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CONVENTION

on long-range transboundary air pollution

(OJ L 171, 27.6.1981, p. 13)

Amended by:

		Official Journal		
		No	page	date
►M1	Protocol to the 1979 Convention on long-range transboundary air pollution on long-term financing of the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP)	L 181	2	4.7.1986
►M2	Protocol to the 1979 Convention on long-range transboundary air pollution concerning the control of emissions of nitrogen oxides or their transboundary fluxes	L 149	16	21.6.1993
►M3	Protocol to the 1979 Convention on long-range transboundary air pollution on further reduction of sulphur emissions	L 326	35	3.12.1998
►M4	Council Decision of 13 June 2003 on the accession of the European Community, to the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-Level Ozone (2003/507/EC)	L 179	3	17.7.2003
►M5	Protocol to the 1979 Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants	L 81	37	19.3.2004

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CONVENTION

on long-range transboundary air pollution

THE PARTIES TO THE PRESENT CONVENTION,

DETERMINED to promote relations and cooperation in the field of environmental protection,

AWARE of the significance of the activities of the United Nations Economic Commission for Europe in strengthening such relations and cooperation, particularly in the field of air pollution including long-range transport of air pollutants,

RECOGNIZING the contribution of the Economic Commission for Europe to the multilateral implementation of the pertinent provisions of the Final Act of the Conference on security and cooperation in Europe,

COGNIZANT of the references in the chapter on environment of the Final Act of the Conference on security and cooperation in Europe calling for cooperation to control air pollution and its effects, including long-range transport of air pollutants, and to the development through international cooperation of an extensive programme for the monitoring and evaluation of long-range transport of air pollutants, starting with sulphur dioxide and with possible extension to other pollutants,

CONSIDERING the pertinent provisions of the Declaration of the United Nations Conference on the human environment, and in particular principle 21, which expresses the common conviction that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

RECOGNIZING the existence of possible adverse effects, in the short and long term, of air pollution including transboundary air pollution,

CONCERNED that a rise in the level of emissions of air pollutants within the region as forecast may increase such adverse effects,

RECOGNIZING the need to study the implications of the long-range transport of air pollutants and the need to seek solutions for the problems identified,

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AFFIRMING their willingness to reinforce active international cooperation to develop appropriate national policies and by means of exchange of information, consultation, research and monitoring, to coordinate national action for combating air pollution including long-range transboundary air pollution,

HAVE AGREED as follows:

Definitions

Article 1

For the purposes of the present Convention:

(a) ‘air pollution’ means the introduction by man, directly or indirectly, of substances or energy into the air resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and material property and impair or interfere with amenities and other legitimate uses of the environment, and ‘air pollutants’ shall be construed accordingly;

(b) ‘long-range transboundary air pollution’ means air pollution whose physical origin is situated wholly or in part within the area under the national jurisdiction of one State and which has adverse effects in the area under the jurisdiction of another State at such a distance that it is not generally possible to distinguish the contribution of individual emission sources or groups of sources.

Fundamental principles

Article 2

The Contracting Parties, taking due account of the facts and problems involved, are determined to protect man and his environment against air pollution and shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution.

Article 3

The Contracting Parties, within the framework of the present Convention, shall, by means of exchanges of information, consultation, research and monitoring, develop without undue delay policies and strategies which shall serve as a means of combating the discharge of air pollutants, taking into account efforts already made at national and international level.

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Article 4

The Contracting Parties shall exchange information on and review their policies, scientific activities and technical measures aimed at combating, as far as possible, the discharge of air pollutants which may have adverse effects, thereby contributing to the reduction of air pollution including long-range transboundary air pollution.

Article 5

Consultations shall be held, upon request, at an early stage between, on the one hand, Contracting Parties which are actually affected by or exposed to a significant risk of long-range transboundary air pollution and, on the other hand, Contracting Parties within which and subject to whose jurisdiction a significant contribution to long-range transboundary air pollution originates, or could originate, in connexion with activities carried on or contemplated therein.

Air-quality management

Article 6

Taking into account Articles 2 to 5, the on-going research, exchange of information and monitoring and the results thereof, the cost and effectiveness of local and other remedies and in order to combat air pollution, in particular that originating from new or rebuilt installations, each Contracting Party undertakes to develop the best policies and strategies including air-quality management systems and, as part of them, control measures compatible with balanced development, in particular by using the best available technology which is economically feasible and low- and non-waste technology.

Research and development

Article 7

The Contracting Parties, as appropriate to their needs, shall initiate and cooperate in the conduct of research into and/or development of:

(a) existing and proposed technologies for reducing emissions of sulphur compounds and other major air pollutants, including technical and economic feasibility, and environmental consequences;

(b) instrumentation and other techniques for monitoring and measuring emission rates and ambient concentrations of air pollutants;

(c) improved models for a better understanding of the transmission of long-range transboundary air pollutants;

(d) the effects of sulphur compounds and other major air pollutants on human health and the environment, including agriculture, forestry, materials, aquatic and other natural ecosystems and visibility, with a view to establishing a scientific basis for dose/effect relationships designed to protect the environment;

(e) the economic, social and environmental assessment of alternative measures for attaining environmental objectives, including the reduction of long-range transboundary air pollution;

(f) education and training programmes related to the environmental aspects of pollution by sulphur compounds and other major air pollutants.

Exchange of information

Article 8

The Contracting Parties, within the framework of the Executive Body referred to in Article 10 and bilaterally, shall, in their common interests, exchange available information on:

(a) data on emissions at periods of time to be agreed upon, of agreed air pollutants, starting with sulphur dioxide, coming from grid-units of agreed size, or on the fluxes of agreed air pollutants, starting with sulphur dioxide, across national borders, at distances and at periods of time to be agreed upon;

(b) major changes in national policies and in general industrial development, and their potential impact, which would be likely to cause significant changes in long-range transboundary air pollution;

(c) control technologies for reducing air pollution relevant to long-range transboundary air pollution;

(d) the projected cost of the emission control of sulphur compounds and other major air pollutants on a national scale;

(e) meteorological and physico-chemical data relating to the processes during transmission;

(f) physico-chemical and biological data relating to the effects of long-range transboundary air pollution and the extent of the damage (1) which these data indicate can be attributed to long-range transboundary air pollution;

(g) national, sub-regional and regional policies and strategies for the control of sulphur compounds and other major air pollutants.

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(1) The present Convention does not contain a rule on State liability as to damage.

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Implementation and further development of the cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe

Article 9

The Contracting Parties stress the need for the implementation of the existing 'cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe' (hereinafter referred to as EMEP) and, with regard to the further development of this programme, agree to emphasize:

(a) the desirability of Contracting Parties joining in and fully implementing EMEP which, as a first step, is based on the monitoring of sulphur dioxide and related substances;

(b) the need to use comparable or standardized procedures for monitoring whenever possible;

(c) the desirability of basing the monitoring programme on the framework of both national and international programmes. The establishment of monitoring stations and the collection of data shall be carried out under the national jurisdiction of the country in which the monitoring stations are located;

(d) the desirability of establishing a framework for a cooperative environmental monitoring programme, based on and taking into account present and future national, sub-regional, regional and other international programmes;

(e) the need to exchange data on emissions at periods of time to be agreed upon, of agreed air pollutants, starting with sulphur dioxide, coming from grid-units of agreed size; or on the fluxes of agreed air pollutants, starting with sulphur dioxide, across national borders, at distances and at periods of time to be agreed upon. The method, including the model, used to determine the fluxes, as well as the method, including the model, used to determine the transmission of air pollutants based on the emissions per grid-unit, shall be made available and periodically reviewed, in order to improve the methods and the models;

(f) their willingness to continue the exchange and periodic updating of national data on total emissions of agreed air pollutants, starting with sulphur dioxide;

(g) the need to provide meteorological and physico-chemical data relating to processes during transmission;

(h) the need to monitor chemical components in other media such as water, soil and vegetation, as well as a similar monitoring programme to record effects on health and environment;

(i) the desirability of extending the national EMEP networks to make them operational for control and surveillance purposes.

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Executive Body

Article 10

1. The representatives of the Contracting Parties shall, within the framework of the Senior Advisers to Economic Commission for Europe Governments on Environmental Problems, constitute the Executive Body of the present Convention, and shall meet at least annually in that capacity.

2. The Executive Body shall:

(a) review the implementation of the present Convention;

(b) establish, as appropriate, working groups to consider matters related to the implementation and development of the present Convention and to this end to prepare appropriate studies and other documentation and to submit recommendations to be considered by the Executive Body;

(c) fulfil such other functions as may be appropriate under the provisions of the present Convention.

3. The Executive Body shall utilize the Steering Body for the EMEP to play an integral part in the operation of the present Convention, in particular with regard to data collection and scientific cooperation.

4. The Executive Body, in discharging its functions, shall, when it deems appropriate, also make use of information from other relevant international organizations.

Secretariat

Article 11

The Executive Secretary of the Economic Commission for Europe shall carry out, for the Executive Body, the following secretariat functions:

(a) to convene and prepare the meetings of the Executive Body;

(b) to transmit to the Contracting Parties reports and other information received in accordance with the provisions of the present Convention;

(c) to discharge the functions consigned by the Executive Body.

Amendments to the Convention

Article 12

1. Any Contracting Party may propose amendments to the present Convention.

2. The text of proposed amendments shall be submitted in writing to the Executive Secretary of the Economic Commission for Europe, who shall communicate them to all Contracting Parties. The Executive Body shall discuss proposed amendments at its next annual meeting provided that such proposals have been circulated by the Executive Secretary of the Economic Commission for Europe to the Contracting Parties at least 90 days in advance.

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3. An amendment to the present Convention shall be adopted by consensus of the representatives of the Contracting Parties, and shall enter into force for the Contracting Parties which have accepted it on the 90th day after the date on which two-thirds of the Contracting Parties have deposited their instruments of acceptance with the depositary. Thereafter, the amendment shall enter into force for any other Contracting Party on the 90th day after the date on which that Contracting Party deposits its instrument of acceptance of the amendment.

Settlement of disputes

Article 13

If a dispute arises between two or more Contracting Parties to the present Convention as to the interpretation or application of the Convention, they shall seek a solution by negotiation or by any other method of dispute settlement acceptable to the Parties to the dispute.

Signature

Article 14

1. The present Convention shall be open for signature at the United Nations Office at Geneva from 13 to 16 November 1979 on the occasion of the High-Level Meeting within the framework of the Economic Commission for Europe on the Protection of the Environment, by the member States of the Economic Commission for Europe as well as States having consultative status with the Economic Commission for Europe, pursuant to paragraph 8 of Economic and Social Council Resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States, members of the Economic Commission for Europe, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the present Convention.

2. In matters within their competence, such regional economic integration organizations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Convention attributes to their member States. In such cases, the member States of these organizations shall not be entitled to exercise such rights individually.

Ratification, acceptance, approval and accession

Article 15

1. The present Convention shall be subject to ratification, acceptance or approval.

2. The present Convention shall be open for accession as from 17 November 1979 by the States and organizations referred to in Article 14 (1).

3. The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of the depositary.

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Entry into force

Article 16

1. The present Convention shall enter into force on the 90th day after the date of deposit of the 24th instrument of ratification, acceptance, approval or accession.

2. For each Contracting Party which ratifies, accepts or approves the present Convention or accedes thereto after the deposit of the 24th instrument of ratification, acceptance, approval or accession, the Convention shall enter into force on the 90th day after the date of deposit by such Contracting Party of its instrument of ratification, acceptance, approval or accession.

Withdrawal

Article 17

At any time after five years from the date on which the present Convention has come into force with respect to a Contracting Party, that Contracting Party may withdraw from the Convention by giving written notification to the depositary. Any such withdrawal shall take effect on the 90th day after the date of its receipt by the depositary.

Authentic texts

Article 18

The original of the present Convention, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

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Protocol to the 1979 convention on long-range transboundary air pollution to abate acidification, eutrophication and ground-level ozone

THE PARTIES,

DETERMINED to implement the Convention on Long-range Transboundary Air Pollution,

AWARE that nitrogen oxides, sulphur, volatile organic compounds and reduced nitrogen compounds have been associated with adverse effects on human health and the environment,

CONCERNED that critical loads of acidification, critical loads of nutrient nitrogen and critical levels of ozone for human health and vegetation are still exceeded in many areas of the United Nations Economic Commission for Europe's region,

CONCERNED ALSO that emitted nitrogen oxides, sulphur and volatile organic compounds, as well as secondary pollutants such as ozone and the reaction products of ammonia, are transported in the atmosphere over long distances and may have adverse transboundary effects,

RECOGNISING that emissions from Parties within the United Nations Economic Commission for Europe's region contribute to air pollution on the hemispheric and global scales, and recognising the potential for transport between continents and the need for further study with regard to that potential,

RECOGNISING ALSO that Canada and the United States of America are bilaterally negotiating reductions of emissions of nitrogen oxides and volatile organic compounds to address the transboundary ozone effect,

RECOGNISING FURTHERMORE that Canada will undertake further reductions of emissions of sulphur by 2010 through the implementation of the Canada-wide Acid Rain Strategy for Post-2000, and that the United States is committed to the implementation of a nitrogen oxides reduction programme in the eastern United States and to the reduction in emissions necessary to meet its national ambient air quality standards for particulate matter,

RESOLVED to apply a multi-effect, multi-pollutant approach to preventing or minimising the excess of critical loads and levels,

TAKING INTO ACCOUNT the emissions from certain existing activities and installations responsible for present air pollution levels and the development of future activities and installations,

AWARE that techniques and management practices are available to reduce emissions of these substances,

RESOLVED to take measures to anticipate, prevent or minimise emissions of these substances, taking into account the application of the precautionary approach as set forth in principle 15 of the Rio Declaration on Environment and Development,

REAFFIRMING that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

CONSCIOUS of the need for a cost-effective regional approach to combating air pollution that takes account of the variations in effects and abatement costs between countries,

NOTING the important contribution of the private and non-governmental sectors to knowledge of the effects associated with these substances and available abatement techniques, and their role in assisting in the reduction of emissions to the atmosphere,

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BEARING IN MIND that measures taken to reduce emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international competition and trade,

TAKING INTO CONSIDERATION the best available scientific and technical knowledge and data on emissions, atmospheric processes and effects on human health and the environment of these substances, as well as on abatement costs, and acknowledging the need to improve this knowledge and to continue scientific and technical cooperation to further understanding of these issues,

NOTING that pursuant to the Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, adopted at Sofia on 31 October 1988, and the Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, adopted at Geneva on 18 November 1991, there is already provision to control emissions of nitrogen oxides and volatile organic compounds, and that the technical Annexes to both those Protocols already contain technical guidance for reducing these emissions,

NOTING ALSO that pursuant to the Protocol on Further Reduction of Sulphur Emissions, adopted at Oslo on 14 June 1994, there is already provision to reduce sulphur emissions in order to contribute to the abatement of acid deposition by diminishing the exceedances of critical sulphur depositions, which has been derived from critical loads of acidity according to the contribution of oxidised sulphur compounds to the total acid deposition in 1990,

NOTING FURTHERMORE that this Protocol is the first agreement under the Convention to deal specifically with reduced nitrogen compounds,

BEARING IN MIND that reducing the emissions of these substances may provide additional benefits for the control of other pollutants, including in particular transboundary secondary particulate aerosols, which contribute to human health effects associated with exposure to airborne particulates,

BEARING IN MIND ALSO the need to avoid, in so far as possible, taking measures for the achievement of the objectives of this Protocol that aggravate other health and environment-related problems,

NOTING that measures taken to reduce the emissions of nitrogen oxides and ammonia should involve consideration of the full biogeochemical nitrogen cycle and, so far as possible, not increase emissions of reactive nitrogen including nitrous oxide which could aggravate other nitrogen-related problems,

AWARE that methane and carbon monoxide emitted by human activities contribute, in the presence of nitrogen oxides and volatile organic compounds, to the formation of tropospheric ozone, and

AWARE ALSO of the commitments that Parties have assumed under the United Nations Framework Convention on Climate Change,

HAVE AGREED AS FOLLOWS:

Article 1

Definitions

For the purposes of the present Protocol,

1. ‘Convention’ means the Convention on Long-range Transboundary Air Pollution, adopted at Geneva on 13 November 1979;

2. ‘EMEP’ means the Cooperative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe;

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3. ‘Executive Body’ means the Executive Body for the Convention constituted under Article 10 (1) of the Convention;

4. ‘Commission’ means the United Nations Economic Commission for Europe;

5. ‘Parties’ means, unless the context otherwise requires, the Parties to the present Protocol;

6. ‘Geographical scope of EMEP’ means the area defined in Article 1 (4) of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), adopted at Geneva on 28 September 1984;

7. ‘Emission’ means the release of a substance from a point or diffuse source into the atmosphere;

8. ‘Nitrogen oxides’ means nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide (NO_2);

9. ‘Reduced nitrogen compounds’ means ammonia and its reaction products;

10. ‘Sulphur’ means all sulphur compounds, expressed as sulphur dioxide (SO_2);

11. ‘Volatile organic compounds’, or ‘VOCs’, means, unless otherwise specified, all organic compounds of an anthropogenic nature, other than methane, that are capable of producing photochemical oxidants by reaction with nitrogen oxides in the presence of sunlight;

12. ‘Critical load’ means a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge;

13. ‘Critical levels’ means concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur, according to present knowledge;

14. ‘Pollutant emissions management area’, or ‘PEMA’, means an area designated in Annex III under the conditions laid down in Article 3 (9);

15. ‘Stationary source’ means any fixed building, structure, facility, installation or equipment that emits or may emit sulphur, nitrogen oxides, volatile organic compounds or ammonia directly or indirectly into the atmosphere;

16. ‘New stationary source’ means any stationary source of which the construction or substantial modification is commenced after the expiry of one year from the date of entry into force of the present Protocol. It shall be a matter for the competent national authorities to decide whether a modification is substantial or not, taking into account such factors as the environmental benefits of the modification.

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Article 2

Objective

The objective of the present Protocol is to control and reduce emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds that are caused by anthropogenic activities and are likely to cause adverse effects on human health, natural ecosystems, materials and crops, due to acidification, eutrophication or ground-level ozone as a result of long-range transboundary atmospheric transport, and to ensure, as far as possible, that in the long term and in a step-by-step approach, taking into account advances in scientific knowledge, atmospheric depositions or concentrations do not exceed:

(a) for Parties within the geographical scope of EMEP and Canada, the critical loads of acidity, as described in Annex I;

(b) for Parties within the geographical scope of EMEP, the critical loads of nutrient nitrogen, as described in Annex I;

(c) for ozone:

  (i) for Parties within the geographical scope of EMEP, the critical levels of ozone, as given in Annex I;

  (ii) for Canada, the Canada-wide Standard for ozone;

  (iii) for the United States of America, the National Ambient Air Quality Standard for ozone.

Article 3

Basic obligations

1. Each Party having an emission ceiling in any table in Annex II shall reduce and maintain the reduction in its annual emissions in accordance with that ceiling and the timescales specified in that Annex. Each Party shall, as a minimum, control its annual emissions of polluting compounds in accordance with the obligations in Annex II.

2. Each Party shall apply the limit values specified in Annexes IV, V and VI to each new stationary source within a stationary source category as identified in those Annexes, no later than the timescales specified in Annex VII. As an alternative, a Party may apply different emission reduction strategies that achieve equivalent overall emission levels for all source categories together.

3. Each Party shall, in so far as it is technically and economically feasible and taking into consideration the costs and advantages, apply the limit values specified in Annexes IV, V and VI to each existing stationary source within a stationary source category as identified in those Annexes, no later than the timescales specified in Annex VII. As an alternative, a Party may apply different emission reduction strategies that achieve equivalent overall emission levels for all source categories together or, for Parties outside the geographical scope of EMEP, that are necessary to achieve national or regional goals for acidification abatement and to meet national air quality standards.

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4. 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 the 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 present Protocol.

5. Each Party shall apply the limit values for the fuels and new mobile sources identified in Annex VIII, no later than the timescales specified in Annex VII.

6. Each Party should apply the best available techniques to mobile sources and to each new or existing stationary source, taking into account guidance documents I to V adopted by the Executive Body at its seventeenth session (Decision 1999/1) and any amendments thereto.

7. Each Party shall take appropriate measures based, *inter alia,* on scientific and economic criteria to reduce emissions of volatile organic compounds associated with the use of products not included in Annexes VI or VIII. The Parties shall, no later than at the second session of the Executive Body after the entry into force of the present Protocol, consider with a view to adopting an annex on products, including criteria for the selection of such products, limit values for the volatile organic compound content of products not included in Annex VI or VIII, as well as timescales for the application of the limit values.

8. Each Party shall, subject to paragraph (10):

(a) apply, as a minimum, the ammonia control measures specified in Annex IX;

(b) apply, where it considers it appropriate, the best available techniques for preventing and reducing ammonia emissions, as listed in guidance document V adopted by the Executive Body at its seventeenth session (Decision 1999/ 1) and any amendments thereto.

9. Paragraph (10) shall apply to any Party:

(a) whose total land area is greater than 2 million square kilometres;

(b) whose annual emissions of sulphur, nitrogen oxides, ammonia and/or volatile organic compounds contributing to acidification, eutrophication or ozone formation in areas under the jurisdiction of one or more other Parties originate predominantly from within an area under its jurisdiction that is listed as a PEMA in Annex III, and which has presented documentation in accordance with subparagraph (c) to this effect;

(c) which has submitted upon signature, ratification, acceptance or approval of, or accession to, the present Protocol a description of the geographical scope of one or more PEMAs for one or more pollutants, with supporting documentation, for inclusion in Annex III;

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(d) which has specified upon signature, ratification, acceptance or approval of, or accession to, the present Protocol its intention to act in accordance with this paragraph.

10. A Party to which this paragraph applies shall:

(a) if within the geographical scope of EMEP, be required to comply with the provisions of this Article and Annex II only within the relevant PEMA for each pollutant for which a PEMA within its jurisdiction is included in Annex III; or

(b) if not within the geographical scope of EMEP, be required to comply with the provisions of paragraphs (1), (2), (3), (5), (6) and (7) and Annex II, only within the relevant PEMA for each pollutant (nitrogen oxides, sulphur and/ or volatile organic compounds) for which a PEMA within its jurisdiction is included in Annex III, and shall not be required to comply with paragraph (8) anywhere within its jurisdiction.

11. Canada and the United States of America shall, upon their ratification, acceptance or approval of, or accession to, the present Protocol, submit to the Executive Body their respective emission reduction commitments with respect to sulphur, nitrogen oxides and volatile organic compounds for automatic incorporation into Annex II.

12. The Parties shall, subject to the outcome of the first review provided for under Article 10 (2), and no later than one year after completion of that review, commence negotiations on further obligations to reduce emissions.

Article 4

Exchange of information and technology

1. Each Party shall, in a manner consistent with its laws, regulations and practices and in accordance with its obligations in the present Protocol, create favourable conditions to facilitate the exchange of information, technologies and techniques, with the aim of reducing emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds by promoting *inter alia:*

1. the development and updating of databases on best available techniques, including those that increase energy efficiency, low-emission burners and good environmental practice in agriculture;

2. the exchange of information and experience in the development of less polluting transport systems;

3. direct industrial contacts and cooperation, including joint ventures;

4. the provision of technical assistance.

2. In promoting the activities specified in paragraph (1), each Party shall create favourable conditions for the facilitation of contacts and cooperation among appropriate organisations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

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Article 5

Public awareness

1. Each Party shall, in a manner consistent with its laws, regulations and practices, promote the provision of information to the general public, including information on:

(a) national annual emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds and progress towards compliance with the national emission ceilings or other obligations referred to in Article 3;

(b) depositions and concentrations of the relevant pollutants and, where applicable, these depositions and concentrations in relation to critical loads and levels referred to in Article 2;

(c) levels of tropospheric ozone;

(d) strategies and measures applied or to be applied to reduce air pollution problems dealt with in the present Protocol and set out in Article 6.

2. Furthermore, each Party may make information widely available to the public with a view to minimising emissions, including information on:

(a) less polluting fuels, renewable energy and energy efficiency, including their use in transport;

(b) volatile organic compounds in products, including labelling;

(c) management options for wastes containing volatile organic compounds that are generated by the public;

(d) good agricultural practices to reduce emissions of ammonia;

(e) health and environmental effects associated with the pollutants covered by the present Protocol;

(f) steps which individuals and industries may take to help reduce emissions of the pollutants covered by the present Protocol.

Article 6

Strategies, policies, programmes, measures and information

1. Each Party shall, as necessary and on the basis of sound scientific and economic criteria, in order to facilitate the implementation of its obligations under Article 3:

(a) adopt supporting strategies, policies and programmes without undue delay after the present Protocol enters into force for it;

(b) apply measures to control and reduce its emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds;

(c) apply measures to encourage the increase of energy efficiency and the use of renewable energy;

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(d) apply measures to decrease the use of polluting fuels;

(e) develop and introduce less polluting transport systems and promote traffic management systems to reduce overall emissions from road traffic;

(f) apply measures to encourage the development and introduction of low-polluting processes and products, taking into account guidance documents I to V adopted by the Executive Body at its seventeenth session (Decision 1999/1) and any amendments thereto;

(g) encourage the implementation of management programmes to reduce emissions, including voluntary programmes, and the use of economic instruments, taking into account guidance document VI adopted by the Executive Body at its seventeenth session (Decision 1999/ 1) and any amendments thereto;

(h) implement and further elaborate policies and measures in accordance with its national circumstances, such as the progressive reduction or phasing-out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all sectors that emit sulphur, nitrogen oxides, ammonia and volatile organic compounds which run counter to the objective of the Protocol, and apply market instruments;

(i) apply measures, where cost-effective, to reduce emissions from waste products containing volatile organic compounds.

2. Each Party shall collect and maintain information on:

(a) actual levels of emissions of sulphur, nitrogen compounds and volatile organic compounds, and of ambient concentrations and depositions of these compounds and ozone, taking into account, for those Parties within the geographical scope of EMEP, the work plan of EMEP;

(b) the effects of ambient concentrations and of the deposition of sulphur, nitrogen compounds, volatile organic compounds and ozone on human health, terrestrial and aquatic ecosystems and materials.

3. Any Party may take more stringent measures than those required by the present Protocol.

Article 7

Reporting

1. Subject to its laws and regulations and in accordance with its obligations under the present Protocol:

(a) each Party shall report, through the Executive Secretary of the Commission, to the Executive Body, on a periodic basis as determined by the Parties at a session of the Executive Body, information on the measures that it has taken to implement the present Protocol. Moreover:

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(i) where a Party applies different emission-reduction strategies under Article 3 (2) and (3), it shall document the strategies applied and its compliance with the requirements of those paragraphs;

(ii) where a Party judges certain limit values, as specified in accordance with Article 3 (3), not to be technically and economically feasible, taking into consideration the costs and advantages, it shall report and justify this;

(b) each Party within the geographical scope of EMEP shall report, through the Executive Secretary of the Commission, to EMEP, on a periodic basis to be determined by the Steering Body of EMEP and approved by the Parties at a session of the Executive Body, the following information:

(i) levels of emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds using, as a minimum, the methodologies and the temporal and spatial resolution specified by the Steering Body of EMEP;

(ii) levels of emissions of each substance in the reference year (1990) using the same methodologies and temporal and spatial resolution;

(iii) data on projected emissions and current reduction plans;

(iv) where it deems it appropriate, any exceptional circumstances justifying emissions that are temporarily higher than the ceilings established for it for one or more pollutants;

(c) parties in areas outside the geographical scope of EMEP shall make available information similar to that specified in subparagraph (b), if requested to do so by the Executive Body.

2. The information to be reported in accordance with paragraph (1)(a) shall be in conformity with a decision regarding format and content to be adopted by the Parties at a session of the Executive Body. The terms of this decision shall be reviewed as necessary to identify any additional elements regarding the format or the content of the information that is to be included in the reports.

3. In good time before each annual session of the Executive Body, EMEP shall provide information on:

(a) ambient concentrations and depositions of sulphur and nitrogen compounds as well as, where available, ambient concentrations of volatile organic compounds and ozone;

(b) calculations of sulphur and oxidised and reduced-nitrogen budgets and relevant information on the long-range transport of ozone and its precursors.

Parties in areas outside the geographical scope of EMEP shall make available similar information if requested to do so by the Executive Body.

4. The Executive Body shall, in accordance with Article 10 (2)(b), of the Convention, arrange for the preparation of information on the effects of depositions of sulphur and nitrogen compounds and concentrations of ozone.

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5. The Parties shall, at sessions of the Executive Body, arrange for the preparation, at regular intervals, of revised information on calculated and internationally optimised allocations of emission reductions for the States within the geographical scope of EMEP, using integrated assessment models, including atmospheric transport models, with a view to reducing further, for the purposes of Article 3 (1), the difference between actual depositions of sulphur and nitrogen compounds and critical load values as well as the difference between actual ozone concentrations and the critical levels of ozone specified in Annex I, or such alternative assessment methods as approved by the Parties at a session of the Executive Body.

Article 8

Research, development and monitoring

The Parties shall encourage research, development, monitoring and co-operation related to:

(a) the international harmonisation of methods for the calculation and assessment of the adverse effects associated with the substances addressed by the present Protocol for use in establishing critical loads and critical levels and, as appropriate, the elaboration of procedures for such harmonisation;

(b) the improvement of emission databases, in particular those on ammonia and volatile organic compounds;

(c) the improvement of monitoring techniques and systems and of the modelling of transport, concentrations and depositions of sulphur, nitrogen compounds and volatile organic compounds, as well as of the formation of ozone and secondary particulate matter;

(d) the improvement of the scientific understanding of the long-term fate of emissions and their impact on the hemispheric background concentrations of sulphur, nitrogen, volatile organic compounds, ozone and particu-late matter, focusing, in particular, on the chemistry of the free troposphere and the potential for intercontinental flow of pollutants;

(e) the further elaboration of an overall strategy to reduce the adverse effects of acidification, eutrophication and photochemical pollution, including synergisms and combined effects;

(f) strategies for the further reduction of emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds based on critical loads and critical levels as well as on technical developments, and the improvement of integrated assessment modelling to calculate internationally optimised allocations of emission reductions taking into account the need to avoid excessive costs for any Party. Special emphasis should be given to emissions from agriculture and transport;

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(g) the identification of trends over time and the scientific understanding of the wider effects of sulphur, nitrogen and volatile organic compounds and photochemical pollution on human health, including their contribution to concentrations of particulate matter, the environment, in particular acidification and eutrophication, and materials, especially historic and cultural monuments, taking into account the relationship between sulphur oxides, nitrogen oxides, ammonia, volatile organic compounds and tropospheric ozone;

(h) emission abatement technologies, and technologies and techniques to improve energy efficiency, energy conservation and the use of renewable energy;

(i) the efficacy of ammonia control techniques for farms and their impact on local and regional deposition;

(j) the management of transport demand and the development and promotion of less polluting modes of transport;

(k) the quantification and, where possible, economic evaluation of benefits for the environment and human health resulting from the reduction of emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds;

(l) the development of tools for making the methods and results of this work widely applicable and available.

Article 9

Compliance

Compliance by each Party with its obligations under the present Protocol shall be reviewed regularly. The Implementation Committee established by Decision 1997/2 of the Executive Body at its fifteenth session shall carry out such reviews and report to the Parties at a session of the Executive Body in accordance with the terms of the Annex to that Decision, including any amendments thereto.

Article 10

Reviews by the Parties at sessions of the Executive Body

1. The Parties shall, at sessions of the Executive Body, pursuant to Article 10 (2)(a), of the Convention, review the information supplied by the Parties, EMEP and subsidiary bodies of the Executive Body, the data on the effects of concentrations and depositions of sulphur and nitrogen compounds and of photochemical pollution as well as the reports of the Implementation Committee referred to in Article 9.

2. (a) The Parties shall, at sessions of the Executive Body, keep under review the obligations set out in the present Protocol, including:

(i) their obligations in relation to their calculated and internationally optimised allocations of emission reductions referred to in Article 7 (5);

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(ii) the adequacy of the obligations and the progress made towards the achievement of the objective of the present Protocol;

(b) Reviews shall 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 related to ammonia and volatile organic compounds, and the fulfilment of the obligations on emission levels;

(c) The procedures, methods and timing for such reviews shall be specified by the Parties at a session of the Executive Body. The first such review shall commence no later than one year after the present Protocol enters into force.

Article 11

Settlement of disputes

1. In the event of a dispute between any two or more Parties concerning the interpretation or application of the present Protocol, the parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice. The parties to the dispute shall inform the Executive Body of their dispute.

2. When ratifying, accepting, approving or acceding to the present Protocol, or at any time thereafter, a Party which is not a regional economic integration organisation may declare in a written instrument submitted to the Depositary that, in respect of any dispute concerning the interpretation or application of the Protocol, it recognises one or both of the following means of dispute settlement as compulsory *ipso facto* and without special agreement, in relation to any Party accepting the same obligation:

(a) submission of the dispute to the International Court of Justice;

(b) arbitration in accordance with procedures to be adopted by the Parties at a session of the Executive Body, as soon as practicable, in an annex on arbitration.

A Party which is a regional economic integration organisation may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b).

3. A declaration made under paragraph (2) shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the Depositary.

4. A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute agree otherwise.

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5. Except in a case where the parties to a dispute have accepted the same means of dispute settlement under paragraph (2), if after 12 months following notification by one party to another that a dispute exists between them, the parties concerned have not been able to settle their dispute through the means mentioned in paragraph (1), the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

6. For the purpose of paragraph (5), a conciliation commission shall be created. The commission shall be composed of an equal number of members appointed by each party concerned or, where parties in conciliation share the same interest, by the group sharing that interest, and a chairperson chosen jointly by the members so appointed. The commission shall render a recommendatory award, which the parties to the dispute shall consider in good faith.

Article 12

Annexes

The Annexes to the present Protocol shall form an integral part of the Protocol.

Article 13

Amendments and adjustments

1. Any Party may propose amendments to the present Protocol. Any Party to the Convention may propose an adjustment to Annex II to the present Protocol to add to it its name, together with emission levels, emission ceilings and percentage emission reductions.

2. Proposed amendments and adjustments shall be submitted in writing to the Executive Secretary of the Commission, who shall communicate them to all Parties. The Parties shall discuss the proposed amendments and adjustments at the next session of the Executive Body, provided that those proposals have been circulated by the Executive Secretary to the Parties at least 90 days in advance.

3. Amendments to the present Protocol, including amendments to Annexes II to IX, shall be adopted by consensus of the Parties present at a session of the Executive Body, and shall enter into force for the Parties which have accepted them on the 90th day after the date on which two thirds of the Parties have deposited with the Depositary their instruments of acceptance thereof. Amendments shall enter into force for any other Party on the 90th day after the date on which that Party has deposited its instrument of acceptance thereof.

4. Amendments to the Annexes to the present Protocol, other than to the Annexes referred to in paragraph 3, shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of 90 days from the date of its communication to all Parties by the Executive Secretary of the Commission, an amendment to any such Annex shall become effective for those Parties which have not submitted to the Depositary a notification in accordance with the provisions of paragraph (5), provided that at least 16 Parties have not submitted such a notification.

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5. Any Party that is unable to approve an amendment to an Annex, other than to an Annex referred to in paragraph (3), shall so notify the Depositary in writing within 90 days from the date of the communication of its adoption. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time substitute an acceptance for its previous notification and, upon deposit of an instrument of acceptance with the Depositary, the amendment to such an Annex shall become effective for that Party.

6. Adjustments to Annex II shall be adopted by consensus of the Parties present at a session of the Executive Body and shall become effective for all Parties to the present Protocol on the 90th day following the date on which the Executive Secretary of the Commission notifies those Parties in writing of the adoption of the adjustment.

Article 14

Signature

1. The present Protocol shall be open for signature at Gothenburg (Sweden) on 30 November and 1 December 1999, then at United Nations Headquarters in New York until 30 May 2000, by States members of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council Resolution 36 (IV) of 28 March 1947, and by regional economic integration organisations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organisations concerned are Parties to the Convention and are listed in Annex II.

