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Treaty Series No. 5 (2006)

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

Aarhus, 24 June 1998

[The United Kingdom instrument of ratification was deposited on 2 September 2005 and the Protocol entered into force on 1 December 2005]

Presented to Parliament
by the Secretary of State for Foreign and Commonwealth Affairs
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PROTOCOL
TO THE 1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION ON PERSISTENT ORGANIC POLLUTANTS[1]

The Parties,

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

Recognizing 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,

Recognizing 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,[2]

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,

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[1] Miscellaneous Series No. 2 (2003) Cm 5794.

[2] Treaty Series No. 100 (1995) Cm 3108.

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,

Recognizing 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;[1]

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)[2], 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;

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[1] Treaty Series No. 57 (1983) Cmnd 9034.

[2] Treaty Series No. 75 (1988) Cm 521.

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.

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) above 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 above, 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;

(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) above shall refer to all stationary sources in that category taken together.

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

ARTICLE 4

Exemptions

1. Article 3, paragraph 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, paragraphs 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 above, 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, paragraph 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;

   (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 minimized; and

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

3. Each Party shall, no later than ninety days after granting an exemption under paragraph 2 above, 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) above, 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 above.

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 organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance;

(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 alternatives.

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;

(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 socio-economic 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) above, 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;

(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, paragraph 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.

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, paragraph 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 fifteenth 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;

(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) 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 twelve 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 ninety days in advance.

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 ninetieth 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 ninetieth 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 ninety 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 sixteen 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 ninety 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 and 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 sixty 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 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 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 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 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 organizations that meet the requirements of article 15, paragraph 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 ninetieth day following the date on which the sixteenth instrument of ratification, acceptance, approval or accession has been deposited with the Depositary.

2. For each State and organization referred to in article 15, paragraph 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 ninetieth 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 ninetieth 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 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.

IN WITNESS WHEREOF the undersigned, being duly authorized thereto, have signed the present Protocol.

Done at Aarhus (Denmark), this twenty-fourth day of June, one thousand nine hundred and ninety-eight.

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.

	Implementation requirements	
Substance	**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 Organization, the Food and Agriculture Organization of the United Nations and the United Nations Environment Programme, review the availability and feasibility of alternatives and, as appropriate, promote the commercialization 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.
Hexabromobiphenyl CAS: 36355–01–8	Production	None
	Use	None
Haxachlorobenzene 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.

Substance	Implementation requirements	
	Elimination of	**Conditions**
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

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a/ The Parties agree to reassess under the Protocol by 31 December 2004 the production and use of polychlorinated terphenyls and “ugilec”.

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.

	Implementation requirements	
Substance	**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.
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%

Substance	Implementation requirements	
	Restricted to uses	Conditions
		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".

ANNEX III

SUBSTANCES REFERRED TO IN ARTICLE 3, PARAGRAPH 5 (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: beno(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.

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 Organization for Standardization (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 substracted, 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 3 tonnes per hour)
    0.1 ng TE/m^3

Medical solid waste (burning more than 1 tonne per hour)
    0.5 ng TE/m^3

Hazardous waste (burning more than 1 tonne per hour)
    0.2 ng TE/m^3

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 time to meet the obligations in article 3, paragraph 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;
- 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 minimize 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.

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 ca. 2 sec—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.

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 1000°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 fluidized 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 fluidized 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 stabilize 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.

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: – Elimination of precursors and chlorine-containing feed material; and – Management of waste streams.	Resulting emission level not quantified; seems not to be linearly dependent on the amount of the feed material.		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. 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: – Optimized combustion conditions; – 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.			Retrofitting of the whole process needed.
Flue gas measures: Avoiding particle deposition by:			
– 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.

Management options	Emission level (%)a/	Estimated costs	Management risks
– Ceramic filters;	Low efficiency		Use at temperatures of 800–1000°C.
– Cyclones; and	Low efficiency	Medium	
– 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 800–1000°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 fluidized 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.
– Entrained flow or circulating fluidized 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 immobilization; 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 pelletizing);

(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.

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 > 5000 m^3/h) using control measures.

Table 2: Emission reduction of PCDD/F in the metallurgical industry

Management options	Emission level (%)[a/]	Estimated costs	Management risks
Sinter plants			
Primary measures:			
– Optimization /encapsulation of sinter conveying belts;		Low	Not 100% achievable
– Waste gas recirculation e.g. emission optimized sintering (EOS) reducing waste gas flow by ca. 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 ng TE/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	
Secondary measures:			
– Quenching the hot waste gases;	High efficiency	Low	

Management options	Emission level (%)[a/]	Estimated costs	Management risks
– 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 fluidized 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	
Secondary measures:			
– Separate collection and treatment of emissions from loading and discharging; and		Low	
– Fabric filter in combination with coke injection.	< 1	Medium	

Management options	Emission level (%)[a]	Estimated costs	Management risks
Secondary aluminium production			
Primary measures:			
– Avoidance of halogenated material (hexachloroethane);		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, swin-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	
– Minimization 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.

