance. - ~~delete~~]

[7. The advisory code shall be reviewed and updated at least every five years and whenever the framework code is revised; it shall take into account the most recent insights and developments related to ammonia emissions abatement. The code should be unambiguously titled and as far as feasible linked to other codes of good agricultural practices describing good management of the overall nitrogen cycle.]

B. Nitrogen management, taking into account the full nitrogen cycle

[8. All available on-farm nitrogen sources and external nitrogen inputs should be used effectively. For that purpose, nitrogen input-output balances shall be established on demonstration farms representative of various farming systems and typical farming conditions. Farm-type-specific baseline values of these farm-level input-output balances shall be established as an average of the first five-year period after the date specified in paragraph 4 of this annex. During the second and subsequent five-year periods a relative improvement of 10 per cent (one option) of the nitrogen-use efficiency and/or a reduction of the nitrogen surplus of 10 per cent (one option) should be achieved relative to the previous five-year average for these demonstration farms. The improvement shall continue under a continuous programme until levels of high efficiency and low nitrogen surplus are achieved according to farm type, as specified in the Guidance Document.]

[9. Parties are encouraged to establish farm-level input-output balances on all farms {(Option A) with more than five livestock units; (Option B) with more than 50 livestock units for cattle farms, 200 livestock units for pigs or 40,000 places for poultry; (Option C) with more than 50 livestock units for cattle farms, 2,000 fattener pigs, 750 sows or 40,000 poultry}, after the date specified in paragraph 4 of this annex. These input-output balances can be used to show a relative improvement until a level of high efficiency is achieved, as specified in the Guidance Document.]

[10. National nitrogen budgets for agriculture shall be established, based on available statistics {annually (option A); every three years (option B); every five years (option C)}, in order to monitor the changes in overall losses of reactive nitrogen from agriculture, including emissions of ammonia and nitrous oxide to air and the leaching of N to groundwater and surface water.]

C. Livestock feeding strategies

[11. Low-protein feeding strategies shall be used on all farms, where animals are housed and where the diet is largely based on concentrate feed, with more than {five livestock units (option A); 50 livestock units for cattle farms or 200 livestock units for pigs or 40,000 places for poultry (option B); 50 livestock units for cattle farms or 2,000 fattener pigs or 750 sows or 40,000 poultry (option C)}, as specified in the Guidance Document.]

D. Animal housing

[12.] [10. Within one year from the date of entry into force of the present Protocol for it, a Party shall use, for new animal housing on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, housing systems which have been shown to reduce emissions by 20 per cent or more compared to the reference (as listed in the Guidance Document) V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto), or other systems or techniques with a demonstrably equivalent efficiency. 2/ Applicability may be limited for animal welfare reasons, for instance in straw-based systems for pigs and aviary and free-range systems for poultry. - delete] [For animal housing, systems shall be used (as listed in the Guidance Document) that have been shown to reduce emissions as specified in table 1 below.]

[Table 1
Ammonia emission reduction requirements for animal housing

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/conditions</i>
Existing pig and poultry housing on farms with >2,000 fattening pigs or >750 sows or >40,000 poultry	20%	{Note: This target can generally be met with negligible additional net costs}
New or largely rebuilt cattle housing ^b	25%	As far as a Party considers it feasible and acceptable for animal welfare reasons. When it is considered not feasible, this shall be documented
New or largely rebuilt pig housing ^b	{60% (option A); 35% (option B); 25% (option C)}	A relaxation of the {35% (option A); 25% (option B)} reduction requirement applies for locations where the average air temperature of the warmest month exceeds 20° C (based on a five-year mean) {Note: The net cost of option C is negligible. For warm countries there is negligible net cost to option B}

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/conditions</i>
New and largely rebuilt broiler housing ^b	20%	Includes chicken, turkeys, geese and other table birds {Note: The net cost of meeting this target is negligible for all countries}
New and largely rebuilt layer housing ^b	{60% (option A); 50% (caged layer hens) and 60% (non-caged layer hens) (option B); 30% (caged layer hens) and 60% (non-caged layer hens) (option C)}	{Note: As there are larger costs for option A, this target might be restricted to new farms with >40,000 birds}
New and largely rebuilt animal housing on farms for animals other than those already listed in this table ^b	Use of low-emission housing systems	As far as they are considered technically and economically feasible. When it is considered not feasible, this should be reported

^a The reference specified is that listed in the Guidance Document.