2. In matters within their competence, such regional economic integration organisations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their Member States. In such cases, the Member States of these organisations shall not be entitled to exercise such rights individually.

Article 15

Ratification, acceptance, approval and accession

1. The present Protocol shall be subject to ratification, acceptance or approval by Signatories.

2. The present Protocol shall be open for accession as from 31 May 2000 by the States and organisations that meet the requirements of Article 14 (1).

3. The instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

Article 16

Depositary

The Secretary-General of the United Nations shall be the Depositary.

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Article 17

Entry into force

1. The present Protocol shall enter into force on the 90th day following the date on which the 16th instrument of ratification, acceptance, approval or accession has been deposited with the Depositary.

2. For each State and organisation that meets the requirements of Article 14 (1), which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the 16th instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the 90th day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 18

Withdrawal

At any time after five years from the date on which the present Protocol has come into force with respect to a Party, that Party may withdraw from it by giving written notification to the Depositary. Any such withdrawal shall take effect on the 90th day following the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

Article 19

Authentic texts

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

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ANNEX I

CRITICAL LOADS AND LEVELS

I. CRITICAL LOADS OF ACIDITY

A. **For Parties within the geographical scope of EMEP**

1. Critical loads (as defined in Article 1) of acidity for ecosystems are determined in accordance with the Convention's Manual on methodologies and criteria for mapping critical levels/loads and geographical areas where they are exceeded. They are the maximum amount of acidifying deposition an ecosystem can tolerate in the long term without being damaged. Critical loads of acidity in terms of nitrogen take account of nitrogen removal processes within an ecosystem (e.g. uptake by plants). Critical loads of acidity in terms of sulphur do not. A combined sulphur and nitrogen critical load of acidity considers nitrogen only when the nitrogen deposition is greater than the ecosystem nitrogen-removal processes. All critical loads reported by Parties are summarised for use in the integrated assessment modelling employed to provide guidance for setting the emission ceilings in Annex II.

B. **For Parties in North America**

2. For eastern Canada, critical sulphur plus nitrogen loads for forested ecosystems have been determined with scientific methodologies and criteria (1997 Canadian Acid Rain Assessment) similar to those in the Convention's Manual on methodologies and criteria for mapping critical levels/loads and geographical areas where they are exceeded. Eastern Canada critical-load values (as defined in Article 1) of acidity are for sulphate in precipitation expressed in kg/ha/year. Alberta in western Canada, where deposition levels are currently below the environmental limits, has adopted the generic critical-load classification systems used for soils in Europe for potential acidity. Potential acidity is defined by subtracting the total (both wet and dry) deposition of base cations from that of sulphur and nitrogen. In addition to critical loads for potential acidity, Alberta has established target and monitoring loads for managing acidifying emissions.

3. For the United States of America, the effects of acidification are evaluated through an assessment of the sensitivity of ecosystems, the total loading within ecosystems of acidifying compounds and the uncertainty associated with nitrogen-removal processes within ecosystems.

4. These loads and effects are used in integrated assessment modelling and provide guidance for setting the emission ceilings and/or reductions for Canada and the United States of America in Annex II.

II. CRITICAL LOADS OF NUTRIENT NITROGEN

For Parties within the geographical scope of EMEP

5. Critical loads (as defined in Article 1) of nutrient nitrogen (eutrophication) for ecosystems are determined in accordance with the Convention's Manual on methodologies and criteria for mapping critical levels/loads and geographical areas where they are exceeded. They are the maximum amount of eutrophying nitrogen deposition an ecosystem can tolerate in the long term without being damaged. All critical loads reported by Parties are summarised for use in the integrated assessment modelling employed to provide guidance for setting the emission ceilings in Annex II.

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III. CRITICAL LEVELS OF OZONE

A. **For Parties within the geographical scope of EMEP**

6. Critical levels (as defined in Article 1) of ozone are determined to protect plants in accordance with the Convention's Manual on methodologies and criteria for mapping critical levels/loads and geographical areas where they are exceeded. They are expressed as a cumulative exposure over a threshold ozone concentration of 40 ppb (parts per billion by volume). This exposure index is referred to as AOT40 (accumulated exposure over a threshold of 40 ppb). The AOT40 is calculated as the sum of the differences between the hourly concentration (in ppb) and 40 ppb for each hour when the concentration exceeds 40 ppb.

7. The long-term critical level of ozone for crops of an AOT40 of 3 000 ppb.hours for May to July (used as a typical growing season) and for daylight hours was used to define areas at risk where the critical level is exceeded. A specific reduction of exceedances was targeted in the integrated assessment modelling undertaken for the present Protocol to provide guidance for setting the emission ceilings in Annex II. The long-term critical level of ozone for crops is considered also to protect other plants such as trees and natural vegetation. Further scientific work is under way to develop a more differentiated interpretation of exceedances of critical levels of ozone for vegetation.

8. A critical level of ozone for human health is represented by the WHO Air Quality Guideline level for ozone of 120 $\mu g/m^3$ as an eight-hour average. In collaboration with the World Health Organisation's Regional Office for Europe (WHO/EURO), a critical level expressed as an AOT60 (accumulated exposure over a threshold of 60 ppb), i.e. 120 $\mu g/m^3$, calculated over one year, was adopted as a surrogate for the WHO Air Quality Guideline for the purpose of integrated assessment modelling. This was used to define areas at risk where the critical level is exceeded. A specific reduction of these exceedances was targeted in the integrated assessment modelling undertaken for the present Protocol to provide guidance for setting the emission ceilings in Annex II.

B. **For Parties in North America**

9. For Canada, critical levels of ozone are determined to protect human health and the environment and are used to establish a Canada-wide Standard for ozone. The emission ceilings in Annex II are defined according to the ambition level required to achieve the Canada-wide Standard for ozone.

10. For the United States of America, critical levels of ozone are determined to protect public health with an adequate margin of safety, to protect public welfare from any known or expected adverse effects, and are used to establish a National Ambient Air Quality Standard. Integrated assessment modelling and the Air Quality Standard are used in providing guidance for setting the emission ceilings and/or reductions for the United States of America in Annex II.

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ANNEX II

EMISSION CEILINGS

The emission ceilings listed in the tables below relate to the provisions of Article 3 (1) and (10), of the present Protocol. The 1980 and 1990 emission levels and the percentage emission reductions listed are given for information purposes only.

Table 1. Emission ceilings for sulphur (thousands of tonnes of SO_2 per year)

Party	Emission levels		Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
	1980	1990		
Armenia	141	73	73	0 %
Austria	400	91	39	– 57 %
Belarus	740	637	480	– 25 %
Belgium	828	372	106	– 72 %
Bulgaria	2 050	2 008	856	– 57 %
Canada national ([a])	4 643	3 236		
PEMA (SOMA)	3 135	1 873		
Croatia	150	180	70	– 61 %
Czech Republic	2 257	1 876	283	– 85 %
Denmark	450	182	55	– 70 %
Finland	584	260	116	– 55 %
France	3 208	1 269	400	– 68 %
Germany	7 514	5 313	550	– 90 %
Greece	400	509	546	7 %
Hungary	1 633	1 010	550	– 46 %
Ireland	222	178	42	– 76 %
Italy	3 757	1 651	500	– 70 %
Latvia	—	119	107	– 10 %

([a]) Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall submit an emission ceiling for sulphur, either at a national level or for its PEMA, and will endeavour to provide a ceiling for 2010. The PEMA for sulphur will be the sulphur oxides management area (SOMA) that was designated pursuant to Annex III to the Protocol on Further Reduction of Sulphur Emissions adopted at Oslo on 14 June 1994 as the south-east Canada SOMA. This is an area of 1 million km^2 which includes all the territory of the provinces of Prince Edward Island, Nova Scotia and New Brunswick, all the territory of the province of Quebec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Quebec-Ontario boundary intersects the James Bay coastline, and all the territory of the province of Ontario south of a straight line between the point where the Ontario-Quebec boundary intersects the James Bay coastline and Nipigon River near the north shore of Lake Superior.

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Party	Emission levels		Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
	1980	1990		
Liechtenstein	0,39	0,15	0,11	– 27 %
Lithuania	311	222	145	– 35 %
Luxembourg	24	15	4	– 73 %
Netherlands	490	202	50	– 75 %
Norway	137	53	22	– 58 %
Poland	4 100	3 210	1 397	– 56 %
Portugal	266	362	170	– 53 %
Republic of Moldova	308	265	135	– 49 %
Romania	1 055	1 311	918	– 30 %
Russian Federation (a)	7 161	4 460		
PEMA	1 062	1 133	635	– 44 %
Slovakia	780	543	110	– 80 %
Slovenia	235	194	27	– 86 %
Spain (a)	2 959	2 182	774	– 65 %
Sweden	491	119	67	– 44 %
Switzerland	116	43	26	– 40 %
Ukraine	3 849	2 782	1 457	– 48 %
United Kingdom	4 863	3 731	625	– 83 %
United States of America (b)				
European Community	26 456	16 436	4 059	– 75 %

(a) Figures apply to the European part within the EMEP area.

(b) Upon ratification, acceptance or approval of, or accession to, the present Protocol, the United States of America shall provide for inclusion in this Annex: (a) specific emission reduction measures applicable to mobile and stationary sources of sulphur to be applied either nationally or within a PEMA if it has submitted a PEMA for sulphur for inclusion in Annex III; (b) a value for total estimated sulphur emission levels for 1990, either national or for the PEMA; (c) an indicative value for total sulphur emission levels for 2010, either national or for the PEMA; and (d) associated estimates of the percentage reduction in sulphur emissions. Item (b) will be included in the table and items (a), (c) and (d) will be included in a footnote to the table.

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Table 2. Emission ceilings for nitrogen oxides (thousands of tonnes of NO2 per year)

Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
Armenia	46	46	0 %
Austria	194	107	– 45 %
Belarus	285	255	– 11 %
Belgium	339	181	– 47 %
Bulgaria	361	266	– 26 %
Canada ([a])	2 104		
Croatia	87	87	0 %
Czech Republic	742	286	– 61 %
Denmark	282	127	– 55 %
Finland	300	170	– 43 %
France	1 882	860	– 54 %
Germany	2 693	1 081	– 60 %
Greece	343	344	0 %
Hungary	238	198	– 17 %
Ireland	115	65	– 43 %
Italy	1 938	1 000	– 48 %
Latvia	93	84	– 10 %
Liechtenstein	0,63	0,37	– 41 %
Lithuania	158	110	– 30 %
Luxembourg	23	11	– 52 %
Netherlands	580	266	– 54 %
Norway	218	156	– 28 %
Poland	1 280	879	– 31 %
Portugal	348	260	– 25 %
Republic of Moldova	100	90	– 10 %
Romania	546	437	– 20 %
Russian Federation ([b])	3 600		
PEMA	360	265	– 26 %

([a]) Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall submit 1990 emission levels and 2010 emission ceilings for nitrogen oxides, either at a national level or for its PEMA for nitrogen oxides, if it has submitted one.

([b]) Figures apply to the European part within the EMEP area.

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Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
Slovakia	225	130	– 42 %
Slovenia	62	45	– 27 %
Spain ([a])	1 113	847	– 24 %
Sweden	338	148	– 56 %
Switzerland	166	79	– 52 %
Ukraine	1 888	1 222	– 35 %
United Kingdom	2 673	1 181	– 56 %
United States of America ([b])			
European Community	13 161	6 671	– 49 %

([a]) Figures apply to the European part within the EMEP area.

([b]) Upon ratification, acceptance or approval of, or accession to, the present Protocol, the United States of America shall provide for inclusion in this Annex: (a) specific emission reduction measures applicable to mobile and stationary sources of nitrogen oxides to be applied either nationally or within a PEMA if it has submitted a PEMA for nitrogen oxides for inclusion in Annex III; (b) a value for total estimated nitrogen oxide emission levels for 1990, either national or for the PEMA; (c) an indicative value for total nitrogen oxide emission levels for 2010, either national or for the PEMA; and (d) associated estimates of the percentage reduction in nitrogen oxide emissions. Item (b) will be included in the table and items (a), (c) and (d) will be included in a footnote to the table.

Table 3. Emission ceilings for ammonia (thousands of tonnes of NH_3 per year)

Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for2010 (base year 1990)
Armenia	25	25	0 %
Austria	81	66	– 19 %
Belarus	219	158	– 28 %
Belgium	107	74	– 31 %
Bulgaria	144	108	– 25 %
Croatia	37	30	– 19 %
Czech Republic	156	101	– 35 %
Denmark	122	69	– 43 %

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Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for2010 (base year 1990)
Finland	35	31	– 11 %
France	814	780	– 4 %
Germany	764	550	– 28 %
Greece	80	73	– 9 %
Hungary	124	90	– 27 %
Ireland	126	116	– 8 %
Italy	466	419	– 10 %
Latvia	44	44	0 %
Liechtenstein	0,15	0,15	0 %
Lithuania	84	84	0 %
Luxembourg	7	7	0 %
Netherlands	226	128	– 43 %
Norway	23	23	0 %
Poland	508	468	– 8 %
Portugal	98	108	10 %
Republic of Moldova	49	42	– 14 %
Romania	300	210	– 30 %
Russian Federation (a)	1 191		
PEMA	61	49	– 20 %
Slovakia	62	39	– 37 %
Slovenia	24	20	– 17 %
Spain (a)	351	353	1 %
Sweden	61	57	– 7 %
Switzerland	72	63	– 13 %
Ukraine	729	592	– 19 %
United Kingdom	333	297	– 11 %
European Community	3 671	3 129	– 15 %

(a) Figures apply to the European part within the EMEP area.

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Table 4. Emission ceilings for volatile organic compounds (thousands of tonnes of VOC per year)

Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
Armenia	81	81	0 %
Austria	351	159	– 55 %
Belarus	533	309	– 42 %
Belgium	324	144	– 56 %
Bulgaria	217	185	– 15 %
Canada ([a])	2 880		
Croatia	105	90	– 14 %
Czech Republic	435	220	– 49 %
Denmark	178	85	– 52 %
Finland	209	130	– 38 %
France	2 957	1 100	– 63 %
Germany	3 195	995	– 69 %
Greece	373	261	– 30 %
Hungary	205	137	– 33 %
Ireland	197	55	– 72 %
Italy	2 213	1 159	– 48 %
Latvia	152	136	– 11 %
Liechtenstein	1,56	0,86	– 45 %
Lithuania	103	92	– 11 %
Luxembourg	20	9	– 55 %
Netherlands	502	191	– 62 %
Norway	310	195	– 37 %
Poland	831	800	– 4 %
Portugal	640	202	– 68 %
Republic of Moldova	157	100	– 36 %
Romania	616	523	– 15 %
Russian Federation ([b])	3 566		
PEMA	203	165	– 19 %

([a]) Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall submit 1990 emission levels and 2010 emission ceilings for volatile organic compounds, either at a national level or for its PEMA for volatile organic compounds, if it has submitted one.

([b]) Figures apply to the European part within the EMEP area.

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Party	Emission levels 1990	Emission ceilings 2010	Percentage emission reductions for 2010 (base year 1990)
Slovakia	149	140	– 6 %
Slovenia	42	40	– 5 %
Spain ([b])	1 094	669	– 39 %
Sweden	526	241	– 54 %
Switzerland	292	144	– 51 %
Ukraine	1 369	797	– 42 %
United Kingdom	2 555	1 200	– 53 %
United States of America ([c])			
European Community	15 353	6 600	– 57 %

([b]) Figures apply to the European part within the EMEP area.

([c]) Upon ratification, acceptance or approval of, or accession to, the present Protocol, the United States of America shall provide for inclusion in this Annex: (a) specific emission reduction measures applicable to mobile and stationary sources of volatile organic compounds to be applied either nationally or within a PEMA if it has submitted a PEMA for volatile organic compounds for inclusion in Annex III; (b) a value for total estimated volatile organic compound emission levels for 1990, either national or for the PEMA; (c) an indicative value for total volatile organic compound emission levels for 2010, either national or for the PEMA; and (d) associated estimates of the percentage reduction in volatile organic compound emissions. Item (b) will be included in the table and items (a), (c) and (d) will be included in a footnote to the table.

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ANNEX III

DESIGNATED POLLUTANT EMISSIONS MANAGEMENT AREA (PEMA)

The following PEMA is listed for the purpose of the present Protocol:

Russian Federation PEMA

This is the area of Murmansk *oblast,* the Republic of Karelia, Leningrad *oblast* (including St. Petersburg), Pskov *oblast,* Novgorod *oblast* and Kaliningrad *oblast.* The boundary of the PEMA coincides with the State and administrative boundaries of these constituent entities of the Russian Federation.

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ANNEX IV

LIMIT VALUES FOR EMISSIONS OF SULPHUR FROM STATIONARY SOURCES

1. Section A applies to Parties other than Canada and the United States of America, section B applies to Canada and section C applies to the United States of America.

A. **Parties other than Canada and the United States of America**

2. For the purpose of section A, except Table 2 and paragraphs (11) and (12), limit value means the quantity of a gaseous substance contained in the waste gases from an installation that is not to be exceeded. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as Mg/ m^3), assuming standard conditions for temperature and pressure for dry gas (volume at 273,15 K, 101,3 kPa). With regard to the oxygen content of the exhaust gas, the values given in the tables below for each source category shall apply. Dilution for the purpose of lowering concentrations of pollutants in waste gases is not permitted. Start-up, shutdown and maintenance of equipment are excluded.

3. Emissions shall be monitored in all cases (1). Compliance with limit values shall be verified. The methods of verification can include continuous or discontinuous measurements, type approval, or any other technically sound method.

4. Sampling and analysis of pollutants, as well as reference measurement methods to calibrate any measurement system, shall be carried out in accordance with the standards laid down by the European Committee for Standardisation (CEN) or by the International Organisation for Standardisation (ISO). While awaiting the development of CEN or ISO standards, national standards shall apply.

5. Measurements of emissions should be carried out continuously when emissions of SO_2 exceed 75 kg/h.

6. In the case of continuous measurement for new plants, compliance with the emission standards is achieved if the calculated daily mean values do not exceed the limit value and if no hourly value exceeds the limit value by 100 %.

7. In the case of continuous measurements for existing plants, compliance with the emission standards is achieved if (a) none of the monthly mean values exceeds the limit values; and (b) 97 % of all the 48-hour mean values do not exceed 110 % of the limit values.

8. In the case of discontinuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the mean value based on an appropriate number of measurements under representative conditions does not exceed the value of the emission standard.

9. Boilers and process heaters with a rated thermal input exceeding 50 Mw_{th}:

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(1) Monitoring is to be understood as an overall activity, comprising measuring of emissions, mass balancing, etc. It can be carried out continuously or discontinuously.

▼**M4**

Table 1. Limit values for SO_x emissions released from boilers ([a])

	Thermal input (MW_{th})	Limit value ([b]) (mg SO_2/Nm^3)	Alternative for domestic solid fuels removal efficiency
Solid and liquid fuels, new installations	50-100	850	90 % ([d])
	100-300	850 - 200 ([c]) (linear decrease)	92 % ([d])
	> 300	200 ([c])	95 % ([d])
Solid fuels, existing installations	50-100	2 000	
	100-500	2 000-400 (linear decrease)	
	> 500	400	
	50-150		40 %
	150-500		40-90 % (linear increase)
	> 500		90 %
Liquid fuels, existing installations	50-300	1 700	
	300-500	1 700-400 (linear decrease)	
	> 500	400	
Gaseous fuels in general, new and existing installations		35	

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[a] In particular, the limit values shall not apply to:
- plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials, e.g. reheating furnaces, furnaces for heat treatment,
- post-combustion plants, i.e. any technical apparatus designed to purify the waste gases by combustion that is not operated as an independent combustion plant,
- facilities for the regeneration of catalytic cracking catalysts;,
- facilities for the conversion of hydrogen sulphide into sulphur,
- reactors used in the chemical industry,
- coke battery furnaces,
- cowpers,
- waste incinerators,
- plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

[b] The O_2 reference content is 6 % for solid fuels and 3 % for others.

[c] 400 with heavy fuel oil S < 0,25 %.

[d] If an installation reaches 300 Mg/Nm^3 SO2, it may be exempted from applying the removal efficiency.

▼**M4**

	Thermal input (MW_{th})	Limit value ([b]) (mg SO_2/Nm^3)	Alternative for domestic solid fuels removal efficiency
Liquefied gas, new and existing installations		5	
Low-calorific-value gases (e.g. gasification of refinery residues or combustion of coke oven gas)		new 400 existing 800	
Blast-furnace gas		new 200 existing 800	
New combustion plant in refineries (average of all new combustion installations)	> 50 (total refinery capacity)	600	
Existing combustion plant in refineries (average of all existing combustion installations)		1 000	

([b]) Референтното съдържание на O_2 е 6 % за твърдо гориво и 3 % за други горива.

10 Gas oil:

Table 2. Limit values for the sulphur content of gas oil ([a])

	Sulphur content (per cent by weight)
Gas oil	< 0,2 after 1 July 2000 < 0,1 after 1 January 2008

([a]) ‘Gas oil’ means any petroleum product within HS 2710, or any petroleum product which, by reason of its distillation limits, falls within the category of middle distillates intended for use as fuel and of which at least 85 % by volume, including distillation losses, distils at 350 °C. Fuels used in on-road and non-road vehicles and agricultural tractors are excluded from this definition. Gas oil intended for marine use is included in the definition if it meets the description above or it has a viscosity or density falling within the ranges of viscosity or density defined for marine distillates in Table I of ISO 8217 (1996).

11. Claus plant: for a plant that produces more than 50 Mg of sulphur a day:

(a) sulphur recovery 99,5 % for new plant;

(b) sulphur recovery 97 % for existing plant.

12. Titanium dioxide production: in new and existing installations, discharges arising from digestion and calcination steps in the manufacture of titanium dioxide shall be reduced to a value of not more than 10 kg of SO2-equivalent per Mg of titanium dioxide produced.

B. **Canada**

13. Limit values for controlling emissions of sulphur dioxide from new stationary sources in the following stationary source category will be determined on the basis of available information on control technology and levels including limit values applied in other countries and the following document: Canada Gazette, Part I. Department of the Environment. Thermal Power Generation Emissions — National Guidelines for New Stationary Sources. May 15, 1993, pp. 1633-1638.

▼**M4**

C. **United States of America**

14. Limit values for controlling emissions of sulphur dioxide from new stationary sources in the following stationarysource categories are specified in the following documents:

    (1) Electric Utility Steam Generating Units — 40 Code of Federal Regulations (C.F.R.) Part 60, Subpart D, and Subpart Da;

    (2) Industrial-Commercial-Institutional Steam Generating Units — 40 C.F.R. Part 60, Subpart Db, and Subpart Dc;

    (3) Sulphuric Acid Plants — 40 C.F.R. Part 60, Subpart H;

    (4) Petroleum Refineries — 40 C.F.R. Part 60, Subpart J;

    (5) Primary Copper Smelters — 40 C.F.R. Part 60, Subpart P;

    (6) Primary Zinc Smelters — 40 C.F.R. Part 60, Subpart Q;

    (7) Primary Lead Smelters — 40 C.F.R. Part 60, Subpart R;

    (8) Stationary Gas Turbines — 40 C.F.R. Part 60, Subpart GG;

    (9) Onshore Natural Gas Processing — 40 C.F.R. Part 60, Subpart LLL;

    (10) Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart Ea, and Subpart Eb;

    (11) Hospital/Medical/Infectious Waste Incinerators — 40 C.F.R. Part 60, Subpart Ec.

▼**M4**

ANNEX V

LIMIT VALUES FOR EMISSIONS OF NITROGEN OXIDES FROM STATIONARY SOURCES

1. Section A applies to Parties other than Canada and the United States of America, section B applies to Canada and section C applies to the United States of America.

A. **Parties other than Canada and the United States of America**

2. For the purpose of section A, limit value means the quantity of a gaseous substance contained in the waste gases from an installation that is not to be exceeded. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as mg/m^3), assuming standard conditions for temperature and pressure for dry gas (volume at 273,15 K, 101,3 kPa). With regard to the oxygen content of exhaust gas, the values given in the tables below for each source category shall apply. Dilution for the purpose of lowering concentrations of pollutants in waste gases is not permitted. Limit values generally address NO together with NO_2, commonly named NO_x, expressed as NO_2. Start-up, shutdown and maintenance of equipment are excluded.

3. Emissions shall be monitored in all cases (1). Compliance with limit values shall be verified. The methods of verification can include continuous or discontinuous measurements, type approval, or any other technically sound method.

4. Sampling and analysis of pollutants, as well as reference measurement methods to calibrate any measurement system, shall be carried out in accordance with the standards laid down by the European Committee for Standardisation (CEN) or by the International Organisation for Standardisation (ISO). While awaiting the development of CEN or ISO standards, national standards shall apply.

5. Measurements of emissions should be carried out continuously when emissions of NO_x exceed 75 kg/h.

6. In the case of continuous measurements, except for existing combustion plant covered in Table 1, compliance with the emission standards is achieved if the calculated daily mean values do not exceed the limit value and if no hourly value exceeds the limit value by 100 %.

7. In the case of continuous measurements for existing combustion plants covered in Table 1, compliance with the emission standards is achieved if (a) none of the monthly mean values exceeds the emission limit values; and (b) 95 % of all the 48-hour mean values do not exceed 110 % of the emission limit values.

8. In the case of discontinuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the mean value based on an appropriate number of measurements under representative conditions does not exceed the value of the emission standard.

9. Boilers and process heaters with a rated thermal input exceeding 50 MW_{th}:

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(1) Monitoring is to be understood as an overall activity, comprising measuring of emissions, mass balancing, etc. It can be carried out continuously or discontinuously.

▼**M4**

Table 1. Limit values for NO_x emissions released from boilers ([a])

	Limit value (mg/Nm^3) ([b])
Solid fuels, new installations:	
— Boilers 50-100 MW_{th}	400
— Boilers 100-300 MW_{th}	300
— Boilers > 300 MW_{th}	200
Solid fuels, existing installations:	
— Solid in general	650
— Solid with less than 10 % volatile compounds	1 300
Liquid fuels, new installations:	
— Boilers 50-100 MW_{th}	400
— Boilers 100-300 MW_{th}	300
— Boilers > 300 MW_{th}	200
Liquid fuels, existing installations	450
Gaseous fuels, new installations:	
Fuel: natural gas	
— Boilers 50-300 MW_{th}	150
— Boilers > 300 MW_{th}	100
Fuel: all other gases	200
Gaseous fuels, existing installations	350

[a] In particular, the limit values shall not apply to:
- plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials, e.g. reheating furnaces, furnaces for heat treatment,
- post-combustion plants, i.e. any technical apparatus designed to purify the waste gases by combustion that is not operated as an independent combustion plant,
- facilities for the regeneration of catalytic cracking catalysts,
- facilities for the conversion of hydrogen sulphide into sulphur,
- reactors used in the chemical industry,
- coke battery furnaces,
- cowpers,
- waste incinerators,
- plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

[b] These values do not apply to boilers running less than 500 hours a year. The O_2 reference content is 6 % for solid fuels and 3 % for others.

10. Onshore combustion turbines with a rated thermal input exceeding 50 MW_{th}: the NO_x limit values expressed in mg/Nm^3 (with an O_2 content of 15 %) are to be applied to a single turbine. The limit values in Table 2 apply only above 70 % load.

▼**M4**

Table 2. Limit values for NO_x emissions released from onshore combustion turbines

> 50 MW_{th} (Thermal input at ISO conditions)	Limit value (mg/Nm^3)
New installations, natural gas (a)	50 (a)
New installations, liquid fuels (c)	120
Existing installations, all fuels (d)	
— Natural gas	150
— Liquid	200

(a) Natural gas is naturally occurring methane with not more than 20 % (by volume) of inerts and other constituents.
(b) 75 mg/Nm^3 if:
— combustion turbine used in a combined heat and power system, or
— combustion turbine driving compressor for public gas grid supply.
For combustion turbines not falling into either of the above categories, but having an efficiency greater than 35 %, determined at ISO base load conditions, the limit value shall be 50* n/35 where n is the combustion turbine efficiency expressed as a percentage (and determined at ISO base load conditions).
(c) This limit value applies only to combustion turbines firing light and medium distillates.
(d) The limit values do not apply to combustion turbines running less than 150 hours a year.

11. Cement production:

Table 3. Limit values for NO_x emissions released from cement production (a)

	Limit value (mg/Nm^3)
New installations (10 % O_2)	
— Dry kilns	500
— Other kilns	800
Existing installations (10 % O_2)	1 200

(a) Installations for the production of cement clinker in rotary kilns with a capacity > 500 mg/day or in other furnaces with a capacity > 50 Mg/day.

12. Stationary engines:

Table 4. Limit values for NO_x emissions released from new stationary engines

Capacity, technique, fuel specification	Limit value (a) (mg/Nm^3)
Spark ignition (= Otto) engines, 4-stroke, > 1 MW_{th}	
— Lean-burn engines	250
— All other engines	500

▼**M4**

Capacity, technique, fuel specification	Limit value ([a]) (mg/Nm^3)
Compression ignition (= Diesel) engines, > 5 MW_{th}	
— Fuel: natural gas (jet ignition engines)	500
— Fuel: heavy fuel oil	600
— Fuel: diesel oil or gas oil	500

([a]) These values do not apply to engines running less than 500 hours a year. The O_2 reference content is 5 %.

13. Production and processing of metals:

Table 5. Limit values for NO_x emissions released from primary iron and steel production ([a])

Capacity, technique, fuel specification	Limit value (mg/Nm^3)
New and existing sinter plants	400

([a]) Production and processing of metals: metal ore roasting or sintering installations, installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting with a capacity exceeding 2,5 Mg/hour, installations for the processing of ferrous metals (hot rolling mills > 20 Mg/hour of crude steel).

14. Nitric acid production:

Table 6. Limit values for NO_x emissions released from nitric acid production excluding acid concentration units

Capacity, technique, fuel specification	Limit value (mg/Nm^3)
— New installations	350
— Existing installations	450

B. **Canada**

15. Limit values for controlling emissions of nitrogen oxides (NO_x) from new stationary sources in the following stationary source categories will be determined on the basis of available information on control technology and levels including limit values applied in other countries and the following documents:

(a) Canadian Council of Ministers of the Environment (CCME). National Emission Guidelines for Stationary Combustion Turbines. December 1992. PN1072;

(b) Canada Gazette, Part I. Department of the Environment. Thermal Power Generation Emissions — National Guidelines for New Stationary Sources. May 15, 1993, pp. 1633-1638;

(c) CCME. National Emission Guidelines for Cement Kilns. March 1998. PN1284.

▼**M4**

C. **United States of America**

16. Limit values for controlling emissions of NO_x from new stationary sources in the followingstationary source categories are specified in the following documents:

    (a) Coal-fired Utility Units — 40 Code of Federal Regulations (C.F.R.) Part 76;

    (b) Electric Utility Steam Generating Units — 40 C.F.R. Part 60, Subpart D, and Subpart Da;

    (c) Industrial-Commercial-Institutional Steam Generating Units — 40 C.F.R. Part 60, Subpart Db;

    (d) Nitric Acid Plants — 40 C.F.R. Part 60, Subpart G;

    (e) Stationary Gas Turbines — 40 C.F.R. Part 60, Subpart GG;

    (f) Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart Ea, and Subpart Eb;

    (g) Hospital/Medical/Infectious Waste Incinerators — 40 C.F.R. Part 60, Subpart Ec.

▼**M4**

ANNEX VI

LIMIT VALUES FOR EMISSIONS OF VOLATILE ORGANIC COMPOUNDS FROM STATIONARY SOURCES

1. Section A applies to Parties other than Canada and the United States of America, section B applies to Canada and section C applies to the United States of America.

A. **Parties other than Canada and the United States of America**

2. This section of the present Annex covers the stationary sources of non-methane volatile organic compound (NMVOC) emissions listed in paragraphs (8) to (21) below. Installations or parts of installations for research, development and testing of new products and processes are not covered. Threshold values are given in the sector-specific tables below. They generally refer to solvent consumption or emission mass flow. Where one operator carries out several activities falling under the same subheading at the same installation on the same site, the solvent consumption or emission mass flow of such activities are added together. If no threshold value is indicated, the given limit value applies to all the installations concerned.

3. For the purpose of section A of the present Annex:

   (a) 'storage and distribution of petrol' means the loading of trucks, railway wagons, barges and seagoing ships at depots and mineral oil refinery dispatch stations, excluding vehicle refuelling at service stations covered by relevant documents on mobile sources;

   (b) 'adhesive coating' means any process in which an adhesive is applied to a surface, with the exception of adhesive coating and laminating associated with printing processes and wood and plastic lamination;

   (c) 'wood and plastic lamination' means any process to adhere together wood and/or plastic to produce laminated products;

   (d) 'coating processes' means the application of metal and plastic surfaces to: passenger cars, truck cabins, trucks, buses or wooden surfaces and covers any process in which a single or multiple application of a continuous film of coating is laid onto:

      (i) new vehicles (see below) defined as vehicles of category M1 and of category N1 insofar as they are coated at the same installation as Ml vehicles;

      (ii) truck cabins, defined as the housing for the driver, and all integrated housing for the technical equipment of category N2 and N3 vehicles;

      (iii) vans and trucks defined as category N1, N2 and N3 vehicles, but excluding truck cabins;

      (iv) buses defined as category M2 and M3 vehicles;

      (v) other metallic and plastic surfaces including those of aeroplanes, ships, trains, etc., wooden surfaces, textile, fabric, film and paper surfaces.

▼**M4**

This source category does not include the coating of substrates with metals by electrophoretic or chemical spraying techniques. If the coating process includes a step in which the same article is printed, that printing step is considered part of the coating process. However, printing processes operated as a separate activity are not included. In this definition:

— Ml vehicles are those used for the carriage of passengers and comprising not more than eight seats in addition to the drivers seat,

— M2 vehicles are those used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 Mg,

— M3 vehicles are those used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 Mg,

— N1 vehicles are those used for the carriage of goods and having a maximum mass not exceeding 3,5 Mg,

— N2 vehicles are those used for the carriage of goods and having a maximum mass exceeding 3,5 Mg but not exceeding 12 Mg,

— N3 vehicles are those used for the carriage of goods and having a maximum mass exceeding 12 Mg.