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 optimization 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;

(c) Quenching hot waste gases (providing utilization 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 minimization of waste gas volume);

(e) Adsorption in a fixed bed reactor or fluidized 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 electrostratic 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) Minimizing 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

(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 undersired 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.

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 recognized 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 summarizes some emission concentrations and factors for wood-firing installations.

Table 3: Quantity-related emission concentrations and factors for wood-firing 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	1400–9400
Residential waste	114	3230	
Charcoal	0.03		

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;
  - 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' 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, eg 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 incineraton 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 1 second) and high temperatures (minimum of 900°C).

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 amortized 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 summarizes PAH emission reduction measures in coke production plants.

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	(Amortization of investment costs, taking into account energy recovery, heated water, gas for synthesis and saved cooling water, may be 5 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		
— Water 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.

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 aluminium oxide ($A1_2O_3$).

62. The operating costs in thermal after-burning can be reduced in an autothermal after-burning mode if the concentration of carbon compounds in the waste gas is high enough. Table 5 summarizes PAH emission control measures for anode production.

Table 5: PAH emission control for anode production

Management options	**Emission level (%)**[a/]	**Estimated costs**	**Management risks**
Modernization 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.
BAT:			
— Electrostatic dust precipitation; and	2–5		Regular cleaning of tar is needed.
— Thermal after-burning.	15	Lower operating costs in an auto-thermal mode.	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 70–90%. 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 summarizes PAH emission control measures for aluminium production.

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: — Prebaked electrodes (avoidance of pitch binders); — Inert anodes.	3–30	Higher costs for electrodes about US$ 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.
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: US$ 50,000–10,000 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–medium	
Gas cleaning:			
— Electrostatic tar filters;	2-5	Low	High rate of sparking and electrical arcing; Wet gas-cleaning generates waste water.
— Combinaton of conventional electrostatic tar filters with electrostatic wet gas cleaning;	> 1	Medium	
— Thermal after-burning.			
Pitch use with higher melting point (HSS + VSS).	High	Medium Low–medium	
Use of dry scrubbing in existing HSS + VSS plants.		Medium–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 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 optimized operation characteristics (e.g. burning rate) effectively control PAH emissions from residential combustion. Optimized combustion conditions include optimized combustion chamber design and optimized supply of air. There are several techniques which optimize 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 1000°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 1000°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. Optimized 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		3	2	1	3	2	1	3	2	1
	Effect (kW)	CO			THC			Particulates		
Manual	< 50	5000	8000	25000	150	300	2000	150/ 125	180/ 150	200/ 180
	50–150	2500	5000	12500	100	200	1500	150/ 125	180/ 150	200/ 180
	> 150 − 300	1200	2000	12500	100	200	1500	150/ 125	180/ 150	200/ 180
Automatic	< 50	3000	5000	15000	100	200	1750	150/ 125	180/ 150	200/ 180
	50–150	2500	4500	12500	80	150	1250	150/ 125	180/ 150	200/ 180
	> 150 − 300	1200	2000	12500	80	150	1250	150/ 125	180/ 150	200/ 180

Note: Emission levels in mg/m^3 at 10% O_2.

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 summarized 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 18-24 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.	30–40	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.

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.

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 amortization period provided for by national legislation.

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

Year	Reference mass	Limit values	
		Mass of hydrocarbons and NO_x	Mass of particulates
01.1.2000	All	0.56 g/km	0.05 g/km
01.1.2005 (indicative)	All	0.3 g/km	0.025 g/km

3. Heavy-duty vehicles

Year/test cycle	Limit values	
	Mass of hydrocarbons	Mass of particulates
01.1.2000/ESC cycle	0.66 g/kWh	0.1 g/kWh
01.1.2000/ETC cycle	0.85 g/kWh	0.16 g/kWh

4. Off-road engines

Step 1 (reference: ECE regulation No. 96)*

Net power (P) (kW)	Mass of hydrocarbons	Mass of particulates
$P \geqslant 130$	1.3 g/kWh	0.54 g/kWh
$75 \leqslant P < 130$	1.3 g/kWh	0.70 g/kWh
$37 \leqslant P < 75$	1.3 g/kWh	0.85 g/kWh

* "Uniform provisions concerning the approval of compression ignition (C.I.) 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
$0 \leqslant P < 18$		
$18 \leqslant P < 37$	1.5 g/kWh	0.8 g/kWh
$37 \leqslant P < 75$	1.3 g/kWh	0.4 g/kWh
$75 \leqslant P < 130$	1.0 g/kWh	0.3 g/kWh
$130 \leqslant P < 560$	1.0 g/kWh	0.2 g/kWh

B. *Fuel parameters*

5. Diesel fuel

Parameter	Unit	Limits		Test method
		Minimum value (2000/2005)*	Maximum value (2000/2005)*	
Cetane number		51/N.S.	–	ISO 5165
Density at 15°C	kg/m^3	–	845/N.S.	ISO 3675
Evaporated 95%	°C	–	360/N.S.	ISO 3405
PAH	mass %	–	11/N.S.	prIP 391
Sulphur	ppm	–	350/50**	ISO 14956

N.S.: Not specified.