^b Livestock farms with five livestock units or less would be exempt from these requirements.]

E. Manure storage [outside of animal houses]

[13.] [8. Within one year of the date of entry into force of the present Protocol for it, a Party shall use for new slurry stores on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, - ~~delete~~] **[For new slurry stores outside of animal houses for cattle, pig and poultry,]** low-emission storage systems or techniques **[shall be used]** that have been shown to reduce ammonia emissions by [40 per cent - ~~delete~~] **[[80 per cent (option A); 60 per cent (option B); 40 per cent (option C)]]** or more compared to the reference, as listed in the Guidance Document [V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto, or other systems or techniques with a demonstrably equivalent efficiency. 2/ - ~~delete~~].

[14.] [9. For existing slurry stores on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, a Party shall achieve ammonia emission reductions of 40 per cent insofar as the Party considers the necessary techniques to be technically and economically feasible. 2/ The timescales for the application of these measures shall be as follows: 31 December 2009 for Parties with economies in transition and 31 December 2007 for all other Parties. 1/ - ~~delete~~] **[For existing slurry stores on farms with more than five livestock units (option A) low-emission storage systems or techniques shall be used that have been shown to reduce ammonia emissions by 60 per cent as compared with the reference described in the Guidance Document. For existing very large lagoons, ammonia emission reductions of 40 per cent should be achieved, as far as the Party considers it technically and economically feasible. No targets for options B and C.]**

[15. For existing and new stores for solid manure, low-emission storage systems such as described in the Guidance Document should be used, so far as the Party considers them technically and economically feasible. When it is considered not feasible, this should be reported.]

[16. As far as technically and economically feasible, all livestock farms should have sufficient manure storage capacity to allow manure to be applied at times most suitable for crop growth.]

[Manure processing and composting

17. Whenever manure-processing and composting systems are used, these should be low-emission systems, as far as it is considered feasible.]

F. Manure application

[18.] [6. Each Party shall ensure that low-emission slurry application techniques (as listed in guidance document V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto), that have been shown to reduce emissions by at least 30 per cent compared to the reference specified in that guidance document are used as far as the Party in question considers them applicable, taking into-account local soil and geomorphological conditions, slurry type and farm structure. The timescales for the application of these measures shall be: 31 December 2009 for Parties with economies in transition and 31 December 2007 for other Parties. 1/ Within one year from the date of entry into force of the present Protocol for it, a Party shall ensure that solid manure applied to land to be ploughed shall be incorporated within at least 24 hours of spreading as far as it considers this measure applicable, taking account of local soil and geomorphological conditions and farm structure. - delete] **[For slurry and solid manure application, approaches shall be used (as listed in the Guidance Document) that have been shown to reduce emissions as specified in table 2 below. This provision applies to the land application of slurry and solid manure from all livestock types to both arable land and grassland.]**

[Table 2 (Option A)

Ammonia emission reduction requirements for slurry and solid manure application to arable land and grassland

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/conditions</i>
For slurry application to arable land and grassland and for solid manure application to bare soil	To use methods that reduce emissions by at least 60% compared with the reference method	Small farms^b Specific soil conditions^c
For slurry application to solid-seeded winter cereal crops after seedling emergence	To use methods that reduce emissions by at least 50% compared with the reference method	{Note: A relaxation of the requirement applies because the most effective low-emission methods are not suitable in this situation }

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/conditions</i>
For solid manure application only to grassland or arable crops after sowing	To use methods that reduce emissions by at least 30% compared with the reference	The reduction should be achieved as far as the Party considers it feasible. When it is considered not feasible, this should be reported {Note: A relaxation of the requirement applies because the most effective low-emission methods are not suitable in this situation}

^a The reference specified is that listed in the Guidance Document.

^b For livestock farms with less than 50 livestock units for cattle or 200 livestock units for pigs or 40,000 poultry, this requirement is relaxed to a 30% reduction. For livestock farms with less than five livestock units, this requirement applies only as far as the Party considers it feasible. The relaxation and exemption do not apply to manure transported for application to arable farms.