(e) ‘coil coating’ means any processes where coiled steel, stainless steel, coated steel, copper alloys or aluminium strip is coated with either a film-forming or laminate coating in a continuous process;

(f) ‘dry cleaning’ means any industrial or commercial process using VOCs in an installation to clean garments, furnishings and similar consumer goods with the exception of the manual removal of stains and spots in the textile and clothing industry;

(g) ‘manufacturing of coatings, varnishes, inks and adhesives’ means the manufacture of coating preparations, varnishes, inks and adhesives, and of intermediates as far as they are produced in the same installation by mixing pigments, resins and adhesive materials with organic solvents or other carriers. This category also includes dispersion, predispersion, realization of a certain viscosity or colour and packing the final products in containers;

(h) ‘printing’ means any process of reproduction of text and/or images in which, with the use of an image carrier, ink is transferred onto a surface and applies to the following subprocesses:

(i) flexography: a printing process using an image carrier of rubber or elastic photopolymers on which the printing inks are above the non-printing areas, using liquid inks that dry through evaporation;

(ii) heat set web offset: a web-fed printing process using an image carrier in which the printing and non-printing areas are in the same plane, where web-fed means that the material to be printed is fed to the machine from a reel as distinct from separate sheets. The non-printing area is treated to attract water and thus reject ink. The printing area is treated to receive and transmit ink to the surface to be printed. Evaporation takes place in an oven where hot air is used to heat the printed material;

▼**M4**

- (iii) publication rotogravure: rotogravure used for printing paper for magazines, brochures, catalogues or similar products, using toluene-based inks;
- (iv) rotogravure: a printing process using a cylindrical image carrier in which the printing area is below the non-printing area, using liquid inks that dry through evaporation. The recesses are filled with ink and the surplus is cleaned off the non-printing area before the surface to be printed contacts the cylinder and lifts the ink from the recesses;
- (v) rotary screen printing: a web-fed printing process in which the ink is passed onto the surface to be printed by forcing it through a porous image carrier, in which the printing area is open and the non-printing area is sealed off, using liquid inks that dry only through evaporation. Web-fed means that the material to be printed is fed to the machine from a reel as distinct from separate sheets;
- (vi) laminating associated to a printing process: the adhering of two or more flexible materials to produce laminates;
- (vii) varnishing: a process by which a varnish or an adhesive coating is applied to a flexible material for the purpose of later sealing the packaging material;

(i) ‘manufacturing of pharmaceutical products’ means chemical synthesis, fermentation, extraction, formulation and finishing of pharmaceutical products and, where carried out at the same site, the manufacture of intermediate products;

(j) ‘conversion of natural or synthetic rubber’ means any process of mixing, crushing, blending, calendering, extruding and vulcanisation of natural or synthetic rubber and additionally processes for the processing of natural or synthetic rubber to derive an end product;

(k) ‘surface cleaning’ means any process except dry cleaning using organic solvents to remove contamination from the surface of material, including degreasing; a cleaning process consisting of more than one step before or after any other processing step is considered as one surface-cleaning process. The process refers to the cleaning of the surface of products and not to the cleaning of process equipment;

(l) ‘extraction of vegetable oil and animal fat and refining of vegetable oil’ means the extraction of vegetable oil from seeds and other vegetable matter, the processing of dry residues to produce animal feed, and the purification of fats and vegetable oils derived from seeds, vegetable matter and/or animal matter;

(m) ‘vehicle refinishing’ means any industrial or commercial coating activity and associated degreasing activities performing:

- (i) the coating of road vehicles, or part of them, carried out as part of vehicle repair, conservation or decoration outside manufacturing installations, or
- (ii) the original coating of road vehicles, or part of them, with refinishing-type materials, where this is carried out away from the original manufacturing line, or
- (iii) the coating of trailers (including semi-trailers);

▼**M4**

(n) 'impregnation of wooden surfaces' means any process impregnating timber with preservative;

(o) 'standard conditions' means a temperature of 273,15 K and a pressure of 101,3 kPa;

(p) 'NMVOCs' comprise all organic compounds except methane which at 273,15 K show a vapour pressure of at least 0,01 kPa or which show a comparable volatility under the given application conditions;

(q) 'waste gas' means the final gaseous discharge containing NMVOCs or other pollutants from a stack or from emission abatement equipment into air. The volumetric flow rates shall be expressed in m^3/h at standard conditions;

(r) 'fugitive emission of NMVOCs' means any emission, not in waste gases, of NMVOC into air, soil and water as well as, unless otherwise stated, solvents contained in any product, and includes uncaptured emissions of NMVOCs released to the outside environment via windows, doors, vents and similar openings. Fugitive limit values are calculated on the basis of a solvent management plan (see Appendix I to the present Annex);

(s) 'total emission of NMVOCs' means the sum of fugitive emission of NMVOCs and emission of NMVOCs in waste gases;

(t) 'input' means the quantity of organic solvents and their quantity in preparations used when carrying out a process, including the solvents recycled inside and outside the installation, and which are counted every time they are used to carry out the activity;

(u) 'limit value' means the maximum quantity of a gaseous substance contained in the waste gases from an installation which is not to be exceeded during normal operation. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as mg C/Nm^3 unless specified otherwise), assuming standard conditions for temperature and pressure for dry gas. For solvent- using installations, limit values are given as mass unit per characteristic unit of the respective activity. Gas volumes that are added to the waste gas for cooling or dilution purposes shall not be considered when determining the mass concentration of the pollutant in the waste gas. Limit values generally address all volatile organic compounds except methane (no further distinction is made, e.g. in terms of reactivity or toxicity);

(v) 'normal operation' means all periods of operation except start-up and shutdown operations and maintenance of equipment;

(w) 'substances harmful to human health' are subdivided into two categories:

  (i) halogenated VOCs that have the possible risk of irreversible effects; or

  (ii) hazardous substances that are carcinogens, mutagens or toxic to reproduction or that may cause cancer, may cause heritable genetic damage, may cause cancer by inhalation, may impair fertility or may cause harm to the unborn child.

▼**M4**

4. The following requirements shall be satisfied:

   (a) emissions of NMVOCs shall be monitored (1) and compliance with limit values shall be verified. The methods of verification may include continuous or discontinuous measurements, type approval or any other technically sound method; furthermore, they shall be economically viable;

   (b) the concentrations of air pollutants in gas-carrying ducts shall be measured in a representative way. Sampling and analysis of all pollutants, as well as reference measurement methods to calibrate any measurement system, shall be carried out according to the standards laid down by the European Committee for Standardisation (CEN) or by the International Organisation for Standardisation (ISO). While awaiting the development of CEN or ISO standards, national standards shall apply;

   (c) if measurements of emissions of NMVOCs are required, they should be carried out continuously if emissions of NMVOCs exceed 10 kg of total organic carbon (TOC)/h in the exhaust duct downstream from an emission reduction installation and the hours of operation exceed 200 hours a year. For all other installations, discontinuous measurement is required as a minimum. For the approval of compliance, own approaches may be used provided that they result in equal stringency;

   (d) in the case of continuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the daily mean does not exceed the limit value during normal operation and no hourly average exceeds the limit values by 150 %. For the approval of compliance, own approaches may be used provided that they result in equal stringency;

   (e) in the case of discontinuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the mean value of all readings does not exceed the limit value and no hourly mean exceeds the limit value by 150 %. For the approval of compliance, own approaches may be used provided that they result in equal stringency;

   (f) all appropriate precautions shall be taken to minimize emissions of NMVOCs during start-up and shutdown, and in case of deviations from normal operation;

   (g) measurements are not required if end-of-pipe abatement equipment is not needed to comply with the limit values below and it can be shown that limit values are not exceeded.

5. The following limit values should be applied for waste gases, unless stated otherwise below:

   (a) 20 mg substance/m^3 for discharges of halogenated volatile organic compounds (which are assigned the risk phrase 'possible risk of irreversible effects'), where the mass flow of the sum of the considered compounds is greater than or equal to 100 g/h;

   (b) 2 mg/m^3 (expressed as the mass sum of individual compounds) for discharges of volatile organic compounds (which are assigned the following risk phrases: may cause cancer, heritable genetic damage, cancer by inhalation or harm to the unborn child; may impair fertility), where the mass flow of the sum of the considered compounds is greater than or equal to 10 g/h.

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(1) Monitoring is to be understood as an overall activity, comprising measuring of emissions, mass balancing, etc. It can be carried out continuously or discontinuously.

▼**M4**

6. For the source categories listed in paragraphs (9) to (21) below, the following revisions are relevant:

   (a) instead of applying the limit values for installations set out below, the operators of the respective installations may be allowed to use a reduction scheme (see Appendix II to the present Annex). The purpose of a reduction scheme is to give the operator the possibility to achieve by other means emission reductions equivalent to those achieved if given limit values were to be applied;

   (b) for fugitive emissions of NMVOCs, the fugitive emission values set out below shall be applied as a limit value. However, where it is demonstrated to the satisfaction of the competent authority that for an individual installation this value is not technically and economically feasible, the competent authority may exempt that installation provided that significant risks to human health or the environment are not expected. For each derogation, the operator must demonstrate to the satisfaction of the competent authority that the best available technique is used.

7. The limit values for VOC emissions for the source categories defined in paragraph (3) shall be as specified in paragraphs (8) to (21) below.

8. Storage and distribution of petrol:

Table 1. Limit values for VOC emissions released from the storage and distribution of petrol, excluding the loading of seagoing ships

Capacity, technique, further specification	Threshold values	Limit value
Vapour recovery unit serving storage and distribution facilities at refinery tank farms or terminals	5 000 m^3 petrol throughput annually	10 g VOC/Nm^3 including methane

Note: The vapour displaced by the filling of petrol storage tanks shall be displaced either into other storage tanks or into abatement equipment meeting the limit values in the table above.

9. Adhesive coating:

Table 2. Limit values for NMVOC emissions released from adhesive coating

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value	Limit value for fugitive emissions of NMVOCs (% of solvent input)
Footwear manufacture; new and existing installations	> 5	25 g solvent per pair	
Other adhesive coating, except footwear; new and existing installations	5-15	50 (^{a}) mg C/Nm^3	25
	> 15	50 (^{a}) mg C/Nm^3	20

(^{a}) If techniques are used which allow reuse of recovered solvent, the limit value shall be 150 mg C/Nm^3.

▼**M4**

10. Wood and plastic lamination:

Table 3. Limit values for NMVOC emissions released from wood and plastic lamination

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value for total emissions of NMVOCs
Wood and plastic laminating; new and existing installations	> 5	30 g NMVOC/m^2

11. Coating processes (metal and plastic surfaces in passenger cars, truck cabins, trucks, buses, wooden surfaces):

Table 4. Limit values for NMVOC emissions released from coating processes in the car industry

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year) ([a])	Limit value for total emissions of NMVOCs ([b])
New installations, car coating (M1, M2)	> 15 (and > 5 000 coated items a year)	45 g NMVOC/m^2 or 1,3 kg/ item and 33 g NMVOC/m^2
Existing installations, car coating (M1, M2)	> 15 (and > 5 000 coated items a year)	60 g NMVOC /m^2 or 1,9 kg/ item and 41 g NMVOC/m^2
New and existing installations, car coating (M1, M2)	> 15 (≤ 5 000 coated monocoques or > 3 500 coated chassis a year)	90 g NMVOC/m^2 or 1,5 kg/ item and 70 g NMVOC/m^2
New installations, coating of new truck cabins (N1, N2, N3)	> 15 (≤ 5 000 coated items a year)	65 g NMVOC/m^2
New installations, coating of new truck cabins (N1, N2, N3)	> 15 (> 5 000 coated items a year)	55 g NMVOC/m^2
Existing installations, coating of new truck cabins (N1, N2, N3)	> 15 (≤ 5 000 coated items a year)	85 g NMVOC/m^2

([a]) For a solvent consumption < 15 Mg a year (coating of cars), Table 14 on car refinishing applies.

([b]) The total limit values are expressed in terms of mass of solvent (g) emitted in relation to the surface area of product (m^2). The surface area of the product is defined as the surface area calculated from the total electrophoretic coating area and the surface area of any parts that might be added in successive phases of the coating process which are coated with the same coatings. The surface of the electrophoretic coating area is calculated using the formula: (2 * total weight of product shell): (average thickness of metal sheet * density of metal sheet).

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Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year) ([a])	Limit value for total emissions of NMVOCs ([b])
Existing installations, coating of new truck cabins (N1, N2, N3)	> 15 (> 5 000 coated items a year)	75 g NMVOC/m^2
New installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (≤ 2 500 coated items a year)	90 g NMVOC/m^2
New installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (> 2 500 coated items a year)	70 g NMVOC/m^2
Existing installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (≤ 2 500 coated items a year)	120 g NMVOC/m^2
Existing installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (> 2 500 coated items a year)	90 g NMVOC/m^2
New installations, coating of new buses (M3)	> 15 (≤ 2 000 coated items a year)	210 g NMVOC/m^2
New installations, coating of new buses (M3)	> 15 (> 2 000 coated items a year)	150 g NMVOC/m^2
Existing installations, coating of new buses (M3)	> 15 (≤ 2 000 coated items a year)	290 g NMVOC/m^2
Existing installations, coating of new buses (M3)	> 15 (> 2 000 coated items a year)	225 gNMVOC/m^2

([a]) For a solvent consumption < 15 Mg a year (coating of cars), Table 14 on car refinishing applies.

([b]) The total limit values are expressed in terms of mass of solvent (g) emitted in relation to the surface area of product (m^2). The surface area of the product is defined as the surface area calculated from the total electrophoretic coating area and the surface area of any parts that might be added in successive phases of the coating process which are coated with the same coatings. The surface of the electrophoretic coating area is calculated using the formula: (2 * total weight of product shell): (average thickness of metal sheet * density of metal sheet).

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Table 5. Limit values for NMVOC emissions released from coating processes in various industrial sectors

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emission of NMVOCs (% of solvent input)
New and existing installations: other coating, incl. metal, plastics, textile, fabric, foil and paper (excl. web screen printing for textiles, see printing)	5-15	100 ([a]) ([b])	25 ([b])
	> 15	50/75 ([b]) ([c]) ([d])	20 ([b])
New and existing installations: wood coating	15-25	100 ([a])	25
	> 25	50/75 ([c])	20

([a]) Limit value applies to coating applications and drying processes operated under contained conditions.

([b]) If contained coating conditions are not possible (boat construction, aircraft coating, etc.), installations may be granted exemption from these values. The reduction scheme of paragraph (6)(a) is then to be used, unless it is demonstrated to the satisfaction of the competent authority that this option is not technically and economically feasible. In this case, the operator must demonstrate to the satisfaction of the competent authority that the best available technique is used.

([c]) The first value applies to drying processes, the second to coating application processes.

([d]) If, for textile coating, techniques are used which allow reuse of recovered solvents, the limit value shall be 150 mg C/Nm^3 for drying and coating together.

12. Coil coating:

Table 6. Limit values for NMVOC emissions released from coil coating

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New installations	> 25	50 ([a])	5
Existing installations	> 25	50 ([a])	10

([a]) If techniques are used which allow reuse of recovered solvent, the limit value shall be 150 mg C/Nm^3.

13. Dry cleaning:

Table 7. Limit values for NMVOC emissions released from dry cleaning

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (NMVOC/kg)
New and existing installations	0	20 g ([a])

([a]) Limit value for total emissions of NMVOCs calculated as mass of emitted solvent per mass of cleaned and dried product.

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14. Manufacturing of coatings, varnishes, inks and adhesives:

Table 8. Limit values for NMVOC emissions released from manufacturing of coatings, varnishes, inks and adhesives

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations	100-1 000	150 (a)	5 (a) (b)
	> 1 000	150 (c)	3 (c) (b)

(a) A total limit value of 5 % of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.

(b) A total limit value of 3 % of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.

(c) The fugitive limit value does not include solvents sold as part of a preparation in a sealed container.

15. Printing (flexography, heat set web offset, publication rotogravure etc.):

Table 9. Limit values for NMVOC emissions released from printing processes

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations: heat set web offset	15-25	100	30 (a)
	> 25	20	30 (a)
New installations: publication rotogravure	> 25	75	10
Existing installations: publication rotogravure	> 25	75	15
New and existing installations: other rotogravure, flexogra-phy, rotary screen printing, lamination and varnishing units	15-25	100	25
	> 25	100	20
New and existing installations: rotary screen printing on textiles, paperboard	> 30	100	20

(a) Solvent residue in finished products is not to be considered as part of the fugitive emissions of NMVOCs.

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16. Manufacturing of pharmaceutical products:

Table 10. Limit values for NMVOC emissions released from manufacturing of pharmaceutical products

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New installations	> 50	20 (a) (b)	5 (b) (d)
Existing installations	> 50	20 (a) (d)	15 (c) (d)

(a) If techniques are used which allow reuse of recovered solvents, the limit value shall be 150 mg C/Nm^3.
(b) A total limit value of 5 % of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.
(c) A total limit value of 15 % of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.
(d) The fugitive limit value does not include solvents sold as part of a coatings preparation in a sealed container.

17. Conversion of natural or synthetic rubber:

Table 11. Limit values for NMVOC emission released from conversion of natural or synthetic rubber

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations: conversion of natural or synthetic rubber	> 15	20 (a) (b)	25 (a) (c)

(a) A total limit value of 25 % of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.
(b) If techniques are used which allow reuse of recovered solvent, the limit value shall be 150 mg C/Nm^3.
(c) The fugitive limit does not include solvents sold as part of a preparation in a sealed container.

18. Surface cleaning:

Table 12. Limit values for NMVOC emissions released from surface cleaning

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations: surface cleaning using substances mentioned in paragraph (3)(w)	1-5	20	15
	> 5	20	10
New and existing installations: other surface cleaning	2-10	75 (a)	20 (a)
	> 10	75 (a)	15 (a)

(a) Installations which demonstrate to the competent authority that the average organic solvent content of all cleaning material used does not exceed 30 % w/w are exempt from applying these values.

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19. Vegetable oil and animal fat extraction and vegetable oil refining processes:

Table 13. Limit values for NMVOC emissions released from extraction of vegetable and animal fat and refining of vegetable oil

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Total limit value (kg/Mg)	
New and existing installations	> 10	Animal fat:	1,5
		Castor:	3,0
		Rape seed:	1,0
		Sunflower seed:	1,0
		Soya beans (normal crush):	0,8
		Soya beans (white flakes):	1,2
		Other seeds and vegetable material:	3,0 ([a])
		All fractionation processes, excl. degumming ([b]):	1,5
		Degumming:	4,0

([a]) Limit values for total emissions of NMVOCs from installations treating single batches of seeds or other vegetable material shall be set case by case by the competent authorities on the basis of the best available technologies.

([b]) The removal of gum from the oil.

20. Vehicle refinishing:

Table 14. Limit values for NMVOC emissions released from vehicle refinishing

Capacity,technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations	> 0,5	50 ([a])	25

([a]) Compliance with limit values to be proven by 15-minute average measurements.

21. Impregnation of wooden surfaces:

Table 15. Limit values for NMVOC emissions released from impregnation of wooden surfaces

Capacity,technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^3)	Limit value for fugitive emission of NMVOCs (% of solvent input)
New and existing installations	> 25	100 ([a]) ([b])	45 ([b])

([a]) Does not apply to impregnation with creosote.

([b]) A total limit value of 11 kg solvent/m^3 of wood treated may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.

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B. **Canada**

22. Limit values for controlling emissions of volatile organic compounds (VOCs) from new stationary sources in the following stationary source categories will be determined on the basis of available information on control technology and levels, including limit values applied in other countries, and the following documents:

    (a) Canadian Council of Ministers of the Environment (CCME). Environmental Code of Practice for the Reduction of Solvent Emissions from Dry Cleaning Facilities. December 1992. PN1053;

    (b) CCME. Environmental Guideline for the Control of Volatile Organic Compounds Process Emissions from New Organic Chemical Operations. September 1993. PN1108;

    (c) CCME. Environmental Code of Practice for the Measurement and Control of Fugitive VOC Emissions from Equipment Leaks. October 1993. PN1106;

    (d) CCME. A Program to Reduce Volatile Organic Compound Emissions by 40 Percent from Adhesives and Sealants. March 1994. PN1116;

    (e) CCME. A Plan to Reduce Volatile Organic Compound Emissions by 20 Percent from Consumer Surface Coatings. March 1994. PN1114;

    (f) CCME. Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks. June 1995. PN1180;

    (g) CCME. Environmental Code of Practice for Vapour Recovery during Vehicle Refueling at Service Stations and Other Gasoline Dispersing Facilities. (Stage II) April 1995. PN1184;

    (h) CCME. Environmental Code of Practice for the Reduction of Solvent Emissions from Commercial and Industrial Degreasing Facilities. June 1995. PN1182;

    (i) CCME. New Source Performance Standards and Guidelines for the Reduction of Volatile Organic Compound Emissions from Canadian Automotive Original Equipment Manufacturer (OEM) Coating Facilities. August 1995. PN1234;

    (j) CCME. Environmental Guideline for the Reduction of Volatile Organic Compound Emissions from the Plastics Processing Industry. July 1997. PN1276; and

    (k) CCME. National Standards for the Volatile Organic Compound Content of Canadian Commercial/ Industrial Surface Coating Products —Automotive Refinishing. August 1997. PN1288.

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C. **United States of America**

23. Limit values for controlling emissions of VOCs from new stationary sources in the following stationary source categories are specified in the following documents:

(a) Storage Vessels for Petroleum Liquids — 40 Code of Federal Regulations (C.F.R.) Part 60, Subpart K, and Subpart Ka;

(b) Storage Vessels for Volatile Organic Liquids — 40 C.F.R. Part 60, Subpart Kb;

(c) Petroleum Refineries — 40 C.F.R. Part 60, Subpart J;

(d) Surface Coating of Metal Furniture — 40 C.F.R. Part 60, Subpart EE;

(e) Surface Coating for Automobile and Light Duty Trucks — 40 C.F.R. Part 60, Subpart MM;

(f) Publication Rotogravure Printing — 40 C.F.R. Part 60, Subpart QQ;

(g) Pressure Sensitive Tape and Label Surface Coating Operations — 40 C.F.R. Part 60, Subpart RR;

(h) Large Appliance, Metal Coil and Beverage Can Surface Coating — 40 C.F.R. Part 60, Subpart SS, Subpart TT and Subpart WW;

(i) Bulk Gasoline Terminals — 40 C.F.R. Part 60, Subpart XX;

(j) Rubber Tire Manufacturing — 40 C.F.R. Part 60, Subpart BBB;

(k) Polymer Manufacturing — 40 C.F.R. Part 60, Subpart DDD;

(l) Flexible Vinyl and Urethane Coating and Printing — 40 C.F.R. Part 60, Subpart FFF;

(m) Petroleum Refinery Equipment Leaks and Wastewater Systems — 40 C.F.R. Part 60, Subpart GGG and Subpart QQQ;

(n) Synthetic Fiber Production — 40 C.F.R. Part 60, Subpart HHH;

(o) Petroleum Dry Cleaners — 40 C.F.R. Part 60, Subpart JJJ;

(p) Onshore Natural Gas Processing Plants — 40 C.F.R. Part 60, Subpart KKK;

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(q) SOCMI Equipment Leaks, Air Oxidation Units, Distillation Operations and Reactor Processes — 40 C.F.R. Part 60, Subpart VV, Subpart III, Subpart NNN and Subpart RRR;

(r) Magnetic Tape Coating — 40 C.F.R. Part 60, Subpart SSS;

(s) Industrial Surface Coatings — 40 C.F.R. Part 60, Subpart TTT; and

(t) Polymeric Coatings of Supporting Substrates Facilities — 40 C.F.R. Part 60, Subpart VVV.

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Appendix I

SOLVENT MANAGEMENT PLAN

Introduction

1. This Appendix to the Annex on limit values for emissions of non-methane volatile organic compounds (NMVOCs) from stationary sources provides guidance on carrying out a solvent management plan. It identifies the principles to be applied (paragraph (2)), provides a framework for the mass balance (paragraph (3)) and provides an indication of the requirements for verification of compliance (paragraph (4)).

Principles

2. The solvent management plan serves the following purposes:

   (a) verification of compliance, as specified in the Annex;

   (b) identification of future reduction options.

Definitions

3. The following definitions provide a framework for the mass balance exercise:

   (a) Inputs of organic solvents:

      I1. The quantity of organic solvents or their quantity in preparations purchased that are used as input into the process in the time-frame over which the mass balance is being calculated.

      I2. The quantity of organic solvents or their quantity in preparations recovered and reused as solvent input into the process. (The recycled solvent is counted every time it is used to carry out the activity.)

   (b) Outputs of organic solvents:

      O1. Emission of NMVOCs in waste gases.

      O2. Organic solvents lost in water, if appropriate taking into account waste-water treatment when calculating O5.

      O3. The quantity of organic solvents that remains as contamination or residue in output of products from the process.

      O4. Uncaptured emissions of organic solvents to air. This includes the general ventilation of rooms, where air is released to the outside environment via windows, doors, vents and similar openings.

      O5. Organic solvents and/or organic compounds lost due to chemical or physical reactions (including, for example, those that are destroyed, e.g. by incineration or other waste-gas or waste-water treatments, or captured, e.g. by adsorption, as long as they are not counted under O6, O7 or O8).

      O6. Organic solvents contained in collected waste.

      O7. Organic solvents, or organic solvents contained in preparations, that are sold or are intended to be sold as a commercially valuable product.

      O8. Organic solvents contained in preparations recovered for reuse but not as input into the process, as long as they are not counted under O7.

      O9. Organic solvents released in other ways.

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Guidance on use of the solvent management plan for verification of compliance

4. The use of the solvent management plan will be determined by the particular requirement which is to be verified, as follows:

   (a) Verification of compliance with the reduction option mentioned in paragraph (6)(a) of the Annex, with a total limit value expressed in solvent emissions per unit product, or as otherwise stated in the Annex.

   (i) For all activities using the reduction option mentioned in paragraph (6)(a) of the Annex, the solvent management plan should be put into effect annually to determine consumption. Consumption can be calculated by means of the following equation:

   $C = I1 - O8$

   A parallel exercise should also be undertaken to determine solids used in coating in order to derive the annual reference emission and the target emission each year;

   (ii) for assessing compliance with a total limit value expressed in solvent emissions per unit product or as otherwise stated in the Annex, the solvent management plan should be put into effect annually to determine emission of NMVOCs. Emission of NMVOCs can be calculated by means of the following equation:

   $E = F + O1$

   Where F is the fugitive emission of NMVOC as defined in subparagraph (b)(i) below. The emission figure should be divided by the relevant product parameter;

   (b) Determination of fugitive emission of NMVOCs for comparison with fugitive emission values in the Annex:

   (i) *Methodology:* The fugitive emission of NMVOC can be calculated by means of the following equation:

   $F = I1 - O1 - O5 - O6 - O7 - O8$

   or

   $F = O2 + O3 + O4 + O9$

   This quantity can be determined by direct measurement of the quantities. Alternatively, an equivalent calculation can be made by other means, for instance by using the capture efficiency of the process.

   The fugitive emission value is expressed as a proportion of the input, which can be calculated by means of the following equation:

   $I = I1 + I2$

   (ii) *Frequency:* Fugitive emission of NMVOCs can be determined by a short but comprehensive set of measurements. This need not to be done again until the equipment is modified.

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Appendix II

REDUCTION SCHEME

Principles

1. The purpose of the reduction scheme is to allow the operator the possibility to achieve by other means emission reductions equivalent to those achieved if the limit values were to be applied. To that end the operator may use any reduction scheme specially designed for his installation, provided that in the end an equivalent emission reduction is achieved. Parties shall report on progress in achieving the same emission reduction, including experience with the application of the reduction scheme.

Practice

2. If applying coatings, varnishes, adhesives or inks, the following scheme can be used. Where it is inappropriate, the competent authority may allow an operator to apply any alternative exemption scheme which it is satisfied fulfils the principles outlined here. The design of the scheme takes into account the following facts:

   (a) where substitutes containing little or no solvent are still under development, a time extension must be given to the operator to implement his emission reduction plans;

   (b) the reference point for emission reductions should correspond as closely as possible to the emissions that would have resulted had no reduction action been taken.

3. The following scheme shall operate for installations for which a constant solid content of product can be assumed and used to define the reference point for emission reductions.

   (a) The operator shall forward an emission reduction plan which includes in particular decreases in the average solvent content of the total input and/or increased efficiency in the use of solids to achieve a reduction of the total emissions from the installation to a given percentage of annual reference emissions, termed the target emission. This must be done in the following time frame:

Time period		Maximum allowed total annual emissions
New installations	Existing installations	
By 31.10.2001	By 31.10.2005	Target emission × 1,5
By 31.10.2004	By 31.10.2007	Target emission

   (b) The annual reference emission is calculated as follows:

      (i) the total mass of solids in the quantity of coating and/or ink, varnish or adhesive consumed in a year is determined. Solids are all materials in coatings, inks, varnishes and adhesives that become solid once the water or the volatile organic compounds are evaporated;

      (ii) the annual reference emissions are calculated by multiplying the mass determined as in subpara- graph (i) by the appropriate factor listed in the table below. The competent authorities may adjust these factors for individual installations to reflect documented increased efficiency in the use of solids;

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Activity	Multiplication factor for use in subparagraph (b)(ii)
Rotogravure printing; flexography printing; laminating as part of a printing activity; printing; varnishing as part of a printing activity; wood coating; coating of textiles, fabric, film or paper; adhesive coating	4
Coil coating; vehicle refinishing	3
Food contact coating; aerospace coating	2,33
Other coatings and rotary screen printing	1,5

(iii) the target emission is equal to the annual reference emission multiplied by a percentage equal to:

- (The fugitive emission value + 15), for installations in the following sectors:
  - vehicle coating (solvent consumption < 15 Mg/year) and vehicle refinishing,
  - metal, plastic, textile, fabric, film and paper coating (solvent consumption between 5 and 15 Mg/year),
  - coating of wooden surfaces (solvent consumption between 15 and 25 Mg/year),
- (The fugitive emission value + 5) for all other installations;

(iv) compliance is achieved if the actual solvent emission determined from the solvent management plan is less than or equal to the target emission.

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ANNEX VII

TIMESCALES UNDER ARTICLE 3

1. The timescales for the application of the limit values referred to in Article 3(2) and (3), shall be:

   (a) for new stationary sources, one year after the date of entry into force of the present Protocol for the Party in question;

   (b) for existing stationary sources:

      (i) in the case of a Party that is not a country with an economy in transition, one year after the date of entry into force of the present Protocol or 31 December 2007, whichever is the later;

      (ii) in the case of a Party that is a country with an economy in transition, eight years after the entry into force of the present Protocol.

2. The timescales for the application of the limit values for fuels and new mobile sources referred to in Article 3(5), and the limit values for gas oil referred to in Annex IV, Table 2, shall be:

   (i) in the case of a Party that is not a country with an economy in transition, the date of entry into force of the present Protocol or the dates associated with the measures specified in Annex VIII and with the limit values specified in Annex IV, Table 2, whichever is the later; and

   (ii) in the case of a Party that is a country with an economy in transition, five years after the date of entry into force of the present Protocol or five years after the dates associated with the measures specified in Annex VIII and with the limit values in Annex IV, Table 2, whichever is the later.

   This timescale shall not apply to a Party to the present Protocol to the extent that that Party is subject to a shorter timescale with regard to gas oil under the Protocol on Further Reduction of Sulphur Emissions.

3. For the purpose of the present Annex, ‘a country with an economy in transition’ means a Party that has made with its instrument of ratification, acceptance, approval or accession a declaration that it wishes to be treated as a country with an economy in transition for the purposes of paragraphs (1) and/or (2) of this Annex.

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ANNEX VIII

LIMIT VALUES FOR FUELS AND NEW MOBILE SOURCES

INTRODUCTION

1. Section A applies to Parties other than Canada and the United States of America, section B applies to Canada and section C applies to the United States of America.

2. The Annex contains limit values for NO_x, expressed as nitrogen dioxide (NO_2) equivalents, and for hydrocarbons, most of which are volatile organic compounds, as well as environmental specifications for marketed fuels for vehicles.

3. The timescales for applying the limit values in this Annex are laid down in Annex VII.

A. Parties other than Canada and the United States of America

Passenger cars and light-duty vehicles

4. Limit values for power-driven vehicles with at least four wheels and used for the carriage of passengers (category M) and goods (category N) are given in Table 1.

Heavy-duty vehicles

5. Limit values for engines for heavy-duty vehicles are given in Tables 2 and 3 depending on the applicable test procedures.

Motorcycles and mopeds

6. Limit values for motorcycles and mopeds are given in Table 6 and Table 7.

Non-road vehicles and machines

7. Limit values for agricultural and forestry tractors and other non-road vehicle/machine engines are listed in Tables 4 and 5. Stage I (Table 4) is based on ECE Regulation 96, ‘Uniform provisions concerning the approval of compression-ignition (CI) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by the engine’.

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Fuel quality

8. Environmental quality specifications for petrol and diesel are given in Tables 8 to 11.

Table 1. Limit values for passenger cars and light-duty vehicles

Category		Class	To be applied from (b)	Reference mass (RW) (kg)	Limit values								
					Carbon monoxide		Hydrocarbons		Nitrogen oxides		Hydrocarbons and nitrogen oxides combined		Particulates (a)
					L1 (g/km)		L2 (g/km)		L3 (g/km)		L2+L3 (g/km)		L4 (g/km)
					Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Diesel
A	M (c)		1.1.2001	All (g)	2,3	0,64	0,20	—	0,15	0,50	—	0,56	0,05
	N1 (e)	I	1.1.2001 (f)	RW < 1 305	2,3	0,64	0,20	—	0,15	0,50	—	0,56	0,05
		II	1.1.2002	1 305 < RW ≤ 1 760	4,17	0,80	0,25	—	0,18	0,65	—	0,72	0,07
		III	1.1.2002	1 760 < RW	5,22	0,95	0,29	—	0,21	0,78	—	0,86	0,10
B	M (c)		1.1.2006	All	1,0	0,50	0,10	—	0,08	0,25	—	0,30	0,025
	N1 (e)	I	1.1.2006 (g)	RW ≤ 1 305	1,0	0,50	0,10	—	0,08	0,25	—	0,30	0,025
		II	1.1.2007	1 305 < RW ≤ 1 760	1,81	0,63	0,13	—	0,10	0,33	—	0,39	0,04
		III	1.1.2007	1 760 < RW	2,27	0,74	0,16	—	0,11	0,39	—	0,46	0,06

(a) For compression-ignition engines.

(b) The registration, sale or entry into service of new vehicles that fail to comply with the respective limit values shall be refused as from the dates given in this column and type approval may no longer be granted with effect from 12 months prior to these dates.

(c) Except vehicles whose maximum mass exceeds 2 500 kg.

(d) And those category M vehicles specified in note (c).

(e) 1.1.2002 for those category M vehicles specified in note (c).

(f) 1.1.2007 for those category M vehicles specified in note (c).

(g) Until 1 January 2003 vehicles in this category fitted with compression-ignition engines that are non-road vehicles and vehicles with a maximum mass of more than 2 000 kg which are designed to carry more than six occupants, including the driver, shall be considered as vehicles in category N1, class III, in row A.

▼**M4**

Table 2. Limit values for heavy-duty vehicles— European steady-state cycle (ESC) and European load-response (ELR) tests

	To be applied from (a)	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulates (g/kWh)	Smoke (m^{-1})
A	1.10.2001	2,1	0,66	5,0	0,10/0,13 (b)	0,8
B1	1.10.2006	1,5	0,46	3,5	0,02	0,5
B2	1.10.2009	1,5	0,46	2,0	0,02	0,5

(a) With effect from the given dates and except for vehicles and engines intended for export to countries that are not parties to the present Protocol and for replacement engines for vehicles in use, Parties shall prohibit the registration, sale, entry into service or use of new vehicles propelled by a compression-ignition or gas engine and the sale and use of new compression-ignition or gas engines if their emissions do not comply with the respective limit values. With effect from 12 months prior to these dates, type approval may be refused if the limit values are not complied with.

(b) For engines with a swept volume below 0,75 dm^3 per cylinder and a rated power speed above 3000 revolutions per minute.

Table 3. Limit values for heavy-duty vehicles — European transient cycle (ETC) test (a)

	To be applied from (b)	Carbon monoxide (g/kWh)	Non-methane hydrocarbons (g/kWh)	Methane (c) (g/kWh)	Nitrogen oxides (g/kWh)	Particulates (d) (g/kWh)
A (2000)	1.10.2001	5,45	0,78	1,6	5,0	0,16/0,21 (e)
B1 (2005)	1.10.2006	4,0	0,55	1,1	3,5	0,03
B2 (2008)	1.10.2009	4,0	0,55	1,1	2,0	0,03

(a) The conditions for verifying the acceptability of the ETC tests when measuring the emissions of gas-fuelled engines against the limit values applicable in row A shall be re-examined and, where necessary, modified in accordance with the procedure laid down in Article 13 of Directive 70/156/EEC.

(b) With effect from the given dates and except for vehicles and engines intended for export to countries that are not parties to the present Protocol and for replacement engines for vehicles in use, Parties shall prohibit the registration, sale, entry into service or use of new vehicles propelled by a compression-ignition or gas engine and the sale and use of new compression-ignition or gas engines if their emissions do not comply with the respective limit values. With effect from 12 months prior to these dates, type approval may be refused if the limit values are not complied with.

(c) For natural gas engines only.

(d) Not applicable to gas-fuelled engines at stage A and stages B1 and B2.

(e) For engines with a swept volume below 0,75 dm^3 per cylinder and a rated power speed above 3000 revolutions per minute.

Table 4. Limit values (stage I) for diesel engines for non-road mobile machines (measurement procedure ISO 8178)

Net power (P) (kW)	To be applied from (a)	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
$37 \leq P < 75$	31.3.1998	6,5	1,3	9,2	0,85
$75 \leq P < 130$	31.12.1998	5,0	1,3	9,2	0,70
$130 \leq P < 560$	31.12.1998	5,0	1,3	9,2	0,54

(a) With effect from the given date and with the exception of machinery and engines intended for export to countries that are not parties to the present Protocol, Parties shall permit the registration, where applicable, and placing on the market of new engines, whether or not installed in machinery, only if they meet the limit values set out in the table. Type approval for an engine type or family shall be refused with effect from 30 June 1998 if it fails to meet the limit values.

Note: These limits are engine-out limits and shall be achieved before any exhaust after-treatment service.

▼**M4**

Table 5. Limit values (stage II) for diesel engines for non-road mobile machines (measurement procedure ISO 8178)

Net power (P) (kW)	To be applied from ([a])	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
$130 \leq P < 560$	31.12.2001	3,5	1,0	6,0	0,2
$75 \leq P < 130$	31.12.2002	5,0	1,0	6,0	0,3
$37 \leq P < 75$	31.12.2003	5,0	1,3	7,0	0,4
$18 \leq P < 37$	31.12.2000	5,5	1,5	8,0	0,8

([a]) With effect from the given dates and with the exception of machinery and engines intended for export to countries that are not parties to the present Protocol, Parties shall permit the registration, where applicable, and placing on the market of new engines, whether or not installed in machinery, only if they meet the limit values set out in the table. Type approval for an engine type or family shall be refused with effect from 12 months prior to these dates if it fails to meet the limit values.

Table 6. Limit values for motorcycles and three- and four-wheelers (> 50 cm 3; > 45 km/h) to be applied from 17 June 1999 ([a])

Engine type	Limit values
Two-stroke	CO = 8 g/km HC = 4 g/km NO_x = 0,1 g/km
Four-stroke	CO = 13 g/km HC = 3 g/km NO_x = 0,3 g/km

([a]) Type approval shall be refused as from the given date if the vehicle's emissions do not meet the limit values.
Note: For three- and four-wheelers, the limit values have to be multiplied by 1,5.

Table 7. Limit values for mopeds ($\leq$ 50 cm^3; < 45 km/h)

Stage	To be applied from ([a])	Limit values	
		CO (g/km)	HC + NO_x (g/km)
I	17.6.1999	6,0 ([b])	3,0 ([b])
II	17.6.2002	1,0 ([c])	1,2

([a]) Type approval shall be refused as from the given dates if the vehicle's emissions do not meet the limit values.
([b]) For three- and four-wheelers, multiply by two.
([c]) For three- and four-wheelers, 3,5 g/km.

▼**M4**

Table 8. Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines

Type: Petrol

Parameter	Limits (a)	Test		Unit	
		Minimum	Maximum	Method (c)	Date of publication
Research octane number		95	—	EN 25164	1993
Motor octane number		85	—	EN 25163	1993
Reid vapour pressure, summer period	kPa	—	60	EN 12	1993
Distillation:					
— evaporated at 100 °C	% v/v	46	—	EN-ISO 3405	1988
— evaporated at 150 °C	% v/v	75	—		
Hydrocarbon analysis:					
— olefins	% v/v	—	18,0 (d)	ASTM D1319	1995
— aromatics		—	42	ASTM D1319	1995
— benzene		—	1	PrEN 12177	1995
Oxygen content	% m/m	—	2,7	EN 1601	1996
Oxygenates:					
— Methanol, stabilising agents must be added	% v/v	—	3	EN 1601	1996
— Ethanol, stabilising agents may be necessary	% v/v	—	5	EN 1601	1996
— Iso-propyl alcohol	% v/v	—	10	EN 1601	1996
— Tert-butyl alcohol	% v/v	—	7	EN 1601	1996
— Iso-butyl alcohol	% v/v	—	10	EN 1601	1996
— Ethers containing five or more carbon atoms per molecule	% v/v	—	15	EN 1601	1996
— Other oxygenates (e)	% v/v	—	10	EN 1601	1996
Sulphur content	mg/kg	—	150	PrEN-ISO/DIS 14596	1996

(a) The values quoted in the specification are 'true values'. In the establishment of their limit values, the terms of ISO 4259, 'Petroleum products — Determination and application of precision data in relation to methods of test', have been applied and, in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259 (published in 1995).

(b) EN — European standard; ASTM — American Society for Testing and Materials; DIS — Draft international standard.

(c) The summer period shall begin no later than 1 May and shall not end before 30 September. For Member States with arctic conditions the summer period shall begin no later than 1 June and not end before 31 August and the RVP is limited to 70 kPa.

(d) Except for regular unleaded petrol (minimum motor octane number (MON) of 81 and minimum research octane number (RON) of 91), for which the maximum olefin content shall be 21 % v/v. These limits shall not preclude the introduction on the market of a Member State of another unleaded petrol with lower octane numbers than set out here.

(e) Other mono-alcohols with a final distillation point no higher than the final distillation point laid down in national specifications or, where these do not exist, in industrial specifications for motor fuels.

Note: Parties shall ensure that, no later than 1 January 2000, petrol can be marketed within their territory only if it complies with the environmental specifications set out in Table 8. Where a Party determines that banning petrol with a sulphur content which does not comply with the specifications for sulphur content in Table 8, but does not exceed the current content, would raise severe difficulties for its industries in making the necessary changes in their manufacturing facilities by 1 January 2000, it may extend the time period of marketing within its territory until 1 January 2003 at the latest. In such a case the Party shall specify, in a declaration to be deposited together with its instrument of ratification, acceptance, approval or accession, that it intends to extend the time period and present written information on the reason for this to the Executive Body.

▼**M4**

Table 9. Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines

Type: Diesel fuel

Parameter	Unit	Limits (a)		Test	
		Minimum	Maximum	Method (b)	Date of publication
Cetane number		51	—	EN-ISO 5165	1992
Density at 15 °C	kg/m^3	—	845	EN-ISO 3675	1995
Distillation point: 95 %	°C	—	360	EN-ISO 3405	1988
Polycyclic aromatic hydrocarbons	% m/m	—	11	IP 391	1995
Sulphur content	mg/kg	—	350	PrEN-ISO/DIS 14596	1996

(a) The values quoted in the specification are 'true values'. In the establishment of their limit values, the terms of ISO 4259, 'Petroleum products — Determination and application of precision data in relation to methods of test', have been applied and, in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259 (published in 1995).

(b) EN — European standard; IP — The Institute of Petroleum; DIS — Draft international standard.

Note: Parties shall ensure that, no later than 1 January 2000, diesel fuel can be marketed within their territory only if it complies with the environmental specifications set out in Table 9. Where a Party determines that banning diesel fuel with a sulphur content which does not comply with the specifications for sulphur content in Table 9, but does not exceed the current content, would raise severe difficulties for its industries in making the necessary changes in their manufacturing facilities by 1 January 2000, it may extend the time period of marketing within its territory until 1 January 2003 at the latest. In such a case the Party shall specify, in a declaration to be deposited together with its instrument of ratification, acceptance, approval or accession, that it intends to extend the time period and present written information on the reason for this to the Executive Body.

▼**M4**

Table 10. Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines

Type: Petrol

Parameter	Limits (a)	Test		Unit	
		Minimum	Maximum	Method (b)	Date of publication
Research octane number		95		EN 25164	1993
Motor octane number		85		EN 25163	1993
Reid vapour pressure, summer period	kPa	—			
Distillation:					
— evaporated at 100 °C	% v/v	—	—		
— evaporated at 150 °C	% v/v % v/v	—	—		
Hydrocarbon analysis:					
— olefins	% v/v	—			
— aromatics	% v/v	—	35	ASTM D1319	1995
— benzene	% v/v	—			
Oxygen content	% m/m	—			
Sulphur content	mg/kg	—	50	PrEN-ISO/DIS 14596	1996

(a) The values quoted in the specification are ‘true values’. In the establishment of their limit values, the terms of ISO 4259, ‘Petroleum products — Determination and application of precision data in relation to methods of test’, have been applied and, in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259 (published in 1995).

(b) EN — European standard; ASTM — American Society for Testing and Materials; DIS — Draft international standard.

Note: Parties shall ensure that, no later than 1 January 2005, petrol can be marketed within their territory only if it complies with the environmental specifications set out in Table 10. Where a Party determines that banning petrol with a sulphur content which does not comply with the specifications for sulphur content in Table 10, but does comply with Table 8, would raise severe difficulties for its industries in making the necessary changes in their manufacturing facilities by 1 January 2005, it may extend the time period of marketing within its territory until 1 January 2007 at the latest. In such a case the Party shall specify, in a declaration to be deposited together with its instrument of ratification, acceptance, approval or accession, that it intends to extend the time period and present written information on the reason for this to the Executive Body.

▼**M4**

Table 11. Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines

Type: Diesel fuel

Parameter	Unit	Limits ([a])		Test	
		Minimum	Maximum	Method ([b])	Date of publication
Cetane number			—		
Density at 15 °C	kg/m^3		—		
Distillation point: 95 %	°C	—			
Polycyclic aromatic hydrocarbons	% m/m	—			
Sulphur content	mg/kg	—	50	PrEN-ISO/DIS 14596	1996

([a]) The values quoted in the specification are ‘true values’. In the establishment of their limit values, the terms of ISO 4259, ‘Petroleum products — Determination and application of precision data in relation to methods of test’, have been applied and, in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259.

([b]) EN — European standard; DIS — Draft international standard.

Note: Parties shall ensure that, no later than 1 January 2005, diesel fuel can be marketed within their territory only if it complies with the environmental specifications set out in Table 11. Where a Party determines that banning diesel fuel with a sulphur content which does not comply with the specifications for sulphur content in Table 11, but does comply with Table 9, would raise severe difficulties for its industries in making the necessary changes in their manufacturing facilities by 1 January 2005, it may extend the time period of marketing within its territory until 1 January 2007 at the latest. In such a case the Party shall specify, in a declaration to be deposited together with its instrument of ratification, acceptance, approval or accession, that it intends to extend the time period and present written information on the reason for this to the Executive Body.

B. Canada

9. New vehicle emission standards for light-duty vehicles, light-duty trucks, heavy-duty vehicles, heavy-duty engines and motorcycles: Motor Vehicle Safety Act (and successor legislation), Schedule V of the Motor Vehicle Safety Regulations: Vehicle Emissions (Standard 1100), SOR/97-376, (28 July, 1997), as amended from time to time.

10. Canadian Environmental Protection Act, Diesel Fuel Regulations, SOR/97-110 (4 February 1997, sulphur in diesel fuel), as amended from time to time.

11. Canadian Environmental Protection Act, Benzene in Gasoline Regulations, SOR/97-493 (6 November 1997), as amended from time to time.

12. Canadian Environmental Protection Act, Sulphur in Gasoline Regulations, Canada Gazette, Part II, June 4 1999, as amended from time to time.

C. United States of America

13. Implementation of a mobile source emission control programme for light-duty vehicles, light-duty trucks, heavy-duty trucks and fuels to the extent required by sections 202(a), 202(g) and 202(h) of the Clean Air Act, as implemented through:

    (a) 40 Code of Federal Regulations (C.F.R.) Part 80, Subpart D — Reformulated Gasoline;

    (b) 40 C.F.R. Part 86, Subpart A — General Provisions for Emission Regulations;

    (c) 40 C.F.R. Part 80, section 80.29 — Controls and Prohibitions on Diesel Fuel Quality.

▼M4

ANNEX IX

MEASURES FOR THE CONTROL OF EMISSIONS OF AMMONIA FROM AGRICULTURAL SOURCES

1. The Parties that are subject to obligations in Article 3(8)(a), shall take the measures set out in this Annex.

2. Each Party shall take due account of the need to reduce losses from the whole nitrogen cycle.

A. **Advisory code of good agricultural practice**

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 advisory code of good agricultural practice to control ammonia emissions. The code shall take into account the specific conditions within the territory of the Party and shall include provisions on:

   — nitrogen management, taking account of the whole nitrogen cycle,

   — livestock feeding strategies,

   — low-emission manure-spreading techniques,

   — low-emission manure-storage systems,

   — low-emission animal housing systems,

   — possibilities for limiting ammonia emissions from the use of mineral fertilisers.

   Parties should give a title to the code with a view to avoiding confusion with other codes of guidance.

B. **Urea and ammonium carbonate fertilisers**

4. Within one year from 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 fertilisers based on urea.

5. Within one year from the date of entry into force of the present Protocol for it, a Party shall prohibit the use of ammonium carbonate fertilisers.

C. **Manure application**

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 % compared to the reference specified in that guidance document are used as far as the Party in question considers them applicable, taking account of 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).

7. 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.

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(1) For the purpose of the present Annex, ‘a country with an economy in transition’ means a Party that has made with its instrument of ratification, acceptance, approval or accession a declaration that it wishes to be treated as a country with an economy in transition for the purposes of paragraphs (6) and/or (9) of this Annex.

▼**M4**

D. **Manure storage**

8. Within one year from 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, low-emission storage systems or techniques that have been shown to reduce emissions by 40 % or more compared to the reference (as listed in the guidance document referred to in paragraph (6)), or other systems or techniques with a demonstrably equivalent efficiency (1).

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 emission reductions of 40 % in s ofar as the Party considers the necessary techniques to be technically and economically feasible (1). The timescales for the application of these measures shall be: 31 December 2009 for Parties with economies in transition and 31 December 2007 for all other Parties (2).

E. **Animal housing**

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 % or more compared to the reference (as listed in the guidance document referred to in paragraph (6)), 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.

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(1) 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 where 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)(1)(a).

(2) For the purpose of the present Annex, ‘a country with an economy in transition’ means a Party that has made with its instrument of ratification, acceptance, approval or accession a declaration that it wishes to be treated as a country with an economy in transition for the purposes of paragraphs (6) and/or (9) of this Annex.

▼M5

PROTOCOL

to the 1979 Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants

THE PARTIES,

DETERMINED to implement the Convention on Long Range Transboundary Air Pollution,

RECOGNISING that emissions of many persistent organic pollutants are transported across international boundaries and are deposited in Europe, North America and the Arctic, far from their site of origin, and that the atmosphere is the dominant medium of transport,

AWARE that persistent organic pollutants resist degradation under natural conditions and have been associated with adverse effects on human health and the environment,

CONCERNED that persistent organic pollutants can biomagnify in upper trophic levels to concentrations which might affect the health of exposed wildlife and humans,

ACKNOWLEDGING that the Arctic ecosystems and especially its indigenous people, who subsist on Arctic fish and mammals, are particularly at risk because of the biomagnification of persistent organic pollutants,

MINDFUL that measures to control emissions of persistent organic pollutants would also contribute to the protection of the environment and human health in areas outside the United Nations Economic Commission for Europe's region, including the Arctic and international waters,

RESOLVED to take measures to anticipate, prevent or minimize emissions of persistent organic pollutants, taking into account the application of the precautionary approach, as set forth in principle 15 of the Rio Declaration on Environment and Development,

REAFFIRMING that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and development policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

NOTING the need for global action on persistent organic pollutants and recalling the role envisaged in chapter 9 of Agenda 21 for regional agreements to reduce global transboundary air pollution and, in particular, for the United Nations Economic Commission for Europe to share its regional experience with other regions of the world,

▼**M5**

RECOGNISING that there are subregional, regional and global regimes in place, including international instruments governing the management of hazardous wastes, their transboundary movement and disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal,

CONSIDERING that the predominant sources of air pollution contributing to the accumulation of persistent organic pollutants are the use of certain pesticides, the manufacture and use of certain chemicals, and the unintentional formation of certain substances in waste incineration, combustion, metal production and mobile sources,

AWARE that techniques and management practices are available to reduce emissions of persistent organic pollutants into the air,

CONSCIOUS of the need for a cost-effective regional approach to combating air pollution,

NOTING the important contribution of the private and non-governmental sectors to knowledge of the effects associated with persistent organic pollutants, available alternatives and abatement techniques, and their role in assisting in the reduction of emissions of persistent organic pollutants,

BEARING IN MIND that measures taken to reduce persistent organic pollutant emissions should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international competition and trade,

TAKING INTO CONSIDERATION existing scientific and technical data on emissions, atmospheric processes and effects on human health and the environment of persistent organic pollutants, as well as on abatement costs, and acknowledging the need to continue scientific and technical cooperation to further the understanding of these issues,

RECOGNISING the measures on persistent organic pollutants already taken by some of the Parties on a national level and/or under other international conventions,

HAVE AGREED as follows:

Article 1

Definitions

For the purposes of the present Protocol,

1. ‘Convention’ means the Convention on Long Range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

2. ‘EMEP’ means the Cooperative Programme for Monitoring and Evaluation of the Long range Transmission of Air Pollutants in Europe;

▼**M5**

3. ‘Executive Body’ means the Executive Body for the Convention constituted under Article 10(1) of the Convention;

4. ‘Commission’ means the United Nations Economic Commission for Europe;

5. ‘Parties’ means, unless the context otherwise requires, the Parties to the present Protocol;

6. ‘Geographical scope of EMEP’ means the area defined in Article 1(4) of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe (EMEP), adopted in Geneva on 28 September 1984;

7. ‘Persistent organic pollutants’ (POPs) are organic substances that: (i) possess toxic characteristics; (ii) are persistent; (iii) bioaccumulate; (iv) are prone to long-range transboundary atmospheric transport and deposition; and (v) are likely to cause significant adverse human health or environmental effects near to and distant from their sources;

8. ‘Substance’ means a single chemical species, or a number of chemical species which form a specific group by virtue of (a) having similar properties and being emitted together into the environment; or (b) forming a mixture normally marketed as a single article;

9. ‘Emission’ means the release of a substance from a point or diffuse source into the atmosphere;

10. ‘Stationary source’ means any fixed building, structure, facility, installation, or equipment that emits or may emit any persistent organic pollutant directly or indirectly into the atmosphere;

11. ‘Major stationary source category’ means any stationary source category listed in annex VIII;

12. ‘New stationary source’ means any stationary source of which the construction or substantial modification is commenced after the expiry of two years from the date of entry into force of: (i) this Protocol; or (ii) an amendment to Annex III or VIII, where the stationary source becomes subject to the provisions of this Protocol only by virtue of that amendment. It shall be a matter for the competent national authorities to decide whether a modification is substantial or not, taking into account such factors as the environmental benefits of the modification.

Article 2

Objective

The objective of the present Protocol is to control, reduce or eliminate discharges, emissions and losses of persistent organic pollutants.

▼**M5**

Article 3

Basic obligations

1. Except where specifically exempted in accordance with Article 4, each Party shall take effective measures:

(a) to eliminate the production and use of the substances listed in Annex I in accordance with the implementation requirements specified therein;

(b) (i) to ensure that, when the substances listed in Annex I are destroyed or disposed of, such destruction or disposal is undertaken in an environmentally sound manner, taking into account relevant subregional, regional and global regimes governing the management of hazardous wastes and their disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;

(ii) to endeavour to ensure that the disposal of substances listed in Annex I is carried out domestically, taking into account pertinent environmental considerations;

(iii) to ensure that the transboundary movement of the substances listed in annex I is conducted in an environmentally sound manner, taking into consideration applicable subregional, regional, and global regimes governing the transboundary movement of hazardous wastes, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;

(c) to restrict the substances listed in Annex II to the uses described, in accordance with the implementation requirements specified therein.

2. The requirements specified in paragraph 1(b) shall become effective for each substance upon the date that production or use of that substance is eliminated, whichever is later.

3. For substances listed in Annex I, II, or III, each Party should develop appropriate strategies for identifying articles still in use and wastes containing such substances, and shall take appropriate measures to ensure that such wastes and such articles, upon becoming wastes, are destroyed or disposed of in an environmentally sound manner.

4. For the purposes of paragraphs 1 to 3, the terms waste, disposal, and environmentally sound shall be interpreted in a manner consistent with the use of those terms under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

5. Each Party shall:

(a) reduce its total annual emissions of each of the substances listed in Annex III from the level of the emission in a reference year set in accordance with that annex by taking effective measures, appropriate in its particular circumstances;

▼**M5**

(b) no later than the timescales specified in Annex VI, apply:

(i) the best available techniques, taking into consideration Annex V, to each new stationary source within a major stationary source category for which Annex V identifies best available techniques;

(ii) limit values at least as stringent as those specified in Annex IV to each new stationary source within a category mentioned in that annex, taking into consideration Annex V. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;

(iii) the best available techniques, taking into consideration Annex V, to each existing stationary source within a major stationary source category for which Annex V identifies best available techniques, insofar as this is technically and economically feasible. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions;

(iv) limit values at least as stringent as those specified in Annex IV to each existing stationary source within a category mentioned in that Annex, insofar as this is technically and economically feasible, taking into consideration Annex V. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions;

(v) effective measures to control emissions from mobile sources, taking into consideration Annex VII.

6. In the case of residential combustion sources, the obligations set out in paragraph 5(b)(i) and (iii) shall refer to all stationary sources in that category taken together.

7. Where a Party, after the application of paragraph 5(b), cannot achieve the requirements of paragraph 5(a) for a substance specified in Annex III, it shall be exempted from its obligations in paragraph 5(a) for that substance.

8. Each Party shall develop and maintain emission inventories for the substances listed in Annex III, and shall collect available information relating to the production and sales of the substances listed in Annexes I and II, for those Parties within the geographical scope of EMEP, using, as a minimum, the methodologies and the spatial and temporal resolution specified by the Steering Body of EMEP, and, for those Parties outside the geographical scope of EMEP, using as guidance the methodologies developed through the work plan of the Executive Body. It shall report this information in accordance with the reporting requirements set out in Article 9.

▼**M5**

Article 4

Exemptions

1. Article 3(1) shall not apply to quantities of a substance to be used for laboratory-scale research or as a reference standard.

2. A Party may grant an exemption from Article 3(1)(a) and (c) in respect of a particular substance, provided that the exemption is not granted or used in a manner that would undermine the objectives of the present Protocol, and only for the following purposes and under the following conditions:

(a) for research other than that referred to in paragraph 1 if:

  (i) no significant quantity of the substance is expected to reach the environment during the proposed use and subsequent disposal;

  (ii) the objectives and parameters of such research are subject to assessment and authorization by the Party; and

  (iii) in the event of a significant release of a substance into the environment, the exemption will terminate immediately, measures will be taken to mitigate the release as appropriate, and an assessment of the containment measures will be conducted before research may resume;

(b) to manage as necessary a public health emergency, if:

  (i) no suitable alternative measures are available to the Party to address the situation;

  (ii) the measures taken are proportional to the magnitude and severity of the emergency;

  (iii) appropriate precautions are taken to protect human health and the environment and to ensure that the substance is not used outside the geographical area subject to the emergency;

  (iv) the exemption is granted for a period of time that does not exceed the duration of the emergency; and

  (v) upon termination of the emergency, any remaining stocks of the substance are subject to the provisions of Article 3(1)(b);

(c) for a minor application judged to be essential by the Party, if:

  (i) the exemption is granted for a maximum of five years;

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(ii) the exemption has not previously been granted by it under this article;

(iii) no suitable alternatives exist for the proposed use;

(iv) the Party has estimated the emissions of the substance resulting from the exemption and their contribution to the total emissions of the substance from the Parties;

(v) adequate precautions are taken to ensure that the emissions to the environment are minimised; and

(vi) upon termination of the exemption, any remaining stocks of the substance are subject to the provisions of Article 3(1)(b).

3. Each Party shall, no later than 90 days after granting an exemption under paragraph 2, provide the secretariat with, as a minimum, the following information:

(a) the chemical name of the substance subject to the exemption;

(b) the purpose for which the exemption has been granted;

(c) the conditions under which the exemption has been granted;

(d) the length of time for which the exemption has been granted;

(e) those to whom, or the organization to which, the exemption applies; and

(f) for an exemption granted under paragraphs 2(a) and (c), the estimated emissions of the substance as a result of the exemption and an assessment of their contribution to the total emissions of the substance from the Parties.

4. The secretariat shall make available to all Parties the information received under paragraph 3.

Article 5

Exchange of information and technology

The Parties shall, in a manner consistent with their laws, regulations and practices, create favourable conditions to facilitate the exchange of information and technology designed to reduce the generation and emission of persistent organic pollutants and to develop cost-effective alternatives, by promoting, inter alia:

(a) contacts and cooperation among appropriate organisations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance;

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(b) the exchange of and access to information on the development and use of alternatives to persistent organic pollutants as well as on the evaluation of the risks that such alternatives pose to human health and the environment, and information on the economic and social costs of such alternatives;

(c) the compilation and regular updating of lists of their designated authorities engaged in similar activities in other international forums;

(d) the exchange of information on activities conducted in other international forums.

Article 6

Public awareness

The Parties shall, consistent with their laws, regulations and practices, promote the provision of information to the general public, including individuals who are direct users of persistent organic pollutants. This information may include, inter alia:

(a) information, including labelling, on risk assessment and hazard;

(b) information on risk reduction;

(c) information to encourage the elimination of persistent organic pollutants or a reduction in their use, including, where appropriate, information on integrated pest management, integrated crop management and the economic and social impacts of this elimination or reduction; and

(d) information on alternatives to persistent organic pollutants, as well as an evaluation of the risks that such alternatives pose to human health and the environment, and information on the economic and social impacts of such alternative.

Article 7

Strategies, policies, programmes, measures and information

1. Each Party shall, no later than six months after the date on which this Protocol enters into force for it, develop strategies, policies and programmes in order to discharge its obligations under the present Protocol.

2. Each Party shall:

(a) encourage the use of economically feasible, environmentally sound management techniques, including best environmental practices, with respect to all aspects of the use, production, release, processing, distribution, handling, transport and reprocessing of substances subject to the present Protocol and manufactured articles, mixtures or solutions containing such substances;

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(b) encourage the implementation of other management programmes to reduce emissions of persistent organic pollutants, including voluntary programmes and the use of economic instruments;

(c) consider the adoption of additional policies and measures as appropriate in its particular circumstances, which may include non-regulatory approaches;

(d) make determined efforts that are economically feasible to reduce levels of substances subject to the present Protocol that are contained as contaminants in other substances, chemical products or manufactured articles, as soon as the relevance of the source has been established;

(e) take into consideration in its programmes for evaluating substances, the characteristics specified in paragraph 1 of Executive Body Decision 1998/2 on information to be submitted and procedures for adding substances to Annex I, II or III, including any amendments thereto.

3. The Parties may take more stringent measures than those required by the present Protocol.

Article 8

Research, development and monitoring

The Parties shall encourage research, development, monitoring and cooperation related, but not limited, to:

(a) emissions, long-range transport and deposition levels and their modelling, existing levels in the biotic and abiotic environment, the elaboration of procedures for harmonizing relevant methodologies;

(b) pollutant pathways and inventories in representative ecosystems;

(c) relevant effects on human health and the environment, including quantification of those effects;

(d) best available techniques and practices, including agricultural practices, and emission control techniques and practices currently employed by the Parties or under development;

(e) methodologies permitting consideration of socioeconomic factors in the evaluation of alternative control strategies;

(f) an effects-based approach which integrates appropriate information, including information obtained under subparagraphs (a) to (e), on measured or modelled environmental levels, pathways, and effects on human health and the environment, for the purpose of formulating future control strategies which also take into account economic and technological factors;

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(g) methods for estimating national emissions and projecting future emissions of individual persistent organic pollutants and for evaluating how such estimates and projections can be used to structure future obligations;

(h) levels of substances subject to the present Protocol that are contained as contaminants in other substances, chemical products or manufactured articles and the significance of these levels for long-range transport, as well as techniques to reduce levels of these contaminants, and, in addition, levels of persistent organic pollutants generated during the life cycle of timber treated with pentachlorophenol.

Priority should be given to research on substances considered to be the most likely to be submitted under the procedures specified in Article 14(6).

Article 9

Reporting

1. Subject to its laws governing the confidentiality of commercial information:

(a) each Party shall report, through the Executive Secretary of the Commission, to the Executive Body, on a periodic basis as determined by the Parties meeting within the Executive Body, information on the measures that it has taken to implement the present Protocol;

(b) each Party within the geographical scope of EMEP shall report, through the Executive Secretary of the Commission, to EMEP, on a periodic basis to be determined by the Steering Body of EMEP and approved by the Parties at a session of the Executive Body, information on the levels of emissions of persistent organic pollutants using, as a minimum, the methodologies and the temporal and spatial resolution specified by the Steering Body of EMEP. Parties in areas outside the geographical scope of EMEP shall make available similar information to the Executive Body if requested to do so. Each Party shall also provide information on the levels of emissions of the substances listed in Annex III for the reference year specified in that Annex.

2. The information to be reported in accordance with paragraph 1 (a) above shall be in conformity with a decision regarding format and content to be adopted by the Parties at a session of the Executive Body. The terms of this decision shall be reviewed as necessary to identify any additional elements regarding the format or the content of the information that is to be included in the reports.

3. In good time before each annual session of the Executive Body, EMEP shall provide information on the long-range transport and deposition of persistent organic pollutants.

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Article 10

Reviews by the Parties at sessions of the Executive Body

1. The Parties shall, at sessions of the Executive Body, pursuant to Article 10(2)(a), of the Convention, review the information supplied by the Parties, EMEP and other subsidiary bodies, and the reports of the Implementation Committee referred to in Article 11 of the present Protocol.

2. The Parties shall, at sessions of the Executive Body, keep under review the progress made towards achieving the obligations set out in the present Protocol.

3. The Parties shall, at sessions of the Executive Body, review the sufficiency and effectiveness of the obligations set out in the present Protocol. Such reviews will take into account the best available scientific information on the effects of the deposition of persistent organic pollutants, assessments of technological developments, changing economic conditions and the fulfilment of the obligations on emission levels. The procedures, methods and timing for such reviews shall be specified by the Parties at a session of the Executive Body. The first such review shall be completed no later than three years after the present Protocol enters into force.

Article 11

Compliance

Compliance by each Party with its obligations under the present Protocol shall be reviewed regularly. The Implementation Committee established by Decision 1997/2 of the Executive Body at its 15th session shall carry out such reviews and report to the Parties meeting within the Executive Body in accordance with the terms of the Annex to that Decision, including any amendments thereto.

Article 12

Settlement of disputes

1. In the event of a dispute between any two or more Parties concerning the interpretation or application of the present Protocol, the Parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice. The parties to the dispute shall inform the Executive Body of their dispute.

2. When ratifying, accepting, approving or acceding to the present Protocol, or at anytime thereafter, a Party which is not a regional economic integration organization may declare in a written instrument submitted to the Depositary that, in respect of any dispute concerning the interpretation or application of the Protocol, it recognizes one or both of the following means of dispute settlement as compulsory ipso facto and without special agreement, in relation to any Party accepting the same obligation:

(a) submission of the dispute to the International Court of Justice;

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(b) arbitration in accordance with procedures to be adopted by the Parties at a session of the Executive Body, as soon as practicable, in an annex on arbitration.

A Party which is a regional economic integration organization may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b).

3. A declaration made under paragraph 2 shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the Depositary.

4. A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute agree otherwise.

5. Except in a case where the parties to a dispute have accepted the same means of dispute settlement under paragraph 2, if after 12 months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

6. For the purpose of paragraph 5, a conciliation commission shall be created. The commission shall be composed of equal numbers of members appointed by each Party concerned or, where the Parties in conciliation share the same interest, by the group sharing that interest, and a chairperson chosen jointly by the members so appointed. The commission shall render a recommendatory award, which the Parties shall consider in good faith.

Article 13

Annexes

The annexes to the present Protocol shall form an integral part of the Protocol. Annexes V and VII are recommendatory in character.

Article 14

Amendments

1. Any Party may propose amendments to the present Protocol.

2. Proposed amendments shall be submitted in writing to the Executive Secretary of the Commission, who shall communicate them to all Parties. The Parties meeting within the Executive Body shall discuss the proposed amendments at its next session, provided that the proposals have been circulated by the Executive Secretary to the Parties at least 90 days in advance.

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3. Amendments to the present Protocol and to Annexes I to IV, VI and VIII shall be adopted by consensus of the Parties present at a session of the Executive Body, and shall enter into force for the Parties which have accepted them on the 90th day after the date on which two thirds of the Parties have deposited with the Depositary their instruments of acceptance thereof. Amendments shall enter into force for any other Party on the 90th day after the date on which that Party has deposited its instrument of acceptance thereof.

4. Amendments to Annexes V and VII shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of 90 days from the date of its communication to all Parties by the Executive Secretary of the Commission, an amendment to any such Annex shall become effective for those Parties which have not submitted to the Depositary a notification in accordance with the provisions of paragraph 5 below, provided that at least 16 Parties have not submitted such a notification.

5. Any Party that is unable to approve an amendment to Annex V or VII shall so notify the Depositary in writing within 90 days from the date of the communication of its adoption. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time substitute an acceptance for its previous notification and, upon deposit of an instrument of acceptance with the Depositary, the amendment to such an Annex shall become effective for that Party.

6. In the case of a proposal to amend Annex I, II, or III by adding a substance to the present Protocol:

(a) the proposer shall provide the Executive Body with the information specified in Executive Body decision 1998/2, including any amendments thereto; and

(b) the Parties shall evaluate the proposal in accordance with the procedures set forth in Executive Body decision 1998/2, including any amendments thereto.

7. Any decision to amend Executive Body decision 1998/2 shall be taken by consensus of the Parties meeting within the Executive Body and shall take effect 60 days after the date of adoption.

Article 15

Signature

1. The present Protocol shall be open for signature at Aarhus, Denmark, from 24 to 25 June 1998, then at United Nations Headquarters in New York until 21 December 1998, by Members States of the Commission as well as States having consultative status with the Commission pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organisations concerned are Parties to the Convention.

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2. In matters within their competence, such regional economic integration organisations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their Member States. In such cases, the Member States of these organisations shall not be entitled to exercise such rights individually.

Article 16

Ratification, acceptance, approval and accession

1. The present Protocol shall be subject to ratification, acceptance or approval by Signatories.

2. The present Protocol shall be open for accession as from 21 December 1998 by the States and organisations that meet the requirements of Article 15(1).

Article 17

Depositary

The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of Depositary.

Article 18

Entry into force

1. The present Protocol shall enter into force on the 90th day following the date on which the 16th instrument of ratification, acceptance, approval or accession has been deposited with the Depositary.

2. For each State and organisation referred to in Article 15(1), which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the 90th day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 19

Withdrawal

At any time after five years from the date on which the present Protocol has come into force with respect to a Party, that Party may withdraw from it by giving written notification to the Depositary. Any such withdrawal shall take effect on the 90th day following the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

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Article 20

Authentic texts

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

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ANNEX I

SUBSTANCES SCHEDULED FOR ELIMINATION

Unless otherwise specified in the present Protocol, this Annex shall not apply to the substances listed below when they occur: (i) as contaminants in products; or (ii) in articles manufactured or in use by the implementation date; or (iii) as site-limited chemical intermediates in the manufacture of one or more different substances and are thus chemically transformed. Unless otherwise specified, each obligation below is effective upon the date of entry into force of the Protocol.

Substance	Implementation requirements	
	Elimination of	Conditions
Aldrin CAS: 309-00-2	Production	None
	Use	None
Chlordane CAS: 57-74-9	Production	None
	Use	None
Chlordecone CAS: 143-50-0	Production	None
	Use	None
DDT CAS: 50-29-3	Production	1. Eliminate production within one year of consensus by the Parties that suitable alternatives to DDT are available for public health protection from diseases such as malaria and encephalitis. 2. With a view to eliminating the production of DDT at the earliest opportunity, the Parties shall, no later than one year after the date of entry into force of the present Protocol and periodically thereafter as necessary, and in consultation with the World Health Organisation, the Food and Agriculture Organisation of the United Nations and the United Nations Environment Programme, review the availability and feasibility of alternatives and, as appropriate, promote the commercialisation of safer and economically viable alternatives to DDT.
	Use	None, except as identified in Annex II.
Dieldrin CAS: 60-57-1	Production	None
	Use	None
Endrin CAS: 72-20-8	Production	None
	Use	None
Heptachlor CAS: 76-44-8	Production	None
	Use	None, except for use by certified personnel for the control of fire ants in closed industrial electrical junction boxes. Such use shall be re-evaluated under this Protocol no later than two years after the date of entry into force.