^c A relaxation of the requirement to a 30% reduction compared with the reference applies due to technical feasibility in the case of fields with: (i) stony soils, (ii) high clay soils (>35% clay particle content) in very dry conditions, (iii) peat soils (>25% organic matter content), and (iv) a slope of more than 15% from horizontal.]

[Table 2 (Option B)

Ammonia emission reduction requirements for slurry and solid manure application to arable land and grassland

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/conditions</i>
For slurry application to arable land and grassland and for solid manure application to bare soil	To use methods that reduce emissions by at least 30% compared with the reference method	Small farms^b Use of small spreaders^c {Note: Exemptions for specific soil conditions are not needed for this option}
For solid manure application only to grassland or arable crops after sowing	To use methods that reduce emissions by at least 30% compared with the reference method	The reduction should be achieved as far as the Party considers it feasible. When it is considered not feasible, this should be reported {Note: Relaxation of the requirement applies because the most effective low-emission methods are not suitable in this situation }

^a The reference specified is that listed in the Guidance Document.

^b For livestock farms with less than five livestock units this requirement applies only as far as the Party considers it feasible. The exemption does not apply to manure transported for application to arable farms.

^c When using existing mobile slurry tankers and solid manure spreaders having less than 3m³ capacity, this requirement applies only as far as the Party considers it feasible.]

[Table 2 (option C)]

Ammonia emission reduction requirements for slurry and solid manure application to arable land and grassland

<i>Category</i>	<i>Minimum emission reduction compared with the reference^a</i>	<i>Exemptions/Conditions</i>
For slurry application to arable land and grassland and for solid manure application to bare soil	To use methods that reduce emissions by at least 30% compared with the reference method	Small farms^b Use of small spreaders^c {Note: Exemptions for specific soil conditions are not needed for this option}
For solid manure application only to grassland or arable crops after sowing	To use methods that reduce emissions by at least 30% compared with the reference method	The reduction should be achieved as far as the Party considers it feasible. When it is considered not feasible, this should be reported {Note: A relaxation of the requirement applies because the most effective low-emission methods are not suitable in this situation }

^a The reference specified is that listed in the Guidance Document.

^b For livestock farms with less than 50 livestock units for cattle or 200 livestock units for pigs or 40,000 poultry, this requirement applies only as far as the Party considers it feasible. The relaxation does not apply to manure transported for application to arable farms.

^c When using any mobile slurry tankers and solid manure spreaders having less than 5m³ capacity, this requirement applies only as far as the Party considers it feasible.]

G. Urea and [ammonium carbonate - ~~delete~~] [ammonium-based] fertilizers

[19.] [4. Within one year of the date of entry into force of the present Protocol for it, a Party shall take such steps as are feasible to limit ammonia emissions from the use of solid fertilizers based on urea. - ~~delete~~] **[For field application of fertilizers based on urea, approaches shall be used (as listed in the Guidance Document) that have been shown to reduce ammonia emissions by at least {80 per cent (option A); 50 per cent (option B); 30 per cent (option C)} compared with the reference specified in that Guidance Document.]**

[20.] [5. - ~~delete~~] Within one year of the date of entry into force of the present Protocol for it, a Party shall prohibit the use of ammonium carbonate fertilizers.

[21. For fertilizers based predominantly on ammonium sulphate or ammonium phosphate when applied to calcareous soils, approaches shall be used (as listed in the Guidance Document), that have been shown to reduce mean ammonia emissions by at least {80 per cent (option A); 50 per cent (option B); 30 per cent (option C)} as compared with the reference specified in that Guidance Document.]^b

^b This paragraph was proposed based on current understanding, pending full documentation of further evaluations and fertilizer trials.

Note[s – ~~delete~~]

¹ For the purpose of the present annex, a country with an economy in transition refers to a Party that, by means of its instrument of ratification, acceptance, approval or accession, has made a declaration stating that it wishes to be treated as a country with an economy in transition for the purposes of [paragraphs 6 and/or 9 - ~~delete~~] [**paragraph 4**] of this annex.

² Where a Party judges that other systems or techniques with a demonstrably equivalent efficiency can be used for manure storage and animal housing in order to comply with paragraphs 8 and 10, or a Party judges the reduction of emissions from manure storage required under paragraph 9 not to be technically or economically feasible, documentation to this effect shall be reported in accordance with article 7, paragraph 1 (a). - ~~delete~~