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Substance	Implementation requirements	
	Elimination of	Conditions
Hexabromobiphenyl CAS: 36355-01-8	Production	None
	Use	None
Hexachlorobenzene CAS: 118-74-1	Production	None, except for production for a limited purpose as specified in a statement deposited by a country with an economy in transition upon signature or accession.
	Use	None, except for a limited use as specified in a statement deposited by a country with an economy in transition upon signature or accession.
Mirex CAS: 2385-85-5	Production	None
	Use	None
PCB (a)	Production	None, except for countries with economies in transition which shall eliminate production as soon as possible and no later than 31 December 2005 and which state in a declaration to be deposited together with their instrument of ratification, acceptance, approval or accession, their intention to do so.
	Use	None, except as identified in Annex II.
Toxaphene CAS: 8001-35-2	Production	None
	Use	None

(a): The Parties agree to reassess under the Protocol by 31 December 2004 the production and use of polychlorinated terphenyls and 'ugilec'.

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ANNEX II

SUBSTANCES SCHEDULED FOR RESTRICTIONS ON USE

Unless otherwise specified in the present Protocol, this annex shall not apply to the substances listed below when they occur: (i) as contaminants in products; or (ii) in articles manufactured or in use by the implementation date; or (iii) as site-limited chemical intermediates in the manufacture of one or more different substances and are thus chemically transformed. Unless otherwise specified, each obligation below is effective upon the date of entry into force of the Protocol.

Substance	Implementation requirements	
	Restricted to uses	Conditions
DDT CAS: 50-29-3	1. For public health protection from diseases such as malaria and encephalitis.	1. Use allowed only as a component of an integrated pest management strategy and only to the extent necessary and only until one year after the date of the elimination of production in accordance with Annex I.
	2. As a chemical intermediate to produce Dicofol.	2. Such use shall be reassessed no later than two years after the date of entry into force of the present Protocol.
HCH CAS: 608-73-1	Technical HCH (i.e. HCH mixed isomers) is restricted to use as an intermediate in chemical manufacturing.	
	Products in which at least 99 % of the HCH isomer is in the gamma form (i.e. lindane, CAS: 58-89-9) are restricted to the following uses: 1. Seed treatment. 2. Soil applications directly followed by incorporation into the topsoil surface layer. 3. Professional remedial and industrial treatment of lumber, timber and logs. 4. Public health and veterinary topical insecticide. 5. Non-aerial application to tree seedlings, small-scale lawn use, and indoor and outdoor use for nursery stock and ornamentals. 6. Indoor industrial and residential applications.	All restricted uses of lindane shall be reassessed under the Protocol no later than two years after the date of entry into force.

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Substance	Implementation requirements	
	Restricted to uses	Conditions
PCB (a)	PCBs in use as of the date of entry into force or produced up to 31 December 2005 in accordance with the provisions of Annex I.	Parties shall make determined efforts designed to lead to: (a) The elimination of the use of identifiable PCBs in equipment (i.e. transformers, capacitors or other receptacles containing residual liquid stocks) containing PCBs in volumes greater than 5 dm^3 and having a concentration of 0,05 % PCBs or greater, as soon as possible, but no later than 31 December 2010, or 31 December 2015 for countries with economies in transition; (b) The destruction or decontamination in an environmentally sound manner of all liquid PCBs referred to in subparagraph (a) and other liquid PCBs containing more than 0,005 % PCBs not in equipment, as soon as possible, but no later than 31 December 2015, or 31 December 2020 for countries with economies in transition; and (c) The decontamination or disposal of equipment referred to in subparagraph (a) in an environmentally sound manner.

(a): The Parties agree to reassess under the Protocol by 31 December 2004 the production and use of polychlorinated terphenyls and ‘ugilec’.

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ANNEX III

SUBSTANCES REFERRED TO IN ARTICLE 3(50)(a), AND THE REFERENCE YEAR FOR THE OBLIGATION

Substance	Reference year
PAHs (a)	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.
Dioxins/furans (b)	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.
Hexachlorobenzene	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.

(a) Polycyclic aromatic hydrocarbons (PAHs): For the purposes of emission inventories, the following four indicator compounds shall be used: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

(b) Dioxins and furans (PCDD/F): Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are tricyclic, aromatic compounds formed by two benzene rings which are connected by two oxygen atoms in PCDD and by one oxygen atom in PCDF and the hydrogen atoms of which may be replaced by up to eight chlorine atoms.

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ANNEX IV

LIMIT VALUES FOR PCDD/F FROM MAJOR STATIONARY SOURCES

I. Introduction

1. A definition of dioxins and furans (PCDD/F) is provided in Annex III to the present Protocol.

2. Limit values are expressed as ng/m^3 or mg/m^3 under standard conditions (273,15 K, 101,3 kPa, and dry gas).

3. Limit values relate to the normal operating situation, including start-up and shutdown procedures, unless specific limit values have been defined for those situations.

4. Sampling and analysis of all pollutants shall be carried out according to the standards laid down by the Comité européen de normalisation (CEN), the International Organisation for Standardisation (ISO), or the corresponding United States or Canadian reference methods. While awaiting the development of CEN or ISO standards, national standards shall apply.

5. For verification purposes, the interpretation of measurement results in relation to the limit value must also take into account the inaccuracy of the measurement method. A limit value is considered to be met if the result of the measurement, from which the inaccuracy of the measurement method is subtracted, does not exceed it.

6. Emissions of different congeners of PCDD/F are given in toxicity equivalents (TE) in comparison to 2,3,7,8-TCDD using the system proposed by the NATO Committee on the Challenges of Modern Society (NATO-CCMS) in 1988.

II. Limit values for major stationary sources

7. The following limit values, which refer to 11 % O_2 concentration in flue gas, apply to the following incinerator types:

— municipal solid waste (burning more than three tonnes per hour)

0,1 ng TE/m^3

— medical solid waste (burning more than one tonne per hour)

0,5 ng TE/m^3

— hazardous waste (burning more than one tonne per hour)

0,2 ng TE/m^3

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ANNEX V

BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES

I. Introduction

1. The purpose of this Annex is to provide the Parties to the Convention with guidance in identifying best available techniques to allow them to meet the obligations in Article 3(5) of the Protocol.

2. 'Best available techniques' (BAT) means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and their impact on the environment as a whole:

— 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned,

— 'available' techniques means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the territory of the Party in question, as long as they are reasonably accessible to the operator,

— 'best' means most effective in achieving a high general level of protection of the environment as a whole.

In determining the best available techniques, special consideration should be given, generally or in specific cases, to the factors below, bearing in mind the likely costs and benefits of a measure and the principles of precaution and prevention:

— the use of low-waste technology,

— the use of less hazardous substances,

— the furthering of recovery and recycling of substances generated and used in the process and of waste,

— comparable processes, facilities or methods of operation which have been tried with success on an industrial scale,

— technological advances and changes in scientific knowledge and understanding,

— the nature, effects and volume of the emissions concerned,

— the commissioning dates for new or existing installations,

— the time needed to introduce the best available technique,

— the consumption and nature of raw materials (including water) used in the process and its energy efficiency,

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— the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,

— the need to prevent accidents and to minimise their consequences for the environment.

The concept of best available techniques is not aimed at the prescription of any specific technique or technology, but at taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions.

3. Information regarding the effectiveness and costs of control measures is based on documents received and reviewed by the Task Force and the Preparatory Working Group on POPs. Unless otherwise indicated, the techniques listed are considered to be well established on the basis of operational experience.

4. Experience with new plants incorporating low-emission techniques, as well as with retrofitting of existing plants, is continuously growing. The regular elaboration and amendment of the Annex will therefore be necessary. Best available techniques (BAT) identified for new plants can usually be applied to existing plants provided there is an adequate transition period and they are adapted.

5. The Annex lists a number of control measures which span a range of costs and efficiencies. The choice of measures for any particular case will depend on a number of factors, including economic circumstances, technological infrastructure and capacity, and any existing air pollution control measures.

6. The most important POPs emitted from stationary sources are:

(a) Polychlorinated dibenzo-p-dioxins/furans (PCDD/F);

(b) Hexachlorobenzene (HCB);

(c) Polycyclic aromatic hydrocarbons (PAHs).

Relevant definitions are provided in Annex III to the present Protocol.

II. Major stationary sources of POP emissions

7. PCDD/F are emitted from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. Major stationary sources of PCDD/F may be as follows:

(a) waste incineration, including co-incineration;

(b) thermal metallurgical processes, e.g. production of aluminium and other non-ferrous metals, iron and steel;

(c) combustion plants providing energy;

(d) residential combustion; and

(e) specific chemical production processes releasing intermediates and by-products.

8. Major stationary sources of PAH emissions may be as follows:

   (a) domestic wood and coal heating;

   (b) open fires such as refuse burning, forest fires and after-crop burning;

   (c) coke and anode production;

   (d) aluminium production (via Soederberg process); and

   (e) wood preservation installations, except for a Party for which this category does not make a significant contribution to its total emissions of PAH (as defined in Annex III).

9. Emissions of HCB result from the same type of thermal and chemical processes as those emitting PCDD/F, and HCB is formed by a similar mechanism. Major sources of HCB emissions may be as follows:

   (a) waste incineration plants, including co-incineration;

   (b) thermal sources of metallurgical industries; and

   (c) use of chlorinated fuels in furnace installations.

III. **General approaches to controlling emissions of POPs**

10. There are several approaches to the control or prevention of POP emissions from stationary sources. These include the replacement of relevant feed materials, process modifications (including maintenance and operational control) and retrofitting existing plants. The following list provides a general indication of available measures, which may be implemented either separately or in combination:

    (a) replacement of feed materials which are POPs or where there is a direct link between the materials and POP emissions from the source;

    (b) best environmental practices such as good housekeeping, preventive maintenance programmes, or process changes such as closed systems (for instance in cokeries or use of inert electrodes for electrolysis);

    (c) modification of process design to ensure complete combustion, thus preventing the formation of persistent organic pollutants, through the control of parameters such as incineration temperature or residence time;

    (d) methods for flue-gas cleaning such as thermal or catalytic incineration or oxidation, dust precipitation, adsorption;

    (e) treatment of residuals, wastes and sewage sludge by, for example, thermal treatment or rendering them inert.

11. The emission levels given for different measures in tables 1, 2, 4, 5, 6, 8 and 9 are generally case-specific. The figures or ranges give the emission levels as a percentage of the emission limit values using conventional techniques.

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12. Cost-efficient considerations may be based on total costs per year per unit of abatement (including capital and operational costs). POP emission reduction costs should also be considered within the framework of the overall process economics, e.g. the impact of control measures and costs of production. Given the many influencing factors, investment and operating cost figures are highly case-specific.

IV. **Control techniques for the reduction of PCDD/F emissions**

A. *Waste incineration*

13. Waste incineration includes municipal waste, hazardous waste, medical waste and sewage sludge incineration.

14. The main control measures for PCDD/F emissions from waste incineration facilities are:

    (a) Primary measures regarding incinerated wastes;

    (b) Primary measures regarding process techniques;

    (c) Measures to control physical parameters of the combustion process and waste gases (e.g. temperature stages, cooling rate, O_2 content, etc.);

    (d) Cleaning of the flue gas; and

    (e) Treatment of residuals from the cleaning process.

15. The primary measures regarding the incinerated wastes, involving the management of feed material by reducing halogenated substances and replacing them by non-halogenated alternatives, are not appropriate for municipal or hazardous waste incineration. It is more effective to modify the incineration process and install secondary measures for flue-gas cleaning. The management of feed material is a useful primary measure for waste reduction and has the possible added benefit of recycling. This may result in indirect PCDD/F reduction by decreasing the waste amounts to be incinerated.

16. The modification of process techniques to optimize combustion conditions is an important and effective measure for the reduction of PCDD/F emissions (usually 850 °C or higher, assessment of oxygen supply depending on the heating value and consistency of the wastes, sufficient residence time - 850 °C for approximately two seconds - and turbulence of the gas, avoidance of cold gas regions in the incinerator, etc.). Fluidized bed incinerators keep a lower temperature than 850 °C with adequate emission results. For existing incinerators this would normally involve redesigning and/or replacing a plant - an option which may not be economically viable in all countries. The carbon content in ashes should be minimized.

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17. Flue gas measures. The following measures are possibilities for lowering reasonably effectively the PCDD/F content in the flue gas. The de novo synthesis takes place at about 250 to 450 °C. These measures are a prerequisite for further reductions to achieve the desired levels at the end of the pipe:

    (a) quenching the flue gases (very effective and relatively inexpensive);

    (b) adding inhibitors such as triethanolamine or triethylamine (can reduce oxides of nitrogen as well), but side-reactions have to be considered for safety reasons;

    (c) using dust collection systems for temperatures between 800 and 1 000 ° C, e.g. ceramic filters and cyclones;

    (d) using low-temperature electric discharge systems; and

    (e) avoiding fly ash deposition in the flue gas exhaust system.

18. Methods for cleaning the flue gas are:

    (a) conventional dust precipitators for the reduction of particle-bound PCDD/F;

    (b) selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR);

    (c) adsorption with activated charcoal or coke in fixed or fluidised systems;

    (d) different types of adsorption methods and optimized scrubbing systems with mixtures of activated charcoal, open hearth coal, lime and limestone solutions in fixed bed, moving bed and fluidised bed reactors. The collection efficiency for gaseous PCDD/F can be improved with the use of a suitable pre-coat layer of activated coke on the surface of a bag filter;

    (e) H_2O_2-oxidation; and

    (f) catalytic combustion methods using different types of catalysts (i.e. Pt/Al_2O_3 or copper-chromite catalysts with different promoters to stabilise the surface area and to reduce ageing of the catalysts).

19. The methods mentioned above are capable of reaching emission levels of 0,1 ng TE/m^3 PCDD/F in the flue gas. However, in systems using activated charcoal or coke adsorbers/filters care must be taken to ensure that fugitive carbon dust does not increase PCDD/F emissions downstream. Also, it should be noted that adsorbers and dedusting installations prior to catalysts (SCR technique) yield PCDD/F-laden residues, which need to be reprocessed or require proper disposal.

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20. A comparison between the different measures to reduce PCDD/F in flue gas is very complex. The resulting matrix includes a wide range of industrial plants with different capacities and configuration. Cost parameters include the reduction measures for minimizing other pollutants as well, such as heavy metals (particle-bound or not particle-bound). A direct relation for the reduction in PCDD/F emissions alone cannot, therefore, be isolated in most cases. A summary of the available data for the various control measures is given in table 1.

Table 1

Comparison of different flue-gas cleaning measures and process modifications in waste incineration plants to reduce PCDD/F emissions

Management options	Emission level (%)(a)	Estimated costs	Management risks
Primary measures by modification of feed materials:			Pre-sorting of feed material not effective; only parts could be collected; other chlorine-containing material, for instance kitchen salt, paper, etc., cannot be avoided. For hazardous chemical waste this is not desirable.
— elimination of precursors and chlorine- containing feed material, and	Resulting emission level not quantified; seems not to be linearly dependent on the amount of the feed material.		
— management of waste streams.			Useful primary measure and feasible in special cases (for instance, waste oils, electrical components, etc.) with the possible added benefit of recycling of the materials.
Modification of process technology:			
— optimised combustion conditions,			Retrofitting of the whole process needed.
— avoidance of temperatures below 850 °C and cold regions in flue gas,			
— sufficient oxygen content; control of oxygen input depending on the heating value and consistency of feed material, and			
— sufficient residence time and turbulence.			
Flue gas measures:			
Avoiding particle deposition by:			

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Management options	Emission level (%)(a)	Estimated costs	Management risks
— soot cleaners, mechanical rappers, sonic or steam soot blowers.			Steam soot blowing can increase PCDD/F formation rates.
Dust removal, generally in waste incinerators:	< 10	Medium	Removal of PCDD/F adsorbed onto particles. Removal methods of particles in hot flue gas streams used only in pilot plants.
— fabric filters,	1 -0,1	Higher	Use at temperatures < 150 °C.
— ceramic filters,	Low efficiency	Medium	Use at temperatures of 800-1 000 °C.
— cyclones, and	Low efficiency		
— electrostatic precipitation.	Medium efficiency		Use at a temperature of 450 °C; promotion of the de novo synthesis of PCDD/F possible, higher NO_x emissions, reduction of heat recovery.
Catalytic oxidation.			Use at temperatures of 800-1 000 °C. Separate gas phase abatement necessary.
Gas quenching.			
High-performance adsorption unit with added activated charcoal particles (electrodynamic venturi).			
Selective catalytic reduction (SCR).		High investment and low operating costs	NO_x reduction if NH_3 is added; high space demand, spent catalysts and residues of activated carbon (AC) or lignite coke (ALC) may be disposed of, catalysts can be reprocessed by manufacturers in most cases, AC and ALC can be combusted under strictly controlled conditions.
Different types of wet and dry adsorption methods with mixtures of activated charcoal, open-hearth coke, lime and limestone solutions in fixed bed, moving bed and fluidised bed reactors:			
— Fixed bed reactor, adsorption with activated charcoal or open-hearth coke; and	< 2 (0,1 ng TE/m^3)	High investment, medium operating costs	Removal of residuals; high demand of space.

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Management options	Emission level (%)(a)	Estimated costs	Management risks
— Entrained flow or circulating fluidised bed reactor with added activated coke/lime or limestone solutions and subsequent fabric filter.	< 10 (0,1 ng TE/m^3)	Low investment, medium operating costs	Removal of residuals.
Addition of H_2O_2.	2-5 (0,1 ng TE/m^3)	Low investment, low operating costs	

(a): Remaining emission compared to unreduced mode.

21. Medical waste incinerators may be a major source of PCDD/F in many countries. Specific medical wastes such as human anatomical parts, infected waste, needles, blood, plasma and cytostatica are treated as a special form of hazardous waste, while other medical wastes are frequently incinerated on-site in a batch operation. Incinerators operating with batch systems can meet the same requirements for PCDD/F reduction as other waste incinerators.

22. Parties may wish to consider adopting policies to encourage the incineration of municipal and medical waste in large regional facilities rather than in smaller ones. This approach may make the application of BAT more cost-effective.

23. The treatment of residuals from the flue-gas cleaning process. Unlike incinerator ashes, these residuals contain relatively high concentrations of heavy metals, organic pollutants (including PCDD/F), chlorides and sulphides. Their method of disposal, therefore, has to be well controlled. Wet scrubber systems in particular produce large quantities of acidic, contaminated liquid waste. Some special treatment methods exist. They include:

    (a) the catalytic treatment of fabric filter dusts under conditions of low temperatures and lack of oxygen;

    (b) the scrubbing of fabric filter dusts by the 3-R process (extraction of heavy metals by acids and combustion for destruction of organic matter);

    (c) the vitrification of fabric filter dusts;

    (d) further methods of immobilisation; and

    (e) the application of plasma technology.

B. *Thermal processes in the metallurgical industry*

24. Specific processes in the metallurgical industry may be important remaining sources of PCDD/F emissions. These are:

    (a) Primary iron and steel industry (e.g. blast furnaces, sinter plants, iron pelletising);

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(b) Secondary iron and steel industry; and

(c) Primary and secondary non-ferrous metal industry (production of copper).

PCDD/F emission control measures for the metallurgical industries are summarized in table 2

Table 2

Emission reduction of PCDD/F in the metallurgical industry

Management options	Emission level (%) (a)	Estimated costs	Management risks
Sinter plants			
Primary measures:			
— Optimisation/encapsulation of sinter conveying belts;		Low	Not 100 % achievable
— Waste gas recirculation e.g. emission optimised sintering (EOS) reducing waste gas flow by approximately 35 % (reduced costs of further secondary measures by the reduced waste gas flow), cap. 1 million Nm^3/h;	40	Low	
Secondary measures:			
— Electrostatic precipitation + molecular sieve;	Medium efficiency	Medium	
— Addition of limestone/activated carbon mixtures;	High efficiency (0,1 ngTE/m^3)	Medium	
— High-performance scrubbers — existing installation: AIRFINE (Voest Alpine Stahl Linz) since 1993 for 600 000 Nm^3/h; second installation planned in the Netherlands (Hoogoven) for 1998.	High efficiency emission reduction to (0,2-0,4 ng TE/ m^3)	Medium	0,1 ng TE/m^3 could be reached with higher energy demand; no existing installation.
Non-ferrous production (e.g. copper)			
Primary measures:			
— Pre-sorting of scrap, avoidance of feed material like plastics and PVC-contaminated scrap, stripping of coatings and use of chlorine-free insulating materials;		Low	

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Management options	Emission level (%) (a)	Estimated costs	Management risks
Secondary measures:			
— Quenching the hot waste gases;	High efficiency	Low	
— Use of oxygen or of oxygen-enriched air in firing, oxygen injection in the shaft kiln (providing complete combustion and minimization of waste gas volume);	5 - 7 (1,5-2 TE/m^3)	High	
— Fixed bed reactor or fluidised jet stream reactor by adsorption with activated charcoal or open- hearth coal dust;	(0,1 ng TE/m^3)	High	
— Catalytic oxidation; and	(0,1 ng TE/m^3)	High	
— Reduction of residence time in the critical region of temperature in the waste gas system.			
Iron and steel production			
Primary measures:			
— Cleaning of the scrap from oil prior to charging of production vessels;		Low	Cleaning solvents have to be used.
— Elimination of organic tramp materials such as oils, emulsions, greases, paint and plastics from feedstock cleaning;		Low	
— Lowering of the specific high waste gas volumes;		Medium	
— Separate collection and treatment of emissions from loading and discharging;		Low	

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Management options	Emission level (%) (a)	Estimated costs	Management risks
Secondary measures:			
— Separate collection and treatment of emissions from loading and discharging; and		Low	
— Fabric filter in combination with coke injection.	< 1	Medium	
Secondary aluminium production			
Primary measures:			
— Avoidance of halogenated material (hexachlor- oethane)		Low	
— Avoidance of chlorine-containing lubricants (for instance chlorinated paraffins); and		Low	
— Clean-up and sorting of dirty scrap charges, e.g. by swarf decoating and drying, swim-sink separation techniques and whirling stream deposition;			
Secondary measures:			
— Single- and multi-stage fabric filter with added activation of limestone/activated carbon in front of the filter;	< 1 (0,1 ng TE/m^3)	Medium/high	
— Minimisation and separate removal and purification of differently contaminated waste gas flows;		Medium/high	
— Avoidance of particulate deposition from the waste gas and promotion of rapid passing of the critical temperature range; and		Medium/high	
— Improved pretreatment of aluminium scrap shredders by using swim-sink separation techniques and grading through whirling stream deposition.		Medium/high	

(a): Remaining emission compared to unreduced mode.

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25. Metal production and treatment plants with PCDD/F emissions can meet a maximum emission concentration of 0,1 ng TE/m^3 (if waste gas volume flow > 5 000 m^3/h) using control measures.

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Sinter plants

26. Measurements at sinter plants in the iron and steel industry have generally shown PCDD/F emissions in the range of 0,4 to 4 ng TE/m^3. A single measurement at one plant without any control measures showed an emission concentration of 43 ng TE/m^3.

27. Halogenated compounds may result in the formation of PCDD/F if they enter sinter plants in the feed materials (coke breeze, salt content in the ore) and in added recycled material (e.g. millscale, blast furnace top gas dust, filter dusts and sludges from waste water treatment). However, similarly to waste incineration, there is no clear link between the chlorine content of the feed materials and emissions of PCDD/F. An appropriate measure may be the avoidance of contaminated residual material and de-oiling or degreasing of millscale prior to its introduction into the sinter plant.

28. The most effective PCDD/F emission reduction can be achieved using a combination of different secondary measures, as follows:

    (a) Recirculating waste gas significantly reduces PCDD/F emissions. Furthermore, the waste gas flow is reduced significantly, thereby reducing the cost of installing any additional end-of-pipe control systems;

    (b) Installing fabric filters (in combination with electrostatic precipitators in some cases) or electrostatic precipitators with the injection of activated carbon/open-hearth coal/limestone mixtures into the waste gas;

    (c) Scrubbing methods have been developed which include pre-quenching of the waste gas, leaching by high-performance scrubbing and separation by drip deposition. Emissions of 0,2 to 0,4 ng TE/m^3 can be achieved. By adding suitable adsorption agents like lignite coal cokes/coal slack, an emission concentration of 0,1 ng TE/m^3 can be reached.

Primary and secondary production of copper

29. Existing plants for the primary and secondary production of copper can achieve a PCDD/F emission level of a few picograms to 2 ng TE/m^3 after flue-gas cleaning. A single copper shaft furnace emitted up to 29 ng TE/m^3 PCDD/F before optimisation of the aggregates. Generally, there is a wide range of PCDD/F emission values from these plants because of the large differences in raw materials used in differing aggregates and processes.

30. Generally, the following measures are suitable for reducing PCDD/F emissions:

    (a) pre-sorting scrap;

    (b) pretreating scrap, for example stripping of plastic or PVC coatings, pretreating cable scrap using only cold/mechanical methods;

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(c) quenching hot waste gases (providing utilisation of heat), to reduce residence time in the critical region of temperature in the waste gas system;

(d) using oxygen or oxygen-enriched air in firing, or oxygen injection in the shaft kiln (providing complete combustion and minimisation of waste gas volume);

(e) adsorption in a fixed bed reactor or fluidised jet stream reactor with activated charcoal or open-hearth coal dust; and

(f) catalytic oxidation.

Production of steel

31. PCDD/F emissions from converter steelworks for steel production and from hot blast cupola furnaces, electric furnaces and electric arc furnaces for the melting of cast iron are significantly lower than 0,1 ng TE/m^3. Cold-air furnaces and rotary tube furnaces (melting of cast iron) have higher PCDD/F emissions.

32. Electric arc furnaces used in secondary steel production can achieve an emission concentration value of 0,1 ng TE/m^3 if the following measures are used:

(a) Separate collection of emissions from loading and discharging; and

(b) Use of a fabric filter or an electrostatic precipitator in combination with coke injection.

33. The feedstock to electric arc furnaces often contains oils, emulsions or greases. General primary measures for PCDD/F reduction can be sorting, de-oiling and de-coating of scraps, which may contain plastics, rubber, paints, pigments and vulcanizing additives.

Smelting plants in the secondary aluminium industry

34. PCDD/F emissions from smelting plants in the secondary aluminium industry are in the range of approximately 0,1 to 14 ng TE/m^3. These levels depend on the type of smelting aggregates, materials used and waste gas purification techniques employed.

35. In summary, single- and multi-stage fabric filters with the addition of limestone/activated carbon/open-hearth coal in front of the filter meet the emission concentration of 0,1 ng TE/m^3, with reduction efficiencies of 99 %.

36. The following measures can also be considered:

(a) minimising and separately removing and purifying differently contaminated waste gas flows;

(b) avoiding waste gas particle deposition;

(c) rapidly passing the critical temperature range;

(d) improving the pre-sorting of scrap aluminium from shredders by using swim-sink separation techniques and grading through whirling stream deposition; and

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(e) improving the pre-cleaning of scrap aluminium by swarf decoating and swarf drying.

37. Options (d) and (e) are important because it is unlikely that modern fluxless smelting techniques (which avoid halide salt fluxes) will be able to handle the low-grade scrap that can be used in rotary kilns.

38. Discussions are continuing under the Convention for the Protection of the Marine Environment of the North-east Atlantic regarding the revision of an earlier recommendation to phase out the use of hexachloroethane in the aluminium industry.

39. The melt can be treated using state-of-the-art technology, for example with nitrogen/chlorine mixtures in the ratio of between 9:1 and 8:2, gas injection equipment for fine dispersion and nitrogen pre- and post-flushing and vacuum degreasing. For nitrogen/chlorine mixtures, a PCDD/F emission concentration of about 0,03 ng TE/m^3 was measured (as compared to values of > 1 ng TE/m^3 for treatment with chlorine only). Chlorine is required for the removal of magnesium and other undesired components.

C. *Combustion of fossil fuels in utility and industrial boilers*

40. In the combustion of fossil fuels in utility and industrial boilers (> 50 MW thermal capacity), improved energy efficiency and energy conservation will result in a decline in the emissions of all pollutants because of reduced fuel requirements. This will also result in a reduction in PCDD/F emissions. It would not be cost-effective to remove chlorine from coal or oil, but in any case the trend towards gas-fired stations will help to reduce PCDD/F emissions from this sector.

41. It should be noted that PCDD/F emissions could increase significantly if waste material (sewage sludge, waste oil, rubber wastes, etc.) is added to the fuel. The combustion of wastes for energy supply should be undertaken only in installations using waste gas purification systems with highly efficient PCDD/F reduction (described in section A above).

42. The application of techniques to reduce emissions of nitrogen oxides, sulphur dioxide and particulates from the flue gas can also remove PCDD/F emissions. When using these techniques, PCDD/F removal efficiencies will vary from plant to plant. Research is ongoing to develop PCDD/F removal techniques, but until such techniques are available on an industrial scale, no best available technique is identified for the specific purpose of PCDD/F removal.

D. *Residential combustion*

43. The contribution of residential combustion appliances to total emissions of PCDD/F is less significant when approved fuels are properly used. In addition, large regional differences in emissions can occur due to the type and quality of fuel, geographical appliance density and usage.

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44. Domestic fireplaces have a worse burn-out rate for hydrocarbons in fuels and waste gases than large combustion installations. This is especially true if they use solid fuels such as wood and coal, with PCDD/F emission concentrations in the range of 0,1 to 0,7 ng TE/m^3.

45. Burning packing material added to solid fuels increases PCDD/F emissions. Even though it is prohibited in some countries, the burning of rubbish and packing material may occur in private households. Due to increasing disposal charges, it must be recognised that household waste materials are being burned in domestic firing installations. The use of wood with the addition of waste packing material can lead to an increase in PCDD/F emissions from 0,06 ng TE/m^3 (exclusively wood) to 8 ng TE/m^3 (relative to 11 % O_2 by volume). These results have been confirmed by investigations in several countries in which up to 114 ng TE/m^3 (with respect to 13 % oxygen by volume) was measured in waste gases from residential combustion appliances burning waste materials.

46. The emissions from residential combustion appliances can be reduced by restricting the input materials to good-quality fuel and avoiding the burning of waste, halogenated plastics and other materials. Public information programmes for the purchasers/operators of residential combustion appliances can be effective in achieving this goal.

E. *Firing installations for wood (< 50 MW capacity)*

47. Measurement results for wood-firing installations indicate that PCDD/F emissions above 0,1 ng TE/m^3 occur in waste gases especially during unfavourable burn-out conditions and/or when the substances burned have a higher content of chlorinated compounds than normal untreated wood. An indication of poor firing is the total carbon concentration in the waste gas. Correlations have been found between CO emissions, burn-out quality and PCDD/F emissions. Table 3 summarises some emission concentrations and factors for wood-firing installations.

Table 3

Quantity-related emission concentrations and factors for woodfiring installations

Fuel	Emission concentration (ng TE/m^3)	Emission factor (ng TE/kg)	Emission factor (ng/GJ)
Natural wood (beech tree)	0,02-0,10	0,23-1,3	12-70
Natural wood chips from forests	0,07-0,21	0,79-2,6	43-140
Chipboard	0,02-0,08	0,29-0,9	16-50
Urban waste wood	2,7-14,4	26-173	140 0-9 400
Residential waste	114	3 230	
Charcoal	0,03		

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48. The combustion of urban waste wood (demolition wood) in moving grates leads to relatively high PCDD/F emissions, compared to non-waste wood sources. A primary measure for emission reduction is to avoid the use of treated waste wood in wood-firing installations. Combustion of treated wood should be undertaken only in installations with the appropriate flue-gas cleaning to minimize PCDD/F emissions.

V. Control techniques for the reduction of PAH emissions

A. *Coke production*

49. During coke production, PAHs are released into the ambient air mainly:

    (a) when the oven is charged through the charging holes;

    (b) by leakages from the oven door, the ascension pipes and the charging hole lids; and

    (c) during coke pushing and coke cooling.

50. Benzo(a)pyrene (BaP) concentration varies substantially between the individual sources in a coke battery. The highest BaP concentrations are found on the top of the battery and in the immediate vicinity of the doors.

51. PAH from coke production can be reduced by technically improving existing integrated iron and steel plants. This might entail the closure and replacement of old coke batteries and the general reduction in coke production, for instance by injecting high-value coal in steel production.

52. A PAH reduction strategy for coke batteries should include the following technical measures:

    (a) charging the coke ovens:

    - particulate matter emission reduction when charging the coal from the bunker into the charging cars,
    - closed systems for coal transfer when coal pre-heating is used,
    - extraction of filling gases and subsequent treatment, either by passing the gases into the adjacent oven or by passing via a collecting main to an incinerator and a subsequent dedusting device. In some cases the extracted filling gases may be burned on the charging cars, but the environmental performance and safety of these charging-car-based systems is less satisfactory. Sufficient suction should be generated by steam or water injection in the ascension pipes;

    (b) emissions at charging hole lids during coking operation should be avoided by:

    - using charging hole lids with highly efficient sealing,
    - luting the charging hole lids with clay (or equally effective material) after each charging operation,
    - cleaning the charging hole lids and frames before closing the charging hole,

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— keeping oven ceilings free from coal residuals;

(c) ascension pipe lids should be equipped with water seals to avoid gas and tar emissions, and the proper operation of the seals should be maintained by regular cleaning;

(d) coke oven machinery for operating the coke oven doors should be equipped with systems for cleaning the seals and surfaces on the oven door frames and oven doors;

(e) coke oven doors:

— highly effective seals should be used (e.g. spring-loaded membrane doors),

— seals on the oven doors and door frames should be cleaned thoroughly at every handling operation,

— doors should be designed in a manner that allows the installation of particulate matter extraction systems with connection to a dedusting device (via a collecting main) during pushing operations;

(f) the coke transfer machine should be equipped with an integrated hood, stationary duct and stationary gas cleaning system (preferably a fabric filter);

(g) low-emission procedures should be applied for coke cooling, e.g. dry coke cooling. The replacement of a wet quenching process by dry coke cooling should be preferred, so long as the generation of waste water is avoided by using a closed circulation system. The dusts generated when dry quenched coke is handled should be reduced.

53. A coke-making process referred to as ‘non-recovery coke-making’ emits significantly less PAH than the more conventional by-product recovery process. This is because the ovens operate under negative pressure, thereby eliminating leaks to the atmosphere from the coke oven doors. During coking, the raw coke oven gas is removed from the ovens by a natural draught, which maintains a negative pressure in the ovens. These ovens are not designed to recover the chemical by-products from raw coke oven gas. Instead, the offgases from the coking process (including PAH) are burned efficiently at high temperatures and with long residence times. The waste heat from this incineration is used to provide the energy for coking, and excess heat may be used to generate steam. The economics of this type of coking operation may require a cogeneration unit to produce electricity from the excess steam. Currently there is only one non-recovery coke plant operating in the United States, and one is in operation in Australia. The process is basically a horizontal sole-flue non-recovery coke oven with an incineration chamber adjoining two ovens. The process provides for alternate charging and coking schedules between the two ovens. Thus, one oven is always providing the incineration chamber with coke gases. The coke gas combustion in the incineration chamber provides the necessary heat source. The incineration chamber design provides the necessary dwell time (approximately one second) and high temperatures (minimum of 900 °C).

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54. An effective monitoring programme for leakages from coke oven door seals, ascension pipes and charging hole lids should be operated. This implies the monitoring and recording of leakages and immediate repair or maintenance. A significant reduction of diffuse emissions can thus be achieved.

55. Retrofitting existing coke batteries to facilitate condensation of flue gases from all sources (with heat recovery) results in a PAH reduction of 86 % to more than 90 % in air (without regard to waste water treatment). Investment costs can be amortised in five years, taking into account recovered energy, heated water, gas for synthesis and saved cooling water.

56. Increasing coke oven volumes results in a decrease in the total number of ovens, oven door openings (amount of pushed ovens per day), number of seals in a coke battery and consequently PAH emissions. Productivity increases in the same way by decreasing operating and personnel costs.

57. Dry coke cooling systems require a higher investment cost than wet methods. Higher operating costs can be compensated for by heat recovery in a process of pre-heating the coke. The energy efficiency of a combined dry coke cooling/coal pre-heating system rises from 38 to 65 %. Coal pre-heating boosts productivity by 30 %. This can be raised to 40 % because the coking process is more homogeneous.

58. All tanks and installations for the storage and treatment of coal tar and coal tar products must be equipped with an efficient vapour recovery return and/or vapour destruction system. The operating costs of vapour destruction systems can be reduced in an autothermal after-burning mode if the concentration of the carbon compounds in the waste is high enough.

59. Table 4 summarises PAH emission reduction measures in coke production plants.

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Table 4

PAH emission control for coke production

Management options	Emission level (%) (a)	Estimated costs	Management risks
Retrofitting of old plants with condensation of emitted flue gases from all sources includes the following measures:	Total < 10 (without waste water)	High	Emissions to waste water by wet quenching are very high. This method should be applied only if the water is reused in a closed cycle.
— evacuation and after-burning of the filling gases during charging of ovens or passing the gases into the adjacent oven as far as possible,	5	(Amortisation of investment costs, taking into account energy recovery, heated water, gas for synthesis and saved cooling water, may be five years.)	
— emissions at charging hole lids should be avoided as far as possible, e.g. by special hole lid construction and highly effective sealing methods. Coke oven doors with highly effective sealings should be used. Cleaning of charging hole lids and frames before closing the charging hole,	< 5		
— waste gases from pushing operations should be collected and fed to a dedusting device,	< 5		
— quenching during coke cooling by wet methods only if properly applied without waste water.			
Low emission procedures for coke cooling, e.g. dry coke cooling.	No emissions into water	Higher investment costs than for wet cooling (but lower costs by preheating of coke and use of waste heat.)	
Increasing the use of high-volume ovens to lower the number of openings and the surface of sealing areas.	Considerable	Investment about 10 % higher than conventional plants.	In most cases total retro-fitting or the installation of a new cokery is needed.

(a): Remaining emission compared to unreduced mode.

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B. *Anode production*

60. PAH emissions from anode production have to be dealt with in a similar fashion as those from coke production.

61. The following secondary measures for emission reduction of PAH-contaminated dust are used:

(a) electrostatic tar precipitation;

(b) combination of a conventional electrostatic tar filter with a wet electrostatic filter as a more efficient technical measure;

(c) thermal after-burning of the waste gases; and

(d) dry scrubbing with limestone/petroleum coke or aluminum oxide (Al_2O_3).

62. The operating costs in thermal after-burning can be reduced in an auto-thermal after-burning mode if the concentration of carbon compounds in the waste gas is high enough. Table 5 summarises PAH emission control measures for anode production.

Table 5

PAH emission control for anode production

Management options	Emission level (%) (a)	Estimated costs	Management risks
Modernisation of old plants by reducing diffuse emissions with the following measures: — reduction of leakages, — installation of flexible sealants at the oven doors — evacuation of filling gases and subsequent treatment, either by passing the gases into the adjacent oven or by passing the gases via a collecting main to an incinerator and a subsequent dedusting device on the ground, — operating and coke oven cooling systems, and — evacuation and purification of particulate emissions from coke.	3-10	High	
Established technologies for anode production in the Netherlands: — new kiln with dry scrubber (with limestone/petroleum cokes or with aluminium), — effluent recycling in paste unit.	45-50		Implemented in the Netherlands in 1990. Scrubbing with limestone or petroleum cokes is effective for reducing PAH; with aluminium not known.

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Management options	Emission level (%) (a)	Estimated costs	Management risks
BAT:			
— electrostatic dust precipitation, and	2-5	Lower operating costs in an auto- thermal mode	Regular cleaning of tar is needed
— thermal after-burning.	15		Operating in autothermal mode only if the concentration of PAH in the waste gas is high.
(a): Remaining emission compared to unreduced mode.			

C. *Aluminium industry*

63. Aluminium is produced from aluminium oxide (Al_2O_3) by electrolysis in pots (cells) electrically connected in series. Pots are classified as prebake or Soederberg pots, according to the type of the anode.

64. Prebake pots have anodes consisting of calcined (baked) carbon blocks, which are replaced after partial consumption. Soederberg anodes are baked in the cell, with a mixture of petroleum coke and coal tar pitch acting as a binder.

65. Very high PAH emissions are released from the Soederberg process. Primary abatement measures include modernization of existing plants and optimization of the processes, which could reduce PAH emissions by 70 to 90 %. An emission level of 0,015 kg B(a)P/tonne of Al could be reached. Replacing the existing Soederberg cells by prebaked ones would require major reconstruction of the existing process, but would nearly eliminate the PAH emissions. The capital costs of such replacements are very high.

66. Table 6 summarises PAH emission control measures for aluminium production.

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Table 6

PAH emission control for aluminium production using the Soederberg process

Management options	Emission level (%) (a)	Estimated costs	Management risks
Replacement of Soederberg electrodes by:	3-30	Higher costs for electrodes about USD 800 million	Soederberg electrodes are cheaper than prebaked ones, because no anode baking plant is needed. Research is in progress, but expectations are low. Efficient operation and monitoring of emission are essential parts of emission control. Poor performance could cause significant diffuse emissions.
— prebaked electrodes (avoidance of pitch binders),			
— inert anodes.			
Closed prebake systems with point feeding of alumina and efficient process control, hoods covering the entire pot and allowing efficient collection of air pollutants.	1-5		
Soederberg pot with vertical contact bolts and waste gas collection systems.	> 10	Retrofit of Soederberg technology by encapsulation and modified feeding point: USd 50 000 to 10 000 per furnace	Diffuse emissions occur during feeding, crust breaking and lifting of iron contact bolts to a higher position.
Sumitomo technology(anode briquettes for VSS process):		Low to medium	
Gas cleaning:			
— electrostatic tar filters,	2-5	Low	High rate of sparking and electrical arcing; Wet gas-cleaning generates waste water.
— combination of conventional electrostatic tar filters with electrostatic wet gas cleaning;	> 1	Medium	
— thermal after-burning.			
Pitch use with higher melting point (HSS + VSS).	High	Low to medium	
Use of dry scrubbing in existing HSS + VSS plants.		Medium to high	

(a).: Remaining emission compared to unreduced mode.

D. *Residential combustion*

67. PAH emissions from residential combustion can be detected from stoves or open fireplaces especially when wood or coal is used. Households could be a significant source of PAH emissions. This is the result of the use of fireplaces and small firing installations burning solid fuels in

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households. In some countries the usual fuel for stoves is coal. Coal-burning stoves emit less PAH than wood-burning ones, because of their higher combustion temperatures and more consistent fuel quality.

68. Furthermore, combustion systems with optimised operation characteristics (e.g. burning rate) effectively control PAH emissions from residential combustion. Optimised combustion conditions include optimised combustion chamber design and optimised supply of air. There are several techniques which optimise combustion conditions and reduce emissions. There is a significant difference in emissions between different techniques. A modern wood-fired boiler with a water accumulation tank, representing BAT, reduces the emission by more than 90 % compared to an outdated boiler without a water accumulation tank. A modern boiler has three different zones: a fireplace for the gasification of wood, a gas combustion zone with ceramics or other material which allow temperatures of some 1 000°C, and a convection zone. The convection part where the water absorbs the heat should be sufficiently long and effective so that the gas temperature can be reduced from 1 000 ° C to 250 °C or less. There are also several techniques to supplement old and outdated boilers, for example with water accumulation tanks, ceramic inserts and pellet burners.

69. Optimised burning rates are accompanied by low emissions of carbon monoxide (CO), total hydrocarbons (THC) and PAHs. Setting limits (type approval regulations) on the emission of CO and THCs also affects the emission of PAHs. Low emission of CO and THCs results in low emission of PAHs. Since measuring PAH is far more expensive than measuring CO, it is more cost-effective to set a limit value for CO and THCs. Work is continuing on a proposal for a CEN standard for coal- and wood-fired boilers up to 300 kW (see table 7).

Table 7

Draft CEN standards in 1997

Class	Effect (kW)	3	2	1	3	2	1	3	2	1
		CO			THC			Particulates		
Manual	< 50	5 000	8 000	25 000	150	300	2 000	150/125	180/150	200/180
	> 50-150	2 500	5 000	12 500	100	200	1 500	150/125	180/150	200/180
	> 150-300	1 200	2 000	12 500	100	200	1 500	150/125	180/150	200/180
Automatic	< 50	3 000	5 000	15 000	100	200	1 750	150/125	180/150	200/180
	> 50-150	2 500	4 500	12 500	80	150	1 250	150/125	180/150	200/180
	> 150-300	1 200	2 000	12 500	80	150	1 250	150/125	180/150	200/180

Note: Emission levels in mg/m^3 at 10 % O_2.

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70. Emissions from residential wood combustion stoves can be reduced:

    (a) For existing stoves, by public information and awareness programmes regarding proper stove operation, the use of untreated wood only, fuel preparation procedures and the correct seasoning of wood for moisture content; and

    (b) For new stoves, by the application of product standards as described in the draft CEN standard (and equivalent product standards in the United States and Canada).

71. More general measures for PAH emission reduction are those related to the development of centralized systems for households and energy conservation such as improved thermal insulation to reduce energy consumption.

72. Information is summarised in table 8.

Table 8

PAH emission control for residential combustion

Management options	Emission level (%) (a)	Estimated costs	Management risks
Use of dried coal and wood (dried wood is wood stored for at least 18 to 24 months).	High effectiveness		
Use of dried coal	High effectiveness		
Design of heating systems for solid fuels to provide optimized complete burning conditions: — gasification zone, — combustion with ceramics, — effective convection zone.	55	Medium	Negotiations have to be held with stove manufacturers to introduce an approval scheme for stoves.
Water accumulation tank			
Technical instructions for efficient operation.	30 to 40	Low	Might be achieved also by vigorous public education, combined with practical instructions and stove type regulation.
Public information programme concerning the use of wood burning stoves.			

(a): Remaining emission compared to unreduced mode.

E. *Wood preservation installations*

73. Wood preservation with PAH-containing coal-tar products may be a major source of PAH emissions to the air. Emissions may occur during the impregnation process itself as well as during storage, handling and use of the impregnated wood in the open air.

74. The most widely used PAH-containing coal-tar products are carbolineum and creosote. Both are coal-tar distillates containing PAHs for the protection of timber (wood) against biological attack.

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75. PAH emissions from wood preservation, installations and storage facilities may be reduced using several approaches, implemented either separately or in combination, such as:

    (a) requirements on storage conditions to prevent pollution of soil and surface water by leached PAH and contaminated rainwater (e.g. storage sites impermeable to rainwater, roof cover, reuse of contaminated water for the impregnation process, quality demands for the material produced);

    (b) measures to reduce atmospheric emissions at impregnation plants (e.g. the hot wood should be cooled down from 90 °C to 30 °C at least before transport to storage sites. However, an alternative method using pressure steam under vacuum conditions to impregnate the wood with creosote should be highlighted as BAT);

    (c) the optimum loading of wood preservative, which gives adequate protection to the treated wood product in situ, can be regarded as a BAT as this will reduce the demand for replacements, thereby reducing emissions from the wood preservation installations;

    (d) using wood preservation products with a lower content of those PAHs that are POPs:

        — possibly using modified creosote which is taken to be a distillation fraction boiling between 270 °C and 355 °C, which reduces both the emissions of the more volatile PAHs and the heavier, more toxic PAHs;

        — discouraging the use of carbolineum would also reduce PAH emissions;

    (e) Evaluating and then using, as appropriate, alternatives, such as those in table 9, that minimize reliance on PAH-based products.

76. Burning of impregnated wood gives rise to PAH emissions and other harmful substances. If burning does take place, it should be done in installations with adequate abatement techniques.

Table 9

Possible alternatives to wood preservation involving PAH-based products

Management options	Management risks
Use of alternative materials for application in construction: — sustainably produced hardwood (riverbanks, fences, gates), — plastics (horticulture posts), — concrete (railway sleepers), — replacement of artificial constructions by natural ones (such as riverbanks, fences, etc.), — use of untreated wood. There are several alternative wood preserving techniques in development which do not include impregnation with PAH based products.	Other environmental problems have to be evaluated such as: — availability of suitably produced wood, — emissions caused by the production and disposal of plastics, especially PVC.

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ANNEX VI

TIMESCALES FOR THE APPLICATION OF LIMIT VALUES AND BEST AVAILABLE TECHNIQUES TO NEW AND EXISTING STATIONARY SOURCES

The timescales for the application of limit values and best available techniques are:

(a) for new stationary sources: two years after the date of entry into force of the present Protocol;

(b) for existing stationary sources: eight years after the date of entry into force of the present Protocol. If necessary, this period may be extended for specific existing stationary sources in accordance with the amortisation period provided for by national legislation.

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ANNEX VII

RECOMMENDED CONTROL MEASURES FOR REDUCING EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MOBILE SOURCES

1. Relevant definitions are provided in Annex III to the present Protocol.

I. **Achievable emission levels for new vehicles and fuel parameters**

A. *Achievable emission levels for new vehicles*

2. Diesel-fuelled passenger cars

Limit values	Year	Reference mass	
		Mass of hydrocarbons and NO_x	Mass of particulates
1.1.2000	All	0,56 g/km	0,05 g/km
1.1.2005 (indicative)	All	0,3 g/km	0,25 g/km

3. Heavy-duty vehicles

Year/test cycle	Limit values	
	Mass of hydrocarbons	Mass of particulates
1.1.2000 /ESC cycle	0,66 g/kWh	0,1 g/kWh
1.1.2000 /ETC cycle	0,85 g/kWh	0,16 g/kWh

4. Off-road engines

Step 1 (reference: Regulation (EEC) No 96 (*)

Net power (P) (kW)	Mass of hydrocarbons	Mass of particulates
$P \geq 130$	1,3 g/kWh	0,54 g/kWh
$75 \leq P < 130$	1,3 g/kWh	0,70 g/kWh
$37 \leq P < 75$	1,3 g/kWh	0,85 g/kWh

(*) 'Uniform provisions concerning the approval of compression ignition (CI) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by the engine.' The Regulation came into force on 15 December 1995 and its amendment came into force on 5 March 1997.

Step 2

Net power (P) (kW)	Mass of hydrocarbons	Mass of particulates
$0 < P < 18$		
$18 \leq P < 37$	1,5 g/kWh	0,8 g/kWh
$37 \leq P < 75$	1,3 g/kWh	0,4 g/kWh
$75 \leq P < 130$	1,0 g/kWh	0,3 g/kWh
$130 \leq P < 560$	1,0 g/kWh	0,2 g/kWh

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B. *Fuel parameters*

5. Diesel fuel

Parameter	Unit	Limits		Test method
		Minimum value (2000/2005) (*)	Maximum value (2000/2005) (*)	
Cetane number	—	51/NS	—	ISO 5165
Density at 15 °C	kg/m^3	—	845/NS	ISO 3675
Evaporated 95 %	°C	—	360/NS	ISO 3405
PAH	mass %	—	11/NS	prIP 391
Sulphur	ppm	—	350/50 (**)	ISO 14956

(*) 1 January of year specified.
(**) Indicative value.
NS: Not specified.

II. **Restriction of halogenated scavengers, additives in fuels and lubricants**

6. In some countries, 1,2-dibromomethane in combination with 1,2-dichloromethane is used as a scavenger in leaded petrol. Moreover, PCDD/F are formed during the combustion process in the engine. The application of three-way catalytic converters for cars will require the use of unleaded fuel. The addition of scavengers and other halogenated compounds to petrol and other fuels and to lubricants should be avoided as far as possible.

7. Table 1 summarizes measures for PCDD/F emission control from the exhaust from road transport motor vehicles.

Table 1

PCDD/F emission control for the exhaust from road transport motor vehicles

Management options	Management risks
Avoiding adding halogenated compounds to fuels — 1,2-dichloromethane — 1,2-dichloromethane and corresponding bromo compounds as scavengers in leaded fuels for spark ignition engines (Bromo compounds may lead to the formation of brominated dioxins or furans) Avoiding halogenated additives in fuels and lubricants.	Halogenated scavengers will be phased out as the market for leaded petrol shrinks because of the increasing use of closed-loop three-way catalytic converters with spark ignition engines.

III. **Control measures for emissions of POPs from mobile sources**

A. *POP emissions from motor vehicles*

8. POP emissions from motor vehicles occur as particle-bound PAHs emitted from diesel-fuelled vehicles. To a minor extent PAHs are also emitted by petrol-fuelled vehicles.

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9. Lubrication oil and fuels may contain halogenated compounds as a result of additives or the production process. These compounds may be transformed during combustion into PCDD/F and subsequently emitted with the exhaust gases.

B. *Inspection and maintenance*

10. For diesel-fuelled mobile sources, the effectiveness of the control of emissions of PAHs may be ensured through programmes to test the mobile sources periodically for particulate emissions, opacity during free acceleration, or equivalent methods.

11. For petrol-fuelled mobile sources, the effectiveness of the control of emissions of PAHs (in addition to other exhaust components) may be ensured through programmes to test periodically the fuel metering and the efficiency of the catalytic converter.

C. *Techniques to control PAH emissions from diesel- and petrol-fuelled motor vehicles*

1. General aspects of control technologies

12. It is important to ensure that vehicles are designed to meet emission standards while in service. This can be done by ensuring conformity of production, lifetime durability, warranty of emission-control components, and recall of defective vehicles. For vehicles in use, continued emission control performance can be ensured by an effective inspection and maintenance programme.

2. Technical measures for emission control

13. The following measures to control PAH emissions are important:

    (a) Fuel-quality specifications and engine modifications to control emissions before they are formed (primary measures); and

    (b) Addition of exhaust treatment systems, e.g. oxidising catalysts or particle traps (secondary measures).

(1) Diesel engines

14. Diesel-fuel modification can yield two benefits: a lower sulphur content reduces emissions of particles and increases the conversion efficiency of oxidising catalysts, and the reduction in di- and tri-aromatic compounds reduces the formation and emission of PAHs.

15. A primary measure to reduce emissions is to modify the engine to achieve more complete combustion. Many different modifications are in use. In general, vehicle exhaust composition is influenced by changes in combustion chamber design and by higher fuel injection pressures. At present, most diesel engines rely on mechanical engine control systems. Newer engines increasingly use computerised electronic control systems with greater potential flexibility in controlling emissions. Another technology to control emissions is the combined technology of turbocharging and intercooling. This system is successful in reducing NO_x as well as increasing fuel economy and power output. For heavy- and light-duty engines the use of intake manifold tuning is also a possibility.

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16. Controlling the lubricating oil is important to reduce particulate matter (PM), as 10 to 50 % of particulate matter is formed from engine oil. Oil consumption can be reduced by improved engine manufacturing specifications and improved engine seals.

17. Secondary measures to control emissions are additions of exhaust treatment systems. In general, for diesel engines the use of an oxidising catalyst in combination with a particulate filter has been shown to be effective in reducing PAH emissions. A particle trap oxidizer is being evaluated. It is located in the exhaust system to trap PM and can provide some regeneration of the filter by burning the collected PM, through electrical heating of the system or some other means of regeneration. For proper regeneration of passive system traps during normal operation, a burner-assisted regeneration system or the use of additives is required.

(2) Petrol engines

18. PAH-reduction measures for petrol-fuelled engines are primarily based on the use of a closed-loop three-way catalytic converter, which reduces PAHs as part of the HC emission reductions.

19. Improved cold start behaviour reduces organic emissions in general and PAHs in particular (for instance start-up catalysts, improved fuel evaporation/atomization, heated catalysts).

20. Table 2 summarises measures for PAH emission control from the exhaust from road transport motor vehicles.

Table 2

PAH emission control for the exhaust from road transport motor vehicles

Management options	Emission level (%)	Management risks
Spark ignition engines:	10 to 20	Availability of unleaded petrol.
— closed-loop three-way catalytic converter,	5 to 15	Commercially available in some countries.
— catalysts for reducing cold start emissions.		Availability of refinery capacity.
Fuel for spark ignition engines:		
— reduction of aromatics,		
— reduction of sulphur.		

▼**M5**

Management options	Emission level (%)	Management risks
Diesel engines:	20 to 70	
— ozidizing catalyst,		Availability of refinery capacity.
— trap oxidizer/particulate filter.		
Diesel fuel modification:		
— reduction of sulphur to reduce particulate emissions.		
Improvement of diesel engine specifications:		Existing technologies.
— electronic control system, injection rate adjustment and high-pressure fuel injection,		
— turbocharging and intercooling,		
— exhaust gas recirculation.		

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ANNEX VIII

Major Stationary Source Categories

I. **Introduction**

Installations or parts of installations for research, development and the testing of new products are not covered by this list. A more complete description of the categories may be found in Annex V.

II. **List of categories**

Category	Description of the category
1	Incineration, including co-incineration, of municipal, hazardous or medical waste, or of sewage sludge.
2	Sinter plants.
3	Primary and secondary production of copper.
4	Production of steel.
5	Smelting plants in the secondary aluminium industry.
6	Combustion of fossil fuels in utility and industrial boilers with a thermal capacity above 50 MW_{th}.
7	Residential combustion.
8	Firing installations for wood with a thermal capacity below 50 MW_{th}.
9	Coke production.
10	Anode production.
11	Aluminium production using the Soederberg process.
12	Wood preservation installations, except for a Party for which this category does not make a significant contribution to its total emissions of PAH (as defined in Annex III).

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PROTOCOL

to the 1979 Convention on long-range transboundary air pollution on long-term financing of the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP)

THE CONTRACTING PARTIES,

Recalling that the Convention on long-range transboundary air pollution (hereinafter referred to as 'the Convention') entered into force on 16 March 1983,

Aware of the importance of the cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe (hereinafter referred to as EMEP), as provided for in Articles 9 and 10 of the Convention,

Cognizant of the positive results achieved so far in the implementation of EMEP,

Recognizing that the implementation of EMEP has hitherto been made possible by financial means provided by the United Nations environment programme (UNEP) and by voluntary contributions from governments,

Bearing in mind that since the UNEP contribution will continue only until the end of 1984, and that since this contribution together with the voluntary contributions from governments have been inadequate to support fully the EMEP work plan, it will therefore be necessary to provide for long-term funding after 1984,

Considering the appeal of the Economic Commission for Europe to ECE member governments, contained in its decision B (XXXVIII), to make available, on a basis to be agreed at the first meeting of the Executive Body for the Convention (hereinafter referred to as the 'Executive Body'), the financial resources to enable the Executive Body to carry out its activities, in particular as regards the work of EMEP,

Noting that the Convention does not contain any provisions for financing EMEP and that it is, therefore, necessary to make appropriate arrangements regarding this matter,

Considering the elements to guide the drafting of a formal instrument supplementing the Convention, as listed in recommendations adopted by the Executive Body at its first session (7 to 10 June 1983),

HAVE AGREED AS FOLLOWS:

Article 1

Definitions

For the purposes of the present Protocol:

1. 'UN assessment rate' means a Contracting Party's rate for the financial year in question in the scale of assessments for the apportionment of the expenses of the United Nations.

2. 'Financial year' means the financial year of the United Nations; and 'annual basis' and 'annual costs' shall be construed accordingly.

▼**M1**

3. ‘General Trust Fund’ means the General Trust Fund for the financing of the implementation of the Convention on long-range transboundary air pollution, which has been established by the Secretary-General of the United Nations.

4. ‘Geographical scope of EMEP’ means the area within which, coordinated by the international centres of EMEP (1), monitoring is carried out.

Article 2

Financing of EMEP

The financing of EMEP shall cover the annual costs of the international centres cooperating within EMEP for the activities appearing in the work programme of the Steering Body of EMEP.

Article 3

Contributions

1. In accordance with the provisions of this Article the financing of EMEP shall consist of mandatory contributions, supplemented by voluntary contributions.

Contributions may be made in convertible currency, non-convertible currency, or in kind.

2. Mandatory contributions shall be made on an annual basis by all Contracting Parties to the present Protocol which are within the geographical scope of EMEP.

3. Voluntary contributions may be made by the Contracting Parties or Signatories to the present Protocol, even if their territory lies outside the geographical scope of EMEP, as well as, subject to approval by the Executive Body, on the recommendation of the Steering Body of EMEP, by any other country, organization or individual which wishes to contribute to the work programme.

4. The annual costs of the work programme shall be covered by the mandatory contributions. Contributions in cash and in kind, such as those provided by host countries for international centres, shall be specified in the work programme. Voluntary contributions may, subject to the approval by the executive Body, on the recommendation of the Steering Body, be utilized either for reducing the mandatory contributions or for financing specific activities within the scope of EMEP.

5. Mandatory and voluntary contributions in cash shall be deposited in the General Trust Fund.

Article 4

Sharing of costs

1. Mandatory contributions shall be made in accordance with the terms of the Annex to the present Protocol.

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(1) The international centres are at present: the Chemical Coordinating Centre, the Meteorological Synthesizing Centre-East and the Meteorological Synthesizing Centre-West.

▼M1

2. The Executive Body shall consider the need to amend the Annex:

(a) if the annual budget of EMEP increases by a factor of two and a half times the level of the annual budget adopted for the year of entry into force of the present Protocol or for the year of last amendment of the Annex, whichever is later; or

(b) if the Executive Body, on the recommendation of the Steering Body, designates a new international centre; or

(c) six years after the entry into force of the present Protocol, or six years after the last amendment to the Annex, whichever is later.

3. Amendments to the Annex shall be adopted by consensus of the Executive Body.

Article 5

Annual budget

An annual budget for EMEP shall be drawn up by the Steering Body of EMEP, and shall be adopted by the Executive Body not later than one year in advance of the financial year to which it applies.

Article 6

Amendments to the Protocol

1. Any Contracting Party to the present Protocol may propose amendments to it.

2. The text of proposed amendments shall be submitted in writing to the Executive Secretary of the Economic Commission for Europe, who shall communicate them to all Contracting Parties to the Protocol. The Executive Body shall discuss the proposed amendments at its next annual meeting provided that such proposals have been circulated by the Executive Secretary of the Economic Commission for Europe to the Contracting Parties to the Protocol at least 90 days in advance.

3. An amendment to the present Protocol, other than an amendment to its Annex, shall be adopted by consensus of the representatives of the Contracting Parties to the Protocol, and shall enter into force for the Contracting Parties to the Protocol which have accepted it on the 90th day after the date on which two-thirds of those Contracting Parties have deposited with the depositary their instruments of acceptance of the amendment. The amendment shall enter into force for any other Contracting Party on the 90th day after the date on which that Contracting Party deposits its instrument of acceptance of the amendment.

Article 7

Settlement of disputes

If a dispute arises between two or more Contracting Parties to the present Protocol as to its interpretation or application, they shall seek a solution by negotiation or by any other method of dispute settlement acceptable to the parties to the dispute.

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Article 8

Signature

1. The present Protocol shall be open for signature at the United Nations Office in Geneva from 28 September 1984 until 5 October 1984 inclusive, then at the Headquarters of the United Nations in New York until 4 April 1985, by the member States of the Economic Commission for Europe as well as States having consultative status with the Economic Commission for Europe, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Economic Commission for Europe, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the present Protocol, provided that the States and organizations concerned are parties to the Convention.

2. In matters within their competence, such regional economic integration organizations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their member States. In such cases, the member States of these organizations shall not be entitled to exercise such rights individually.

Article 9

Ratification, acceptance, approval and accession

1. The present Protocol shall be subject to ratification, acceptance or approval by Signatories.

2. The present Protocol shall be open for accession as from 5 October 1984 by the States and organizations referred to in Article 8, paragraph 1.

3. The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of the depositary.

Article 10

Entry into force

1. The present Protocol shall enter into force on the 90th day following the date on which:

(a) instruments of ratification, acceptance, approval or accession have been deposited by at least 19 States and organizations referred to in Article 8 (1) which are within the geographical scope of EMEP; and

(b) the aggregate of the UN assessment rates for such States and organizations exceeds 40 %.

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2. For each State and organization referred to in Article 8 (1) which ratifies, accepts or approves the present Protocol or accedes thereto after the requirements for entry into force laid down in paragraph 1 above have been met, the Protocol shall enter into force on the 90th day after the date of deposit by such State or organization of its instrument of ratification, acceptance, approval or accession.

Article 11

Withdrawal

1. At any time after five years from the date on which the present Protocol has come into force with respect to a Contracting Party, that Contracting Party may withdraw from it by giving written notification to the depositary. Any such withdrawal shall take effect on the 90th day after the date of its receipt by the depositary.

2. Withdrawal shall not affect the financial obligations of the withdrawing Party until the date on which the withdrawal takes effect.

Article 12

Authentic texts

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

▼M1

ANNEX

referred to in Article 4 of the Protocol to the 1979 Convention on long-range transboundary air pollution on long-term financing of the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP)

Mandatory contributions for sharing of costs for financing the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP), shall be calculated according to the following scale:

	%
Austria	1,59
Bulgaria	0,35
Belorussian SSR	0,71
Czechoslovakia	1,54
Finland	1,07
German Democratic Republic	2,74
Holy See	0,02
Hungary	0,45
Iceland	0,06
Liechtenstein	0,02
Norway	1,13
Poland	1,42
Portugal	0,30
Romania	0,37
San Marino	0,02
Spain	3,54
Sweden	2,66
Switzerland	2,26
Turkey	0,60
Ukrainian SSR	2,60
USSR	20,78
Yugoslavia	0,60
Member States the European Economic Community:	
Belgium	2,36
Denmark	1,38
France	11,99
Germany, Federal Republic of	15,73
Greece	1,00
Ireland	0,50
Italy	6,89
Luxembourg	0,10
Netherlands	3,28
United Kingdom	8,61
European Economic Community	3,33
	Total 100,00

The order in which the Contracting Parties are listed in this Annex is specifically made in relation to the cost-sharing system agreed upon by the Executive Body for the Convention. Accordingly, the listing is a feature which is specific to the Protocol on the financing of EMEP.

▼**M3**

PROTOCOL

to the 1979 convention on long-range transboundary air pollution on further reduction of sulphur emissions

THE PARTIES,

DETERMINED to implement the Convention on Long-range Transboundary Air Pollution,

CONCERNED that emissions of sulphur and other air pollutants continue to be transported across international boundaries and, in exposed parts of Europe and North America, are causing widespread damage to natural resources of vital environmental and economic importance, such as forests, soils and waters, and to materials, including historic monuments, and, under certain circumstances, have harmful effects on human health,

RESOLVED to take precautionary measures to anticipate, prevent or minimise emissions of air pollutants and mitigate their adverse effects,

CONVINCED that where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that such precautionary measures to deal with emissions of air pollutants should be cost-effective,

MINDFUL that measures to control emissions of sulphur and other air pollutants would also contribute to the protection of the sensitive Arctic environment,

CONSIDERING that the predominant sources of air pollution contributing to the acidification of the environment are the combustion of fossil fuels for energy production, and the main technological processes in various industrial sectors, as well as transport, which lead to emissions of sulphur, nitrogen oxides, and other pollutants,

CONSCIOUS of the need for a cost-effective regional approach to combating air pollution that takes account of the variations in effects and abatement costs between countries,

DESIRING to take further and more effective action to control and reduce sulphur emissions,

COGNISANT that any sulphur control policy, however cost-effective it may be at the regional level, will result in a relatively heavy economic burden on countries with economies that are in transition to a market economy,

BEARING IN MIND that measures taken to reduce sulphur emissions should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international competition and trade,

TAKING INTO CONSIDERATION existing scientific and technical data on emissions, atmospheric processes and effects on the environment of sulphur oxides, as well as on abatement costs,

AWARE that, in addition to emissions of sulphur, emissions of nitrogen oxides and of ammonia are also causing acidification of the environment,

NOTING that under the United Nations Framework Convention on Climate Change, adopted in New York on 9 May 1992, there is agreement to establish national policies and take corresponding measures to combat climate change, which can be expected to lead to reductions of sulphur emissions,

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AFFIRMING the need to ensure environmentally sound and sustainable development,

RECOGNISING the need to continue scientific and technical cooperation to elaborate further the approach based on critical loads and critical levels, including efforts to assess several air pollutants and various effects on the environment, materials and human health,

UNDERLINING that scientific and technical knowledge is developing and that it will be necessary to take such developmeents into account when reviewing the adequacy of the obligations entered into under the present Protocol and deciding on further action,

ACKNOWLEDGING the Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes by at least 30 per cent, adopted in Helsinki on 8 July 1985, and the measures already taken by many countries which have had the effect of reducing sulphur emissions,

HAVE AGREED AS FOLLOWS:

Article 1

DEFINITIONS

For the purposes of the present Protocol,

1. ‘Convention’ means the Convention on long-range transboundary air pollution, adopted in Geneva on 13 November 1979;

2. ‘EMEP’ means the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe;

3. ‘executive body’ means the executive body for the Convention constituted under Article 10, paragraph 1, of the Convention;

4. ‘Commission’ means the United Nations Economic Commission for Europe;

5. ‘Parties’ means, unless the context otherwise requires, the Parties to the present Protocol;

6. ‘geographical scope of EMEP’ means the area defined in Article 1, paragraph 4, of the Protocol to the 1979 Convention on long-range transboundary air pollution on long-term financing of the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP), adopted in Geneva on 28 September 1984;

7. ‘SOMA’ means a sulphur oxides management area designated in Annex III under the conditions laid down in Article 2, paragraph 3;

8. ‘critical load’ means a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge;

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9. ‘critical levels’ means the concentration of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur, according to present knowledge;

10. ‘critical sulphur deposition’ means a quantitative estimate of the exposure to oxidised sulphur compunds, taking into account the effects of base cation uptake and base cation deposition, below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge;

11. ‘emission’ means the discharge of substances into the atmosphere;

12. ‘sulphur emissions’ means all emissions of sulphur compunds expressed as kilotonnes of sulphur dioxide (kt SO2) to the atmosphere originating from anthropogenic sources excluding from ships in international traffic outside territorial waters;

13. ‘fuel’ means any solid, liquid or gaseous combustible material with the exception of domestic refuse and toxic or dangerous waste;

14. ‘stationary combustion source’ means any technical apparatus or group of technical apparatus that is co-located on a common site and is or could be discharging waste gases through a common stack, in which fuels are oxidised in order to use the heat generated;

15. ‘major new stationary combustion source’ means any stationary combustion source the construction or substantial modification of which is authorised after 31 December 1995 and the thermal input of which, when operating at rated capacity, is at least 50 MW_{th}. It is a matter for the competent national authorities to decide whether a modification is substantial or not, taking into account such factors as the environmental benefits of the modification;

16. ‘major existing stationary combustion source’ means any existing stationary combustion source the thermal input of which, when operating at rated capacity, is at least 50 MW_{th};

17. ‘gas oil’ means any petroleum product within HS 2710, or any petroleum product which, by reason of its distillation limits, falls within the category of middle distillates intended for use as fuel and of which at least 85 % by volume, including distillation losses, distils at 350 ^{o}C;

18. ‘emission limit value’ means the permissible concentration of sulphur compounds expressed as sulphur dioxide in the waste gases from a stationary combustion source expressed in terms of mass per volume of the waste gases expressed in mg SO_2/Nm^3, assuming an oxygen content by volume in the waste gas of 3 % in the case of liquid and gaseous fuels and 6 % in the case of solid fuels;

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19. ‘emission limitation’ means the permissible total quantity of sulphur compounds expressed as sulphur dioxide discharged from a combustion source or group of combustion sources located either on a common site or within a defined geographical area, expressed in kilotonnes per year;

20. ‘desulphurisation rate’ means the ratio of the quantity of sulphur which is separated at the combustion source site over a given period to the quantity of sulphur contained in the fuel which is introduced into the combustion source facilities and which is used over the same period;

21. ‘sulphur budget’ means a matrix of calculated contributions to the deposition of oxidised sulphur compounds in receiving areas, originating from the emissions from specified areas.

Article 2

Basic obligations

1. The Parties shall control and reduce their sulphur emissions in order to protect human health and the environment from adverse effects, in particular acidifying effects, and to ensure, as far as possible, without entailing excessive costs, that depositions of oxidised sulphur compounds in the long term do not exceed critical loads for sulphur given, in Annex I, as critical sulphur depositions, in accordance with present scientific knowledge.

2. As a first step, the Parties shall, as a minimum, reduce and maintain their annual sulphur emissions in accordance with the timing and levels specified in Annex II.

3. In addition, any Party:

(a) whose total land area is greater than 2 million square kilometres;

(b) which has committed itself under paragraph 2 above to a national sulphur emission ceiling no greater than the lesser of its 1990 emissions or its obligation in the 1985 Helsinki Protocol on the reduction of sulphur emissions or their transboundary fluxes by at least 30 %, as indicated in Annex II;

(c) whose annual sulphur emissions that contribute to acidification in areas under the jurisdiction of one or more other Parties originate only from within areas under its jurisdiction that are listed as SOMAs in Annex III, and has presented documentation to this effect; and

(d) which has specified upon signature of, or accession to, the present Protocol its intention to act in accordance with this paragraph,

shall, as a minimum, reduce and maintain its annual sulphur emissions in the area so listed in accordance with the timing and levels specified in Annex II.

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4. Furthermore, the Parties shall make use of the most effective measures for the reduction of sulphur emissions, appropriate in their particular circumstances, for new and existing sources, which include, *inter alia:*

— measures to increase energy efficiency,

— measures to increase the use of renewable energy,

— measures to reduce the sulphur content of particular fuels and to encourage the use of fuel with a low sulphur content, including the combined use of high-sulphur with low-sulphur or sulphur-free fuel,

— measures to apply best available control technologies not entailing excessive cost,

using the guidance in Annex IV.

5. Each Party, except those Parties subject to the United States/Canada Air Quality Agreement of 1991, shall as a minimum:

(a) apply emission limit values at least as stringent as those specified in Annex V to all major new stationary combustion sources;

(b) no later than 1 July 2004 apply, as far as possible without entailing excessive costs, emission limit values at least as stringent as those specified in Annex V to those major existing stationary combustion sources the thermal input of which is above 500 MW_{th} taking into account the remaining lifetime of a plant, calculated from the date of entry into force of the present Protocol, or apply equivalent emission limitations or other appropriate provisions, provided that these achieve the sulphur emission ceilings specified in Annex II and, subsequently, further approach the critical loads as given in Annex I; and no later than 1 July 2004 apply emission limit values or emission limitations to those major existing stationary combustion sources the thermal input of which is between 50 and 500 MW_{th} using Annex V as guidance;

(c) no later than two years after the date of entry into force of the present Protocol apply national standards for the sulphur content of gas oil at least as stringent as those specified in Annex V. In cases where the supply of gas oil canot otherwise be ensured, a State may extend the time period given in this subparagraph to a period of up to 10 years. In this case it shall specify, in a declaration to be deposited together with the instrument of ratification, acceptance, approval or accession, its intention to extend the time period.

6. The Parties may, in addition, apply economic instruments to encourage the adoption of cost-effective approaches to the reduction of sulphur emissions.

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7. The Parties to this Protocol may, at a session of the executive body, in accordance with rules and conditions which the executive body shall elaborate and adopt, decide whether two or more Parties may jointly implement the obligations set out in Annex II. These rules and conditions shall ensure the fulfilment of the obligations set out in paragraph 2 above and also promote the achievement of the environmental objectives set out in paragraph 1 above.

8. The Parties shall, subject to the outcome of the first review provided for under Article 8 and no later than one year after the completion of that review, commence negotiations on further obligations to reduce emissions.

Article 3

Exchange of technology

1. The Parties shall, consistent with their national laws, regulations and practices, facilitate the exchange of technologies and techniques, including those that increase energy efficiency, the use of renewable energy and the processing of low-sulphur fuels, to reduce sulphur emissions, particularly through the promotion of:

(a) the commercial exchange of available technology;

(b) direct industrial contacts and cooperation, including joint ventures;

(c) the exchange of information and experience;

(d) the provision of technical assistance.

2. In promoting the activities specified in paragraph 1 above, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organisations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

3. The Parties shall, no later than six months after the date of entry into force of the present Protocol, commence consideration of procedures to create more favourable conditions for the exchange of technology to reduce sulphur emissions.

Article 4

National strategies, policies, programmes, measures and information

1. Each Party shall, in order to implement its obligations under Article 2:

(a) adopt national strategies, policies and programmes, no later than six months after the present Protocol enters into force for it, and

(b) take and apply national measures,

to control and reduce its sulphur emissions.

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2. Each Party shall collect and maintain information on:

(a) actual levels of sulphur emissions, and of ambient concentrations and depositions of oxidised sulphur and other acidifying compounds, taking into account, for those Parties within the geographical scope of EMEP, the work plan of EMEP; and

(b) the effects of depositions of oxidised sulphur and other acidifying compounds.

Article 5

Reporting

1. Each Party shall report, through the executive secretary of the Commission, to the executive body, on a periodic basis as determined by the executive body, information on:

(a) the implementation of national strategies, policies, programmes and measures referred to in Article 4, paragraph 1;

(b) the levels of national annual sulphur emissions, in accordance with guidelines adopted by the executive body, containing emission data for all relevant source categories; and

(c) the implementation of other obligations that it has entered into under the present Protocol,

in conformity with a decision regarding format and content to be adopted by the Parties at a session of the executive body. The terms of this decision shall be reviewed as necessary to identify any additional elements regarding the format and/or content of the information that are to be included in the reports.

2. Each Party within the geographical scope of EMEP shall report, through the executive secretary of the Commission, to EMEP, on a periodic basis to be determined by the steering body of EMEP and approved by the Parties at a session of the executive body, information on the levels of sulphur emissions with temporal and spatial resolution as specified by the steering body of EMEP.

3. In good time before each annual session of the executive body, EMEP shall provide information on:

(a) ambient concentrations and deposition of oxidised sulphur compounds; and

(b) calculations of sulphur budgets.

Parties in areas outside the geographical scope of EMEP shall make available similar information if requested to do so by the executive body.

4. The executive body shall, in accordance with Article 10, paragraph 2(b), of the Convention, arrange for the preparation of information on the effects of depositions of oxidised sulphur and other acidifying compounds.

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5. The Parties shall, at sessions of the executive body, arrange for the preparation, at regular intervals, of revised information on calculated and internationally optimised allocations of emission reductions for the States within the geographical scope of EMEP, with integrated assessment models, with a view to reducing further, for the purposes of Article 2, paragraph 1, of the present Protocol, the difference between actual depositions of oxidised sulphur compunds and critical load values.

Article 6

Research, development and monitoring

The Parties shall encourage research, development, monitoring and co-operation related to:

(a) the international harmonisation of methods for the establishment of critical loads and critical levels and the elaboration of procedures for such harmonisation;

(b) the improvement of monitoring techniques and systems and of the modelling of transport, concentrations and deposition of sulphur compounds;

(c) strategies for the further reduction of sulphur emissions based on critical loads and critical levels as well as on technical developments, and the improvement of integrated assessment modelling to calculate internationally optimised allocations of emission reductions taking into account an equitable distribution of abatement costs;

(d) the understanding of the wider effects of sulphur emissions on human health, the environment, in particular acidification, and materials, including historic and cultural monuments, taking into account the relationship between sulphur oxides, nitrogen oxides, ammonia, volatile organic compounds and tropospheric ozone;

(e) emission abatement technologies, and technologies and techniques to enhance energy efficiency, energy conservation and the use of renewable energy;

(f) the economic evaluation of benefits for the environment and human health resulting from the reduction of sulphur emissions.

Article 7

Compliance

1. An implementation committee is hereby established to review the implementation of the present Protocol and compliance by the Parties with their obligations. It shall report to the Parties at sessions of the executive body and may make such recommendations to them as it considers appropriate.

2. Upon consideration of a report, and any recommendations, of the implementation committee, the Parties, taking into account the circumstances of a matter and in accordance with Convention practice, may decide upon and call for action to bring about full compliance with the present Protocol, including measures to assist a Party's compliance with the Protocol, and to further the objectives of the Protocol.

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3. The Parties shall, at the first session of the executive body after the entry into force of the present Protocol, adopt a decision that sets out the structure and functions of the implementation committee as well as procedures for its review of compliance.

4. The application of the compliance procedure shall be without prejudice to the provisions of Article 9 of the present Protocol.

Article 8

Reviews by the Parties at sessions of the executive body

1. The Parties shall, at sessions of the executive body, pursuant to Article 10, paragraph 2(a), of the Convention, review the information supplied by the Parties and EMEP, the data on the effects of depositions of sulphur and other acidifying compounds and the reports of the implementation committee referred to in Article 7, paragraph 1, of the present Protocol.

2. (a) The Parties shall, at sessions of the executive body, keep under review the obligations set out in the present Protocol, including:

   (i) their obligations in relation to their calculated and internationally optimised allocations of emission reductions referred to in Article 5, paragraph 5; and

   (ii) the adequacy of the obligations and the progress made towards the achievement of the objectives of the present Protocol.

   (b) Reviews shall take into account the best available scientific information on acidification, including assessments of critical loads, technological developments, changing economic conditions and the fulfilment of the obligations on emission levels.

   (c) In the context of such reviews, any Party whose obligations on sulphur emission ceilings under Annex II hereto do not conform to the calculated and internationally optimised allocations of emission reductions for that Party, required to reduce the difference between depositions of sulphur in 1990 and critical sulphur depositions within the geographical scope of EMEP by at least 60 %, shall make every effort to undertake revised obligations.

   (d) The procedures, methods and timing for such reviews shall be specified by the Parties at a session of the executive body. The first such review shall be completed in 1997.

Article 9

Settlement of disputes

1. In the event of a dispute between any two or more Parties concerning the intepretation or application of the present Protocol, the Parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice. The parties to the dispute shall inform the executive body of their dispute.

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2. When ratifying, accepting, approving or acceding to the present Protocol, or at any time thereafter, a Party which is not a regional economic integration organisation may declare in a written instrument submitted to the depositary that, in respect of any dispute concerning the interpretation or application of the Protocol, it recognises one or both of the following means of dispute settlement as compulsory *ipso facto* and without agreement, in relation to any Party accepting the same obligation:

(a) submission of the dispute to the International Court of Justice;

(b) arbitration in accordance with procedures to be adopted by the Parties at a session of the executive body as soon as practicable, in an annex on arbitration.

A Party which is a regional economic integration organisation may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b) above.

3. A declaration made under paragraph 2 above shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the depositary.

4. A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute agree otherwise.

5. Except in a case where the parties to a dispute have accepted the same means of dispute settlement under paragraph 2, if after 12 months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

6. For the purpose of paragraph 5, a conciliation commission shall be created. The commission shall be composed of an equal number of members appointed by each party concerned or, where parties in conciliation share the same interest, by the group sharing that interest, and a chairman chosen jointly by the members so appointed. The commission shall render a recommendatory award, which the parties shall consider in good faith.

Article 10

Annexes

The Annexes to the present Protocol shall form an integral part of the Protocol. Annexes I and IV are recommendatory in character.

Article 11

Amendments and adjustments

1. Any Party may propose amendments to the present Protocol. Any Party to the Convention may propose an adjustment to Annex II to the present Protocol to add to it its name, together with emission levels, sulphur emission ceilings and percentage emission reductions.

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2. Such proposed amendments and adjustments shall be submitted in writing to the executive secretary of the Commission, who shall communicate them to all Parties. The Parties shall discuss the proposed amendments and adjustments at the next session of the executive body, provided that those proposals have been circulated by the executive secretary to the Parties at least 90 days in advance.

3. Amendments to the present Protocol and to its Annexes II, III and V shall be adopted by consensus of the Parties present at a session of the executive body, and shall enter into force for the Parties which have accepted them on the 90th day after the date on which two thirds of the Parties have deposited with the depositary their instruments of acceptance thereof. Amendments shall enter into force for any other Party on the 90th day after the date on which that Party has deposited its instrument of acceptance thereof.

4. Amendments to the Annexes to the present Protocol, other than to the Annexes referred to in paragraph 3 above, shall be adopted by consensus of the Parties present at a session of the executive body. On the expiry of 90 days from the date of its communication by the executive secretary of the Commission, an amendment to any such Annex shall become effective for those Parties which have not submitted to the depositary a notification in accordance with the provisions of paragraph 5 below, provided that at least 16 Parties have not submitted such a notification.

5. Any Party that is unable to approve an amendment to an annex, other than to an annex referred to in paragraph 3 above, shall so notify the depositary in writing within 90 days from the date of the communication of its adoption. The depositary shall without delay notify all Parties of any such notification received. A Party may at any time substitute an acceptance for its previous notification and received. A Party may at any time substitute an acceptance for its previous notification and, upon deposit of an instrument of acceptance with the depositary, the amendment to such an annex shall become effective for that Party.

6. Adjustments to Annex II shall be adopted by consensus of the Parties present at a session of the executive body and shall become effective for all Parties to the present Protocol on the 90th day following the date on which the executive secretary of the Commission notifies those Parties in writing of the adoption of the adjustment.

Article 12

Signature

1. The present Protocol shall be open for signature at Oslo from 13 June 1994 until 14 June 1994 inclusive, then at United Nations headquarters in New York until 12 December 1994 by States members of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council Resolution 36(IV) of 28 March 1947, and by regional economic integration organisations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organisations concerned are Parties to the Convention and are listed in Annex II.

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2. In matters within their competence, such regional economic integration organisations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their member States. In such cases, the member States of these organisations shall not be entitled to exercise such rights individually.

Article 13

Ratification, acceptance, approval and accession

1. The present Protocol shall be subject to ratification, acceptance or approval by signatories.

2. The present Protocol shall be open for accession as from 12 December 1994 by the States and organisations that meet the requirements of Article 12, paragraph 1.

Article 14

Depositary

The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of depositary.

Article 15

Entry into Force

1. The present Protocol shall enter into force on the 90th day following the date on which the 16th instrument of ratification, acceptance, approval or accession has been deposited with the depositary.

2. For each State and organisation referred to in Article 12, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the 16th instrument of ratification acceptance, approval or accession, the Protocol shall enter into force on the 90th day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 16

Withdrawal

At any time after five years from the date on which the present Protocol has come into force with respect to a Party, that Party may withdraw from it by giving written notification to the depositary. Any such withdrawal shall take effect on the 90th day following the date of its receipt by the depositary, or on such later date as may be specified in the notification of the withdrawal.

Article 17

Authentic texts

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

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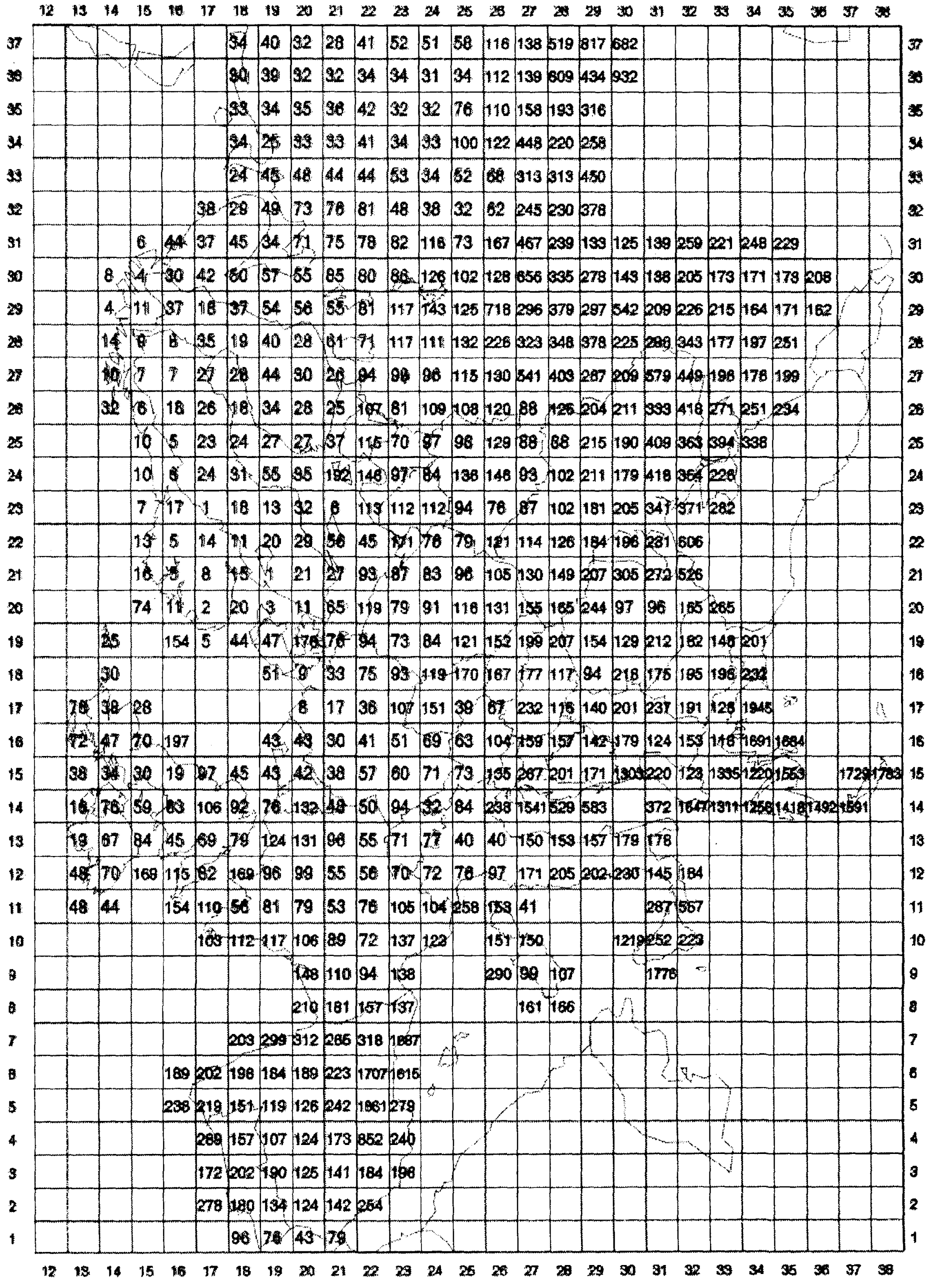
ANNEX I

CRITICAL SULPHUR DEPOSITION

(5-percentile in centigrams of sulphur per square metre per year)



	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
37							34	40	32	28	41	52	51	58	116	138	519	817	682								
36							30	39	32	32	34	34	31	34	112	139	609	434	932								
35							33	34	35	36	42	32	32	76	110	158	193	316									
34							34	25	33	33	41	34	33	100	122	448	220	258									
33							24	45	48	44	44	53	34	52	68	313	313	450									
32						38	29	49	73	76	81	48	38	32	62	245	230	378									
31				6	44	37	45	34	71	75	78	82	116	73	167	467	239	133	125	139	259	221	248	229			
30			8	4	30	42	60	57	55	85	80	86	126	102	128	656	335	278	143	138	205	173	171	173	208		
29			4	11	37	18	37	54	56	55	81	117	143	125	718	296	379	297	542	209	226	215	164	171	162		
28			14	9	8	35	19	40	28	61	71	117	111	132	226	323	348	378	225	286	343	177	197	251			
27			10	7	7	27	28	44	30	26	94	99	96	115	130	541	403	267	209	579	449	196	176	199			
26			32	6	18	26	18	34	28	25	107	81	109	108	120	88	126	204	211	333	418	271	251	234			
25				10	5	23	24	27	27	37	115	70	97	98	129	88	68	215	190	409	363	394	338				
24				10	6	24	31	55	95	192	146	97	84	138	146	93	102	211	179	418	364	226					
23				7	17	1	18	13	32	6	113	112	112	94	76	87	102	181	205	341	371	282					
22				13	5	14	11	20	29	56	45	171	76	79	121	114	126	184	196	281	606						
21				16	5	8	15	1	21	27	93	87	83	96	105	130	149	207	305	272	526						
20				74	11	2	20	3	11	65	119	79	91	116	131	155	165	244	97	96	165	265					
19			25		154	5	44	47	176	76	94	73	84	121	152	199	207	154	129	212	182	148	201				
18			30					51	9	33	75	93	119	170	167	177	117	94	218	175	195	196	232				
17		78	38	28					8	17	36	107	151	39	67	232	116	140	201	237	191	126	1945				
16		72	47	70	197			43	43	30	41	51	69	63	104	159	157	142	179	124	153	116	1691	1684			
15		38	34	30	19	97	45	43	42	38	57	60	71	73	135	267	201	171	1303	220	123	1335	1220	1553		1729	1783
14		16	76	59	63	106	92	76	132	48	50	94	32	84	238	1541	529	583		372	1647	1311	1258	1418	1492	1591	
13		19	67	84	45	69	79	124	131	96	55	71	77	40	40	150	153	157	179	178							
12		48	70	169	115	62	169	96	99	55	58	70	72	78	97	171	205	202	230	145	184						
11		48	44		154	110	56	81	79	53	78	105	104	258	153	41				287	567						
10						103	112	117	106	89	72	137	122		151	150			1219	252	223						
9									148	110	94	138			290	99	107			1776							
8									210	181	157	137				161	166										
7							203	299	312	285	318	1687															
6					189	202	198	184	189	223	1707	1615															
5					238	219	151	119	126	242	1861	279															
4						269	157	107	124	173	852	240															
3						172	202	190	125	141	184	198															
2						278	180	134	124	142	254																
1							96	76	43	79																	

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ANNEX II

SULPHUR EMISSION CEILINGS AND PERCENTAGE EMISSION REDUCTIONS

The sulphur emission ceilings listed in the table below give the obligations referred to in paragrphs 2 and 3 Article 2 of the present Protocol. The 1980 and 1990 emission levels and the percentage emission reductions listed are given for information purposes only.

	Emission levels kt SO_2 per year		Sulphur emission ceilings ([a]) kt SO_2 per year			Percentage emission reductions (base year 1980) ([b])		
	1980	1990	2000	2005	2010	2000	2005	2010
Austria	397	90	78			80		
Belarus	740		456	400	370	38	46	50
Belgium	828	443	248	232	215	70	72	74
Bulgaria	2 050	2 020	1 374	1 230	1 127	33	40	45
Canada — national	4 614	3 700	3 200			30		
— SOMA	3 245		1 750			46		
Croatia	150	160	133	125	117	11	17	22
Czech Republic	2 257	1 876	1 128	902	632	50	60	72
Denmark	451	180	90			80		
Finland	584	260	116			80		
France	3 348	1 202	868	770	737	74	77	78
Germany	7 494	5 803	1 300	990		83	87	
Greece	400	510	595	580	570	0	3	4
Hungary	1 632	1 010	898	816	653	45	50	60
Ireland	222	168	155			30		
Italy	3 800		1 330	1 042		65	73	
Liechtenstein	0,4	0,1	0,1			75		
Luxembourg	24		10			58		
Netherlands	466	207	106			77		
Norway	142	54	34			76		
Poland	4 100	3 210	2 583	2 173	1 397	37	47	66
Portugal	266	284	304	294		0	3	
Russian Federation ([c])	7 161	4 460	4 440	4 297	4 297	38	40	40
Slovakia	843	539	337	295	240	60	65	72
Slovenia	235	195	130	94	71	45	60	70
Spain	3 319	2 316	2 143			35		
Sweden	507	130	100			80		
Switzerland	126	62	60			52		
Ukraine	3 850		2 310	2 118	1 696	40	45	56
United Kingdom	4 898	3 780	2 449	1 470	980	50	70	80
European Community	25 513		9 598			62		

Notes

([a]) If, in a given year before 2005, a Party finds that, due to a particularly cold winter, a particularly dry summer and an unforeseen short-term loss of capacity in the power supply system, domestically or in a neighbouring country, it cannot comply with its obligations under this Annex, it may fulfil those obligations by averaging its national annual sulphur emissions for the year in question, the year preceding that year and the year following it, provided that the emission level in any single year is not more than 20 % above the sulphur emission ceiling.

The reason for exceedance in any given year and the method by which the three-year average figure will be achieved, shall be reported to the Implementation Committee.

([b]) For Greece and Portugal percentage emission reductions given are based on the sulphur emission ceilings indicated for the year 2000.

([c]) European part within the EMEP area.

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ANNEX III

DESIGNATION OF SULPHUR OXIDES MANAGEMENT AREAS (SOMAs)

The following SOMA is listed for the purposes of the present Protocol:

South-east Canada SOMA

This is an area of 1 million km^2 which includes all the territory of the provinces of Prince Edward Island, Nova Scotia and New Brunswick, all the territory of the province of Quebec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Quebec-Ontario boundary intersects the James Bay coastline, and all the territory of the province of Ontario south of a straight line between the point where the Ontario-Quebec boundary intersects the James Bay coastline and Nipigon River near the north shore of Lake Superior.

▼**M3**

ANNEX IV

CONTROL TECHNOLOGIES FOR SULPHUR EMISSIONS FROM STATIONARY SOURCES

I. INTRODUCTION

1. The aim of this Annex is to provide guidance for identifying sulphur control options and technologies for giving effect to the obligations of the present Protocol.

2. The Annex is based on information on general options for the reduction of sulphur emissions and in particular on emission control technology performance and costs contained in official documentation of the executive body and its subsidiary bodies.

3. Unless otherwise indicated, the reduction measures listed are considered, on the basis of operational experience of several years in most cases, to be the most well-established and economically feasible best available technologies. However, the continuously expanding experience of low-emission measures and technologies at new plants as well as of the retrofitting of existing plants will necessitate regular review of this Annex.

4. Although the Annex lists a number of measures and technologies spanning a wide range of costs and efficiencies, it cannot be considered as an exhaustive statement of control options. Moreover, the choice of control measures and technologies for any particular case will depend on a number of factors, including current legislation and regulatory provisions and, in particular, control technology requirements, primary energy patterns, industrial infrastructure, economic circumstances and specific in-plant conditions.

5. The Annex mainly addresses the control of oxidised sulphur emissions considered as the sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3), expressed as SO_2. The share of sulphur emitted as either sulphur oxides or other sulphur compounds from non-combustion processes and other sources is small compared to sulphur emissions from combustion.

6. When measures or technologies are planned for sulphur sources emitting other components, in particular nitrogen oxides (N_x), particulates, heavy metals and volatile organic compounds (VOCs), it is worthwhile to consider them in conjunction with pollutant-specific control options in order to maximise the overall abatement effect and minimise the impact on the environment and, especially, to avoid the transfer of air pollution problems to other media (such as waste water and solid waste).

II. MAJOR STATIONARY SOURCES FOR SULPHUR EMISSIONS

7. Fossil fuel combustion processes are the main source of anthropogenic sulphur emissions from stationary sources. In addition, some non-combustion processes may contribute considerably to the emissions: The major stationary source categories, based on EMEP/CORINAIR'90, include:

   (i) public power, cogeneration and district heating plants:

      (a) boilers;

      (b) stationary combustion turbines and internal combustion engines;

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(ii) commercial, institutional and residential combustion plants:

  (a) commercial boilers;

  (b) domestic heaters;

(iii) industrial combustion plants and processes with combustion:

  (a) boilers and process heaters;

  (b) processes, e.g. metallurgical operations such as roasting and sintering, coke oven plants, processing of titanium dioxide (TiC_2), etc.;

  (c) pulp production;

(iv) non-combustion processes, e.g. sulphuric acid production, specific organic synthesis processes, treatment of metallic surfaces;

(v) extraction, processing and distribution of fossil fuels;

(vi) waste treatment and disposal, e.g. thermal treatment of municipal and industrial waste.

8. Overall data (1990) for the ECE region indicate that about 88 % of total sulphur emissions originate from all combustion processes (20 % from industrial combustion), 5 % from production processes and 7 % from oil refineries. The power plant sector in many countries is the major single contributor to sulphur emissions. In some countries, the industrial sector (including refineries) is also an important SO_2 emitter. Although emissions from refineries in the ECE region are relatively small, their impact on sulphur emissions from other sources is large due to the sulphur in the oil products. Typically 60 % of the sulphur intake present in the crudes remains in the products, 30 % is recovered as elemental sulphur and 10 % is emitted from refinery stacks.

III. GENERAL OPTIONS FOR REDUCTION OF SULPHUR EMISSIONS FROM COMBUSTION

9. General options for reduction of sulphur emissions are:

(i) **Energy management measures** ([1])

(a) *Energy saving*

The rational use of energy (improved energy efficiency/process operation, cogeneration and/or demand-side management) usually results in a reduction in sulphur emissions.

(b) *Energy mix*

In general, sulphur emissions can be reduced by increasing the proportion of non-combustion energy sources (i.e. hydro, nuclear, wind, etc.) to the energy mix. However, further environmental impacts have to be considered.

(ii) **Technological options**

(a) *Fuel switching*

The SO_2 emissions during combustion are directly related to the sulphur content of the fuel used.

([1]) Options (i), (a) and (b) are integrated in the energy structure and policy of a Party. Implementation status, efficiency and costs per sector are not considered here.

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Fuel switching (e.g. from high- to low-sulphur coals and/or liquid fuels, or from coal to gas) leads to lower sulphur emissions, but there may be certain restrictions, such as the availability of low-sulphur fuels and the adaptability of existing combustion systems to different fuels. In many ECE countries, some coal or oil combustion plants are being replaced by gas-fired combustion plants. Dual-fuel plants may facilitate fuel switching.

(b) *Fuel cleaning*

Cleaning of natural gas is state-of-the-art technology and widely applied for operational reasons.

Cleaning of process gas (acid refinery gas, coke oven gas, biogas, etc.) is also state-of-the-art technology.

Desulphurisation of liquid fuels (light and middle fractions) is state-of-the-art technology.

Desulphurisaton of heavy fractions is technically feasible; nevertheless, the crude properties should be kept in mind. Desulphurisation of atmospheric residue (bottom products from atmospheric crude distillation units) for the production of low-sulphur fuel oil is not, however, commonly practised; processing low-sulphur crude is usually preferable. Hydro-cracking and full conversion technology have matured and combine high sulphur retention with improved yield of light products. The number of full conversion refineries is as yet limited. Such refineries typically recover 80 to 90 % of the sulphur intake and convert all residues into light products or other marketable products. For this type of refinery, energy consumption and investment costs are increased. Typical sulphur content for refinery products is given in Table 1 below.

Table 1

Sulphur content from refinery products

[Sulphur content (%)]

	Typical present values	Anticipated future values
Gasoline	0,1	0,05
Jet kerosene	0,1	0,01
Diesel	0,05-0,3	< 0,05
Heating oil	0,1-0,2	< 0,1
Fuel oil	0,2-3,5	< 1
Marine diesel	0,5-1,0	< 0,5
Bunker oil	3,0-5,0	< 1 (coastal areas) < 2 (high seas)

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Current technologies to clean hard coal can remove approximately 50 % of the inorganic sulphur (depending on coal properties) but none of the organic sulphur. More effective technologies are being developed which, however, involve higher specific investment and costs. Thus the efficiency of sulphur removal by coal cleaning is limited compared to flue gas desulphurisation. There may be a country-specific optimisation potential for the best combination of fuel cleaning and flue gas cleaning.

(c) *Avanced combustion technologies*

These combustion technologies with improved thermal efficiency and reduced sulphur emissions include: fluidised-bed combustion (FBC): bubbling (BFBC), circulating (CFBC) and pressurised (PFBC); integrated gasification combined-cycle (IGCC); and combined-cycle gas turbines (CCGT).

Stationary combustion turbines can be integrated into combustion systems in existing conventional power plants which can increase overall efficiency by 5 to 7 %, leading, for example, to a significant reduction SO_2 emissions. However, major alterations to the existing furnace system become necessary.

Fluidised-bed combustion is a combustion technology for burning hard coal and brown coal, but it can also burn other solid fuels such as petroleum coke and low-grade fuels such as waste, peat and wood. Emissions can additionally be reduced by integrated combustion control in the system due to the addition of lime/limestone to the bed material. The total installed capacity of FBC has reached approximately 30 000 MW_{th} (250 to 350 plants), including 8 000 MW_{th}, in the capacity range of greater than 50 MW_{th}. By-products from this process may cause problems with respect to use and/or disposal, and further development is required.

The IGCC process includes coal gasification and combined-cycle power generation in a gas and steam turbine. The gasified coal is burnt in the combustion chamber of the gas turbine. Sulphur emission control is achieved by the use of state-of-the-art technology for raw gas cleaning facilities upstream of the gas turbine. The technology also exists for heavy oil residues and bitumen emulsions. The installed capacity is presently about 1 000 MW_{el} (5 plants).

Combined-cycle gas-turbine power stations using natural gas as fuel with an energy efficiency of approximately 48 to 52 % are currently being planned.

(d) *Process and combustion modifications*

Combustion modifications comparable to the measures used for NO_x emission control do not exist, as during combustion the organically and/or inorganically bound sulphur is almost completely oxidised (a certain percentage depending on the fuel properties and combustion technology is retained in the ash).

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In this Annex dry additive processes for conventional boilers are considered as process modifications due to the injection of an agent into the combustion unit. However, experience has shown that, when applying these processes, thermal capacity is lowered, the Ca/S ratio is high and sulphur removal low. Problems with the further utilisation of the by-product have to be considered, so that this solution should usually be applied as an intermediate measure and for smaller units (Table 2).

Table 2

Emissions of sulphur oxides obtained from the application of technological options to fossil-fuelled boilers

	Uncontrolled emissions		Additive injection		Wet scrubbing (a)		Spray dry absorption (b)	
Reduction efficiency (%)			up to 60		95		up to 90	
Energy efficiency (kW$_{el}$/10^3 m^3/h)			0,1-1		6-10		3-6	
Total installed capacity (ECE Eur) (MW$_{th}$)					194 000		16 000	
Type of by-product			Mix of Ca salts and fly ashes		Gypsum (sludge/waste water)		Mix of CaSO$_3$ x ½ H$_2$O and fly ashes	
Specific investment (cost ECU (1990)/kW$_{el}$)			20-50		60-250		50-220	
	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$
Hard coal (d)	1 000-10 000	3,5-35	400-4 000	1,4-14	< 400 (< 200, 1 % S)	< 1,4 < 0,7	< 400 (< 200, 1 % S)	< 1,4 < 0,7
Brown coal (d)	1 000-20 000	4,2-84	400-8 000	1,7-33,6	< 400 (< 200, 1 % S)	< 1,7 < 0,8	< 400 (< 200, 1 % S)	< 1,7 < 0,8
Heavy oil (d)	1 000-10 000	2,8-28	400-4 000	1,1-11	< 400 (< 200, 1 % S)	< 1,1 < 0,6	< 400 (< 200, 1 % S)	< 1,1 < 0,6
	Ammonia scrubbing (b)		Wellman Lord (a)		Activated carbon (a)		Combined catalytic (a)	
Reduction efficiency (%)	up to 90		95		95		95	
Energy efficiency (kW$_{el}$/10^3 m^3/h)	3-10		10-15		4-8		2	
Total installed capacity (ECE Eur) (MW$_{th}$)	200		2 000		700		1 300	
Type of by-product	Ammonia fertiliser		Elemental S Sulphuric acid (99 vol. %)		Elemental S Sulphuric acid (99 vol. %)		Sulphuric acid (70 wt. %)	
Specific investment (cost ECU (1990)/kW$_{el}$)	230-270 (e)		200-300 (e)		280-320 (e) (f)		320-350 (e) (f)	

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	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$	mg/m^3 (c)	g/kWh$_{el}$
Hard coal (d)	< 400 (< 200, 1 % S)	< 1,4 < 0,7	< 400 (< 200, 1 % S)	< 1,4 < 0,7	< 400 (< 200, 1 % S)	< 1,4 < 0,7	< 400 (< 200, 1 % S)	<1,4 < 0,7
Brown coal (d)	< 400 (< 200, 1 % S)	< 1,7 < 0,8	< 400 (< 200, 1 % S)	< 1,7 < 0,8	< 400 (< 200, 1 % S)	< 1,7 < 0,8	< 400 (< 200, 1 % S)	< 1,7 < 0,8
Heavy oil (d)	< 400 (< 200, 1 % S)	< 1,1 < 0,6	< 400 (< 200, 1 % S)	< 1,1 < 0,6	< 400 (< 200, 1 % S)	< 1,1 < 0,6	< 400 (< 200, 1 % S)	< 1,1 < 0,6

(a) For high sulphur content in the fuel the removal efficiency has to be adapted. However, the scope for doing so may be process-specific. Availability of these processes is usually 95 %.

(b) Liquid applicability for high-sulphur fuels.

(c) Emission in mg/m^3 (STP), dry, 6 % oxygen for solid fuels, 3 % oxygen for liquid fuels.

(d) Conversion factor depends on fuel properties, specific fuel gas volume and thermal efficiency of boiler (conversion factors (m^3/kWh$_{el}$, thermal efficiency: 36 %) used: hard coal: 3,50; brown coal: 4,20; heavy oil: 2,80).

(e) Specific investment cost relates to a small sample of installations.

(f) Specific investment cost includes denitrification process.

The table was established mainly for large combustion installations in the public sector. However, the control options are also valid for other sectors with similar exhaust gases.

(e) *Flue gas desulphurisation (FGD) processes*

These processes aim at removing already formed sulphur oxides, and are also referred to as secondary measures. The state-of-the-art technologies for flue gas treatment processes are all based on the removal of sulphur by wet, dry or semi-dry and catalytic chemical processes.

To achieve the most efficient programme for sulphur emission reductions beyond the energy management measures listed in (i) above a combination of technological options identified in (ii) above should be considered.

In some cases options for reducing sulphur emissions may also result in the reduction of emissions of CO$_2$, NO$_x$ and other pollutants.

In public power, cogeneration and district heating plants, flue gas treatment processes used include: lime/limestone wet scrubbing (LWS); spray dry absorption (SDA); Wellman Lord process (WL); ammonia scrubbing (AS); and combined NO$_x$/SO$_x$ removal processes (activated carbon process (AC) and combined catalytic NO$_x$/SO$_x$ removal).

In the power generation sector, LWS and SDA cover 85 % and 10 %, respectively, of the installed FGD capacity.

Several new flue gas desulphurisation processes, such as electron beam dry scrubbing (EBDS) and Mark 13A, have not yet passed the pilot stage.

Table 2 above shows the efficiency of the abovementioned secondary measures based on the practical experience gathered from a large number of implemented plants. The implemented capacity as well as the capacity range are also mentioned. Despite comparable characteristics for several sulphur abatement technologies, local or plant-specific influences may lead to the exclusion of a given technology.

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Table 2 also includes the usual investment cost ranges for the sulphur abatement technologies listed in sections (ii)(c), (d) and (e). However, when applying these technologies to individual cases it should be noted that investment costs of emission reduction measures will depend amongst other things on the particular technologies used, the required control systems, the plant size, the extent of the required reduction and the timescale of planned maintenance cycles. The table thus gives only a board range of investment costs. Investment costs for retrofit generally exceed those for new plants.

IV. CONTROL TECHNIQUES FOR OTHER SECTORS

10. The control techniques listed in section 9(ii)(a) to (e) are valid not only in the power plant sector but also in various other sectors of industry. Several years of operational experience have been acquired, in most cases in the power plant sector.

11. The application of sulphur abatement technologies in the industrial sector merely depends on the process' specific limitations in the relevant sectors. Important contributors to sulphur emission and corresponding reduction measures are presented in Table 3 below.

Table 3

Source	Reduction measures
Roasting of non-ferrous sulphides	Wet sulphuric acid catalytic process (WSA)
Viscose production	Double-contact process
Sulphuric acid production	Double-contact process, improved yield
Kraft pulp production	Variety of process integrated measures

12. In the sectors listed in Table 3, process-integrated measures, including raw material changes (if necessary combined with sector-specific flue gas treatment), can be used to achieve the most effective reduction of sulphur emissions.

13. Reported examples are the following:

(a) in new kraft pulp mills, sulphur emission of less than 1 kg of sulphur per tonne of pulp AD (air dried) can be achieved (1);

(b) in sulphite pulp mills, 1 to 1,5 kg of sulphur per tonne of pulp AD can be achieved;

(c) in the case of roasting of sulphides, removal efficiencies of 80 to 99 % for 10 000 to 200 000 m^3/h units have been reported (depending on the process);

(d) for one iron or sintering plant, an FGD unit of 320 000 m^3/h capacity achieves a clean gas value below 100 mg SO_x/Nnv^3 at 6 % O_2;

(e) coke ovens are achieving less than 400 mg SO_x/Nm^3 at 6 % O_2;

(f) sulphuric acid plants achieve a conversion rate larger than 99 %;

(g) advanced Claus plant achieves sulphur recovery of more than 99 %.

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(1) Control of sulphur-to-sodium ratio is required, i.e. removal of sulphur in the form of neutral salts and use of sulphur-free sodium make-up.

▼**M3**

V. BY-PRODUCTS AND SIDE-EFFECTS

14. As efforts to reduce sulphur emissions from stationary sources are increased in the countries of the ECE region, the quantities of by-products will also increase.

15. Options which would lead to usable by-products should be selected. Furthermore, options that lead to increased thermal efficiency and minimise the waste disposal issue whenever possible should be selected. Although most by-products are usable or recyclable products such as gypsum, ammonia salts, sulphuric acid or sulphur, factors such as market conditions and quality standards need to be taken into account. Further utilisation of FBC and SDA by-products have to be improved and investigated, as disposal sites and disposal criteria limit disposal in several countries.

16. The following side-effects will not prevent the implementation of any technology or method but should be considered when several sulphur abatement options are possible:

    (a) energy requirements of the gas treatment processes;

    (b) corrosion attack due to the formation of sulphuric acid by the reaction of sulphur oxides with water vapour;

    (c) increased use of water and waste water treatment;

    (d) reagent requirements;

    (e) solid waste disposal.

VI. MONITORING AND REPORTING

17. The measures taken to carry out national strategies and policies for the abatement of air pollution include: legislation and regulatory provisions, economic incentives and disincentives; as well as technological requirements (best available technology).

18. In general, standards are set, per emission source, according to plant size, operating mode, combustion technology, fuel type and whether it is a new or existing plant. An alternative approach also used is to set a target for the reduction of total sulphur emissions from a group of sources and to allow a choice of where to take action to reach this target (the bubble concept).

19. Efforts to limit the sulphur emissions to the levels set out in the national framework legislation have to be controlled by a permanent monitoring and reporting system and reported to the supervising authorities.

20. Several monitoring systems, using both continuous and is continuous measurement methods, are available. However, quality requirements vary. Measurements are to be carried out by qualified institutes using measuring and monitoring systems. To this end, a certification system can provide the best assurance.

21. In the framework of modern automated monitoring systems and process control equipment, reporting does not create a problem. The collection of data for further use is a state-of-the-art technique; however, data to be reported to competent authorities differ from case to case. To obtain better comparability, data sets and prescribing regulations should be harmonised. Harmonisation is also desirable for quality assurance of measuring and monitoring systems. This should be taken into account when comparing data.

▼**M3**

22. To avoid discrepancies and inconsistencies, key issues and parameters, including the following, must be well defined:

    (a) definition of standards expressed as ppmv, mg/Nm^3, g/GJ, kg/h or kg/tonne of product. Most of these units need to be calculated and need specification in terms of gas temperature, humidity, pressure, oxygen content or heat input value;

    (b) definition of period over which standards are to be averaged, expressed as hours, months or a year;

    (c) definition of failure times and corresponding emergency regulations regarding by pass of monitoring systems or shut-down of the installation;

    (d) definition of methods for back-filling of data missed or lost as a result of equipment failure;

    (e) definition of the parameter set to be measured. Depending on the type of industrial process, the necessary information may differ. This also involves the location of the measurement point within the system.

23. Quality control of measurements has to be ensured.

▼**M3**

ANNEX V

EMISSION AND SULPHUR CONTENT LIMIT VALUES

A. **Emission limit values for major stationary combustion sources** ([a])

	(i) (MW_{th})	(ii) Emission limit value (mg SO_2/Nm^3) ([b])	(iii) Desulphurisation rate (%)
1. SOLID FUELS (based on 6 % oxygen in flue gas)	50-100	2 000	
	100-500	2 000-400 (linear decrease)	40 (for 100-167 MW_{th}) 40-90 (linear increase for 167-500 MW_{th})
	> 500	400	90
2. LIQUID FUELS (based on 3 % oxygen in flue gas)	50-300	1 700	
	300-500	1 700-400 (linear decrease)	90
	> 500	400	90
3. GASEOUS FUELS (based on 3 % oxygen in flue gas)			
Gaseous fuels in general		35	
Liquefied gas		5	
Low calorific gases from gasification of refinery residues, coke oven gas, blast-furnace gas		800	

B. **Gas oil**

	Sulphur content (%)
Diesel for on-road vehicles	0,05
Other types	0,2

Notes

[a] As guidance, for a plant with a multi-fuel firing unit involving the simultaneous use of two or more types of fuels, the competent authorities shall set emission limit values taking into account the emission limit values from column (ii) relevant for each individual fuel, the rate of thermal input delivered by each fuel and, for refineries, the relevant specific characteristics of the plant. For refineries, such a combined limit value shall under no circumstances exceed 1 700 mg $SO_2/Nm)^3$.

In particular, the limit values shall not apply to the following plants:

- plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials, e.g. reheating furnaces, furnaces for heat treatment,
- post-combustion plants, i.e. any technical apparatus designed to purify the waste gases by combustion which is not operated as an independent combustion plant,
- facilities for the regeneration of catalytic cracking catalysts,
- facilities for the conversion of hydrogen sulphide into sulphur,
- reactors used in the chemical industry,
- coke battery furnaces,

▼**M3**

— cowpers,

— waste incinerators,

— plants powered by diesel, petrol and gas engines or by gas turbines, irrespective of the fuel used.

In a case where a Party, due to the high sulphur content of indigenous solid or liquid fuels, cannot meet the emission limit values set forth in column (ii), it may apply the desulphurisation rates set forth in column (iii) or a maximum limit value of 800 mg SO_2/Nm^3 (although preferably not more than 650 mg SO_2/Nm^3). The Party shall report any such application to the implementation committee in the calendar year in which it is made.

Where two or more separate new plants are installed in such a way that, taking technical and economic factors into account, their waste gases could, in the judgement of the competent authorities, be discharged through a common stack, the combination formed by such plants is to be regarded as a single unit.

(b) mg SO_2/Nm^3 is defined at a temperature of 273 °K and a pressure of 101,3 kPa, after correction for the water vapour content.

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PROTOCOL

to the 1979 Convention on long-range transboundary air pollution concerning the control of emissions of nitrogen oxides or their transboundary fluxes

THE PARTIES,

Determined to implement the Convention on long-range transboundary air pollution,

Concerned that present emissions of air pollutants are causing damage, in exposed parts of Europe and North America, to natural resources of vital environmental and economic importance,

Recalling that the executive body for the Convention recognized at its second session the need to reduce effectively the total annual emissions of nitrogen oxides from stationary and mobile sources or their transboundary fluxes by 1995, and the need on the part of other States that had already made progress in reducing these emissions to maintain and review their emission standards for nitrogen oxides,

Taking into consideration existing scientific and technical data on emissions, atmospheric movements and effects on the environment of nitrogen oxides and their secondary products, as well as on control technologies,

Conscious that the adverse environmental effects of emissions of nitrogen oxides vary among countries,

Determined to take effective action to control and reduce national annual emissions of nitrogen oxides or their transboundary fluxes by, in particular, the application of appropriate national emission standards to new mobile and major new stationary sources and the retrofitting of existing major stationary sources,

Recognizing that scientific and technical knowledge of these matters is developing and that it will be necessary to take such developments into account when reviewing the operation of this Protocol and deciding on further action,

Noting that the elaboration of an approach based on critical loads is aimed at the establishment of an effect-oriented scientific basis to be taken into account when reviewing the operation of this Protocol and at deciding on further internationally agreed measures to limit and reduce emissions of nitrogen oxides or their transboundary fluxes,

Recognizing that the expeditious consideration of procedures to create more favourable conditions for exchange of technology will contribute to the effective reduction of emissions of nitrogen oxides in the region of the Commission,

Noting with appreciation the mutual commitment undertaken by several countries to implement immediate and substantial reductions of national annual emissions of nitrogen oxides,

Acknowledging the measures already taken by some countries which have had the effect of reducing emissions of nitrogen oxides,

HAVE AGREED AS FOLLOWS:

▼M2

Article 1

Definitions

For the purpose of the present Protocol:

1. ‘Convention’ means the Convention on long-range transboundary air pollution, adopted in Geneva on 13 November 1979;

2. ‘EMEP’ means the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe;

3. ‘Executive Body’ means the executive body for the Convention constituted pursuant to Article 10 (1) of the Convention;

4. ‘geographical scope of EMEP’ means the area defined in Article 1 (4) of the Protocol to the 1979 Convention on long-range transboundary air pollution, on long-term financing of the cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP), adopted in Geneva on 28 September 1984;

5. ‘Parties’ means, unless the context otherwise requires, the parties to the present Protocol;

6. ‘Commission’ means the United Nations Economic Commission for Europe;

7. ‘critical load’ means a quantitative estimate of the exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge;

8. ‘major existing stationary source’ means any existing stationary source the thermal input of which is at least 100 MW;

9. ‘major new stationary source’ means any new stationary source the thermal input of which is at least 50 MW;

10. ‘major source category’ means any category of sources which emits or may emit air pollutants in the form of nitrogen oxides, including the categories described in the Technical Annex, and which contribute at least 10 % of the total national emissions of nitrogen oxides on an annual basis as measured or calculated in the first calendar year after the date of entry into force of the present Protocol, and every fourth year thereafter;

11. ‘new stationary source’ means any stationary source the construction or substantial modification of which is commenced after the expiration of two years from the date of entry into force of this Protocol;

12. ‘new mobile source’ means a motor vehicle or other mobile source which is manufactured after the expiration of two years from the date of entry into force of the present Protocol.

▼**M2**

Article 2

Basic obligations

1. The Parties shall, as soon as possible and as a first step, take effective measures to control and/or reduce their national annual emissions of nitrogen oxides or their transboundary fluxes so that these, at the latest by 31 December 1994, do not exceed their national annual emissions of nitrogen oxides or transboundary fluxes of such emissions for the calendar year 1987 or any previous year to be specified upon signature of, or accession to, the Protocol, provided that in addition, with respect to any party specifying such a previous year, its national average annual transboundary fluxes or national average annual emissions of nitrogen oxides for the period from 1 January 1987 to 1 January 1996 do not exceed its transboundary fluxes or national emissions for the calendar year 1987.

2. Furthermore, the Parties shall in particular, and no later than two years after the date of entry into force of the present Protocol:

(a) apply national emissions standards to major new stationary sources and/or source categories, and to substantially modified stationary sources in major source categories, based on the best available technologies which are economically feasible, taking into consideration the Technical Annex;

(b) apply national emission standards to new mobile sources in all major source categories based on the best available technologies which are economically feasible, taking into consideration the Technical Annex and the relevant decisions taken within the framework of the Inland Transport Committee of the Commission; and

(c) introduce pollution control measures for major existing stationary sources, taking into consideration the Technical Annex and the characteristics of the plant, its age and its rate of utilization and the need to avoid undue operational disruption.

3. (a) The Parties shall, as a second step, commence negotiations, no later than six months after the date of entry into force of the present Protocol, on further steps to reduce national annual emissions of nitrogen oxides or transboundary fluxes of such emissions, taking into account the best available scientific and technological developments, internationally accepted critical loads and other elements resulting from the work programme undertaken pursuant to Article 6;

(b) To this end, the Parties shall cooperate in order to establish:

(i) critical loads;

(ii) reductions in national annual emissions of nitrogen oxides or transboundary fluxes of such emissions as required to achieve agreed objectives based on critical loads, and

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(iii) measures and a timetable commencing no later than 1 January 1996 for achieving such reductions.

4. Parties may take more stringent measures than those required by the present Article.

Article 3

Exchange of technology

1. The Parties shall, consistent with their national laws, regulations and practices, facilitate the exchange of technology to reduce emissions of nitrogen oxides, particularly through the promotion of:

(a) commercial exchange of available technology;

(b) direct industrial contacts and cooperation, including joint ventures;

(c) exchange of information and experience; and

(d) provision of technical assistance.

2. In promoting the activities specified in subparagraphs (a) to (d) above, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

3. The Parties shall, no later than six months after the date of entry into force of the present Protocol, commence consideration of procedures to create more favourable conditions for the exchange of technology to reduce emissions of nitrogen oxides.

Article 4

Unleaded fuel

The Parties shall, as soon as possible and no later than two years after the date of entry into force of the present Protocol, make unleaded fuel sufficiently available, in particular cases as a minimum along main international transit routes, to facilitate the circulation of vehicles equipped with catalytic converters.

Article 5

Review process

1. The Parties shall regularly review the present Protocol, taking into account the best available scientific substantiation and technological development.

2. The first review shall take place no later than one year after the date of entry into force of the present Protocol.

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Article 6

Work to be undertaken

The Parties shall give high priority to research and monitoring related to the development and application of an approach based on critical loads to determine, on a scientific basis, necessary reductions in emissions of nitrogen oxides. The Parties shall, in particular, through national research programmes, in the work plan of the executive body and through other cooperative programmes within the framework of the Convention, seek to:

(a) identify and quantify effects of emissions of nitrogen oxides on humans, plant and animal life, waters, soils and materials, taking into account the impact on these of nitrogen oxides from sources other than atmospheric deposition;

(b) determine the geographical distribution of sensitive areas;

(c) develop measurements and model calculations including harmonized methodologies for the calculation of emissions, to quantify the long-range transport of nitrogen oxides and related pollutants;

(d) improve estimates of the performance and costs of technologies for control of emissions of nitrogen oxides and record the development of improved and new technologies; and

(e) develop, in the context of an approach based on critical loads, methods to integrate scientific, technical and economic data in order to determine appropriate control strategies.

Article 7

National programmes, policies and strategies

The Parties shall develop without undue delay national programmes, policies and strategies to implement the obligations under the present Protocol that shall serve as a means of controlling and reducing emissions of nitrogen oxides or their transboundary fluxes.

Article 8

Information exchange and annual reporting

1. The Parties shall exchange information by notifying the executive body of the national programmes, policies and strategies that they develop in accordance with Article 7 and by reporting to it annually on progress achieved under, and any changes to, those programmes, policies and strategies, and in particular on:

(a) the levels of national annual emissions of nitrogen oxides and the basis upon, which they have been calculated;

(b) progress in applying national emission standards required pursuant to Article 2, subparagraph 2 (a) and (b), the national emission standards applied or to be applied and the sources and/or source categories concerned;

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(c) progress in introducing the pollution control measures required pursuant to Article 2, subparagraph 2 (c), the source concerned and the measures introduced or to be introduced;

(d) progress in making unleaded fuel available;

(e) measures taken to facilitate the exchange of technology; and

(f) progress in establishing critical loads.

2. Such information shall, as far as possible, be submitted in accordance with a uniform reporting framework.

Article 9

Calculations

EMEP shall, utilizing appropriate models and in good time before the annual meetings of the executive body, provide to the executive body calculations of nitrogen budgets and also of transboundary fluxes and deposition of nitrogen oxides within the geographical scope of EMEP. In areas outside the geographical scope of EMEP, models appropriate to the particular circumstances of Parties to the Convention therein shall be used.

Article 10

Technical Annex

The Technical Annex to the present Protocol is recommendatory in character. It shall form an integral part of the Protocol.

Article 11

Amendments to the Protocol

1. Any Party may propose amendments to the present Protocol.

2. Proposed amendments shall be submitted in writing to the Executive Secretary of the Commission who shall communicate them to all Parties. The executive body shall discuss the proposed amendments at its next annual meeting provided that these proposals have been circulated by the Executive Secretary to the Parties at least 90 days in advance.

3. Amendments to the Protocol, other than amendments to its Technical Annex, shall be adopted by consensus of the Parties present at a meeting of the Executive Body, and shall enter into force for the Parties which have accepted them on the 90th day after the date on which two-thirds of the Parties have deposited their instruments of acceptance thereof. Amendments shall enter into force for any Party which has accepted them after two-thirds of the Parties have deposited their instruments of acceptance of the amendment, on the 90th day after the date on which that Party deposited its instrument of acceptance of the amendments.

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4. Amendments to the Technical Annex shall be adopted by consensus of the Parties present at a meeting of the Executive Body and shall become effective 30 days after the date on which they have been communicated in accordance with paragraph 5 below.

5. Amendments under paragraphs 3 and 4 above shall, as soon as possible after their adoption, be communicated by the Executive Secretary to all Parties.

Article 12

Settlement of disputes

If a dispute arises between two or more Parties as to the interpretation or application of the present Protocol, they shall seek a solution by negotiation or by any other method of dispute settlement acceptable to the Parties to the dispute.

Article 13

Signature

1. The present Protocol shall be open for signature at Sofia from 1 November to 4 November 1988 inclusive, then at the Headquarters of the United Nations in New York until 5 May 1989, by the Member States of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic intregration organizations, constituted by sovereign States, members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organizations concerned are Parties to the Convention.

2. In matters which their competence, such regional economic integration organizations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their Member States. In such cases, the Member States of these organizations shall not be entitled to exercise such rights individually.

Article 14

Ratification, acceptance, approval and accession

1. The present Protocol shall be subject to ratification, acceptance or approval by Signatories.

2. The present Protocol shall be open for accession as from 6 May 1989 by the States and organizations referred to in Article 13 (1).

3. A State or organization which accedes to the present Protocol after 31 December 1993 may implement Articles 2 and 4 no later than 31 December 1995.

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4. The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of depositary.

Article 15

Entry into force

1. The present Protocol shall enter into force on the 90th day following the date on which the 16th instrument of ratification, acceptance, approval or accession has been deposited.

2. For each State and organization referred to in Article 13 (1) which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the 16th instrument of ratification, acceptance, approval, or accession, the Protocol shall enter into force on the 90th day following the date of deposit by such Party of its instrument of ratification, acceptance, approval, or accession.

Article 16

Withdrawal

At any time after five years from the date on which the present Protocol has come into force with respect to a Party, that Party may withdraw from it by giving written notification to the depositary. Any such withdrawal shall take effect on the 90th day following the date of its receipt by the depositary, or on such later date as may be specified in the notification of the withdrawal.

Article 17

Authentic texts

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

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TECHNICAL ANNEX

1. Information regarding emission performance and costs is based on official documentation of the executive body and its subsidiary bodies, in particular documents EB.AIR/WG.3/R. 8, R. 9 and R. 16, and ENV/WP.l /R. 86, and Corr. 1, as reproduced in chapter 7 of *Effects and Control of Transboundary Air Pollution* ([1]). Unless otherwise indicated, the technologies listed are considered to be well established on the basis of operational experience ([2]).

2. The information contained in this Annex is incomplete. Because experience with new engines and new plants incorporating low emission technology, as well as with retrofitting existing plants, is continuously expanding, regular elaboration and amendment of the Annex will be necessary. The Annex cannot be an exhaustive statement of technical options; its aim is to provide guidance for the Parties in identifying economically feasible technologies for giving effect to the obligations of the Protocol.

I. CONTROL TECHNOLOGIES FOR NO_x-EMISSIONS FROM STATIONARY SOURCES

3. Fossil fuel combustion is the main stationary source of anthropogenic NO_x emissions. In addition, some non-combustion processes can contribute relevant NO_x emissions.

4. Major stationary source categories of NO_x emissions may include:

   (a) combustion plants;

   (b) industrial process furnaces (e.g., cement manufacture);

   (c) stationary gas turbines and internal combustion engines; and

   (d) non-combustion processes (e.g. nitric acid production).

5. Technologies for the reduction of NO_x emissions focus on certain combustion/process modifications, and, especially for large power plants, on flue gas treatment.

6. For retrofitting of existing plants, the extent of application of low-NO_x technologies may be limited by negative operational side-effects or by other site-specific constraints. In the case of retrofitting, therefore, only approximate estimates are given for typically achievable NO_x emission values. For new plants, negative side-effects can be minimized or excluded by appropriate design features.

7. According to currently available data, the costs of combustion modifications can be considered as small for new plants. However, in the case of retrofitting for instance at large power plants, they ranged from about 8 to 25 Swiss francs per kW_{el} (in 1985). As a rule, investment costs of flue gas treatment systems are considerably higher.

8. For stationary sources, emission factors are expressed in milligrams of NO_2 per normal (0 °C, 1013 mb) cubic metre (mg/m^3), dry basis.

([1]) Air Pollution Studies No 4 (United Nations publication, sales No E.87.II.E.36).

([2]) It is at present difficult to provide reliable data on the costs of control technologies in absolute terms. For cost data included in the present Annex, emphasis should therefore be placed on the relationship between the costs of different technologies rather than on absolute cost figures.

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Combustion plants

9. The category of combustion plants comprises fossil fuel combustion in furnaces, boilers, indirect heaters and other combustion facilities with a heat input larger than 10 MW, without mixing the combustion flue gases with other effluents or treated materials. The following combustion technologies, either singly or in combination, are available for new and existing installations:

   (a) low-temperature design of the firebox, including fluidized bed combustion;

   (b) low excess-air operation;

   (c) installation of special low-NO_x burners;

   (d) flue gas recirculation into the combustion air;

   (e) staged combustion/overfire-air operation; and

   (f) reburning (fuel staging) (1).

   Performance standards that can be achieved are summarized in Table 1.

Table 1:

NO_x performance standards (mg/m^3) that can be achieved by combustion modifications

		Plant type (a)	Uncontrolled baseline	Existing plant retrofit (b)		New plant	O_2 (%)
				Range	Tropical value		
Solid Fuels	10 (c) to 300 MW	Grate combustion (coal)					
		Fluidized bed combustion	300-1 000	—	600	400	7
		(i) stationary	300-600	—	—	400	7
		(ii) circulating	150-300	—	—	200	7
		Pulverized coal combustion					
		(i) dry bottom	700-1 700	600-1 100	800	< 600	6
		(ii) wet bottom	1 000-2 300	1 000-1 400	—	< 1 000	6
	***> 300 MW	Pulverized coal combustion					
		(i) dry bottom	700-1 700	600-1 100	—	< 600	6
		(ii) wet bottom	1 000-2 300	1 000-1 400	—	< 1 000	6
Liquid Fuels	10 (c) to 300 MW	Distillate oil combustion	—	—	300	—	3
		Residual oil combustion	500-1 400	200-400	400	—	3
	> 300 MW	Residual oil combustion	200-1 400	200-400	—	—	3
Gaseous Fuels	10 (c) to 300 MW		150-1 000	100-300	—	< 300	3
	> 300 MW		250-1 400	100-300	—	< 300	3

(a) Capacity numbers refer to MW (thermal) heat input by fuel (lower heating value).
(b) Only approximate values can be given due to site-specific factors and greater uncertainty for retrofitting of existing plant.
(c) For small (10 to 100 MW) plants a greater degree of uncertainty applies to all figures given.

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(1) There is limited operational experience of this type of combustion technology.

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10. Flue gas treatment by selective catalytic reduction (SCR) is an additional NO_x emission reduction measure with efficiencies of up to 80 % and more. Considerable operational experience from new and retrofitted installations is now being obtained within the region of the Commission, in particular for power plants larger than 300 MW (thermal). When combined with combustion modifications, emission values of 200 mg/m^3 (solid fuels, 6 % O_2) and 150 mg/m^3 (liquid fuels, 3 % O_2) can be easily met.

11. Selective non-catalytic reduction (SNCR), a flue gas treatment for a 20 to 60 % NO_x reduction, is a cheaper technology for special applications (e. g. refinery furnaces and base load gas combustion).

Stationary gas turbines and internal combustion (IC) engines

12. NO_X emissions from stationary gas turbines can be reduced either by combustion modification (dry control) or by water/steam injection (wet control). Both measures are well established. By these means, emission values of 150 mg/m^3 (gas, 15 % O_2) and 300 mg/m^3 (oil, 15 % O_2)can be met. Retrofit is possible.

13. NO_X emissions from stationary spark ignition IC engines can be reduced either by combustion modifications (e.g. lean-burn and exhaust gas recirculation concepts) or by flue gas treatment (closed-loop three-way catalytic converter, SCR). The technical and economic feasibility of these various processes depends on engine size, engine type (two-stroke/four-stroke), and engine operation mode (constant/varying load). The lean-burn concept is capable of meeting NO_X emission values of 800 mg/m^3 (5 % O_2), the SCR process reduces NO_X emissions well below 400 mg/m^3 (5 % O_2), and the three-way catalytic converter reduces such emissions even below 200 mg/m^3 (5 % O_2).

Industrial process furnaces — Cement calcination

14. The precalcination process is being evaluated within the region of the Commission as a possible technology with the potencial for reducing NO_X concentrations in the flue gas of new and existing cement calcination furnaces to about 300 mg/m^3 (10 % O_2).

Non-combustion processes — Nitric acid production

15. Nitric acid production with a high pressure absorption (> 8 bar) is capable of keeping NO_X concentrations in undiluted effluents below 400 m^3. The same emission performance can be met by medium pressure absorption in combination with a SCR process or any other similar efficient NO_X reduction process. Retrofit is possible.

II. CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM MOTOR VEHICLES

16. The motor vehicles considered in this Annex are those used for road transport, namely: petrol-fuelled and diesel-fuelled passenger cars, light-duty vehicles and heavy-duty vehicles. Appropriate reference is made, as necessary, to the specific vehicle categories (M_1, M_2, M_3, N_1, N_2, N_3) defined in EEC Regulation No 13 pursuant to the 1958 Agreement concerning the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicles equipment and parts.

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17. Road transport is a major source of anthropogenic NO_X emission in many Commission countries, contributing between 40 and 80 % of total national emissions. Typically, petrol-fuelled vehicles contribute two-thirds of total road transport NO_X emissions.

18. The technologies available for the control of nitrogen oxides from motor vehicles are summarized in Tables 3 and 6. It is convenient to group the technologies by reference to existing or proposed national and international emission standards differing in stringency of control. Because current regulatory test cycles only reflect urban and metropolitan driving, the estimates of relative NO_X emissions given below take account of higher speed driving where NO_X emissions can be particularly important.

19. The additional production cost figures for the various technologies given in Tables 3 and 6 are manufacturing cost estimates rather than retail prices.

20. Control of production conformity and in-use vehicle performance is important in ensuring that the reduction potential of emission standards is achieved in practice.

21. Technologies that incorporate or are based on the use of catalytic converters require unleaded fuel. Free circulation of vehicles equipped with catalytic converters depends on the general availability of unleaded petrol.

Petrol-fuelled and diesel-fuelled passenger cars (M_1)

22. In Table 2, four emission standards are summarized. These are used in Table 3 to group the various engine technologies for petrol vehicles according to their NO_X emission reduction potential.

Table 2

Definition of emission standards

Standard	Limits	Comments
A. ECE R. 15-04	HC + NO_X: 19-28 g/test	Current ECE standard (Regulation No 15, including the 04 series of amendments, pursuant to the 1953 Agreement referred to all paragraph 16 above), also adopted by the European Economic Community (Directive 83/351/EEC). ECE R. 15 urban test cycle. Emission limit varies with vehicle mass.
B. 'Luxembourg 1985'	HC + NO_X: 1,4-2,0 l: 8,0 g/test This standard only used to group technology (< 1,4 l: 15,0 g/test; >2,0 l: 6,5 g/test)	Standards to be introduced during 1988 to 1993 in the European Economic Community, as discussed at the 1985 Luxembourg meeting of the EEC Council of Ministers and finally agreed upon in December 1987. ECE R. 15 urban test cycle applies. Standard for engines > 2 l is generally equivalent to US 1983 standard. Standard for engines < 1,4 l is provisional, definite standard to be elaborated. Standard for engines of 1,4-2,0 applies to all diesel cars > 1,4 l.
C. 'Stockholm 1985'	NO_X: 0,62 g/km NO_X: 0,76 g/km	Standards for national legislation based on the 'master document' developed after the 1985 Stockholm meeting of Environment Ministers from eight countries. Matching US 1987 standards, with the following test procedures: US Federal Test Procedure (1975); highway fuel economy test procedure.
D. 'California 1989'	NO_X: 0,25 g/km	Standards to be introduced in the State of California, United States from 1989 models onwards. US Federal Test Procedure.

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Table 3

Petrol engine technologies, emission performance, costs and fuel consumption for emission standard levels

Standard	Technology	Composite [a] NO_X reduction (%)	Additional [b] production cost (1986 in Swiss francs)	Fuel consumption index [a]
A.	Baseline (Current conventional spark-ignition engine with carburettor)	[c]	—	100
B.	(a) Fuel injection + secondary air [d]	25	200	105
	(b) Open-loop three-way catalyst (+ EGR)	55	150	103
	(c) Lean-burn engine with oxidation catalyst (+ EGR) [e]	60	200-600	90
C.	Closed-loop three-way catalyst	90	300-600	95
D.	Closed-loop three-way catalyst (+ EGR)	92	350-600	98

[a] Composite NO_X reduction and fuel consumption index estimates are for an average-weight European car operating under average European driving conditions.

[b] Additional production costs could be more realistically expressed as a percentage of the total car cost. However, since cost estimates are primarily for comparison in relative terms only, the formulation of the original documents has been retained.

[c] Composite NO_X emission factor = 2,6 g/km.

[d] 'EGR' means exhaust gas recirculation.

[e] Based entirely on data for experimental engines. Virtually no production of lean-burn engined vehicles exists.

23. The emission standards A, B, C and D include limits on hydrocarbon (HC) and carbon monoxide (CO) emissions as well-as NO_X. Estimates of emission reductions for these pollutants, relative to the baseline ECE R. 15-04 case, are given in Table 4.

Table 4

Estimated reductions in HC and CO emissions from petrol-fuelled passenger cars for different technologies

Standard	HC-reduction (%)	CO-reduction (%)
B.	(a) 30-40	50
	(b) 50-60	40-50
	(c) 70-90	70-90
C.	90	90
D.	90	90

24. Current diesel cars can meet the NO_X emission requirements of standards A, B and C. Strict particulate emission requirements, together with the stringent NO_X limits of standard D, imply that diesel passenger cars will require further development, probably including electronic control of the fuel pump, advanced fuel injection systems, exhaust gas recirculation and particulate traps. Only experimental vehicles exist to date. (See also Table 6, footnote (a)).

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Other light-duty vehicles (N_1)

25. The control methods for passenger cars are applicable but NO_X reductions, costs and commercial lead time factors may differ.

Heavy-duty petrol-fuelled vehicles (M_2, M_3, N_2, N_3)

26. This class of vehicle is insignificant in western Europe and is decreasing in eastern Europe. US 1990 and US 1991 NO_X emission levels (see Table 5) could be achieved at modest cost without significant technology advancement.

Heavy-duty diesel-fuelled vehicles (M_2, M_3, N_2, N_3)

27. In Table 5, three emission standards are summarized. These are used in Table 6 to group engine technologies for heavy-duty diesel vehicles according to NO_X reduction potential. The baseline engine configuration is changing, with a trend away from naturally aspirated to turbo-charged engines. This trend has implications for improved baseline fuel consumption performance. Comparative estimates of consumption are therefore not included.

Table 5

Definition of emission standards

Standard	NO_X limits (g/kWh)	Comments
I. ECER. 49	18	13 mode test
II. US-1990	8,0	Transient test
III. US-1991	6,7	Transient test

Table 6

Heavy-duty diesel engine technologies, emission performance ([a]), **and costs for emission standard levels**

Standard	Technology	NO_X reduction estimate (%)	Additional production (cost (1984 US$)
I.	Current conventional direct injection diesel engine	—	—
II. ([b])	Turbo-charging + after-cooling + injection timing retard (combustion chamber and port modification) (naturally-aspirated engines are unlikely to meet this standard)	40	$115 ($69 attributable to NO_X standard) ([c])
III. ([b])	Further refinements of technologies listed under II together with variable injection timing and use of electronics	50	$404 ($68 attributable to NO_X standard) ([c])

([a]) Deterioration in diesel fuel quality would adversely affect emission and may affect fuel consumption for both heavy- and light-duty vehicles.

([b]) It is still necessary to verify on a large scale the availability of new components.

([c]) Particulate control and other considerations account for the balance.