* 1 January of year specified.

** Indicative value.

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 becuase 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.

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. oxidizing catalysts or particle traps (secondary measures).

(a) *Diesel engines*

14. Diesel-fuel modfication can yield two benefits: a lower sulphur content reduces emissions of particles and increases the conversion efficiency of oxidizing 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 computerized 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.

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 oxidizing 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.

(b) *Petrol engines*

18. PAH-reduction measures for petrol-fuelled engines are primarily based on the use of a closed-loop three-way catalytic converted, 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 summarizes 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:		
— Closed-loop three-way catalytic converter,	10–20	Availability of unleaded petrol.
— Catalysts for reducing cold start emissions.	5–15	Commercially available in some countries.
Fuel for spark ignition engines: — Reduction of aromatics, — Reduction of sulphur.		Availability of refinery capacity.
— Diesel engines: — Oxidizing catalyst, — Trap oxidizer/particulate filter.	20–70	
Diesel fuel modification: — Reduction of sulphur to reduce particulate emissions.		Availability of refinery capacity.
Improvement of diesel engine specifications: — Electronic control system, injection rate adjustment and high-pressure fuel injection, — Turbocharging and intercooling, — Exhaust gas recirculation.		Existing technologies.

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).

RATIFICATIONS, ACCESSIONS, EFFECTIVE DATES AND DECLARATIONS

State	*Action*	*Date*	*Effective Date*
Armenia	Signature	18 Dec 1998	
Austria	Signature	24 Jun 1998	
	Ratification	27 Aug 2002	25 Nov 2002
Belgium	Signature	24 Jun 1998	
Bulgaria	Signature	24 Jun 1998	
	Ratification	05 Dec 2001	05 Mar 2002
Canada	Signature	24 Jun 1998	
	Ratification	18 Dec 1998	18 Mar 1999
Croatia	Signature	24 Jun 1998	
Cyprus	Signature	24 Jun 1998	
	Ratification	02 Sep 2004	01 Dec 2004
Czech Republic	Signature	24 Jun 1998	
	Ratification	06 Aug 2002	04 Nov 2002
Denmark	Signature	24 Jun 1998	
	Approval	06 Jul 2001	04 Oct 2001
Estonia	Accession	11 May 2005	09 Aug 2005
European Community	Signature	24 Jun 1998	
	Approval	30 Apr 2004	29 Jul 2004
Finland	Signature	24 Jun 1998	
	Acceptance	03 Sep 2002	02 Dec 2002
France	Signature	24 Jun 1998	
	Approval	25 Jul 2003	23 Oct 2003
Germany	Signature	24 June 1998	
	Ratification	25 Apr 2002	24 Jul 2002
Greece	Signature	24 Jun 1998	
Hungary	Signature	18 Dec 1998	
	Ratification	07 Jan 2004	06 Apr 2004
Iceland	Signature	24 Jun 1998	
	Ratification	29 May 2003	27 Aug 2003
Ireland	Signature	24 Jun 1998	
Italy	Signature	24 Jun 1998	
Latvia	Signature	24 Jun 1998	
	Ratification	28 Oct 2004	26 Jan 2005
Liechtenstein	Signature	24 Jun 1998	
	Acceptance	23 Dec 2003	22 Mar 2004
Lithuania	Signature	24 Jun 1998	
Luxembourg	Signature	24 Jun 1998	
	Ratification	01 May 2000	30 Jul 2000
Netherlands[1]	Signature	24 Jun 1998	
	Acceptance	23 Jun 2000	21 Sep 2000
Norway	Signature	24 Jun 1998	
	Ratification	16 Dec 1999	15 Mar 2000
Poland	Signature	24 Jun 1998	
Portugal	Signature	24 Jun 1998	
Republic of Moldova	Signature	24 Jun 1998	
	Ratification	01 Oct 2002	30 Dec 2002
Romania	Signature	24 Jun 1998	
	Ratification	05 Sep 2003	04 Dec 2003
Slovakia	Signature	24 Jun 1998	
	Acceptance	30 Dec 2002	30 Mar 2003
Slovenia	Signature	24 Jun 1998	
	Ratification	15 Nov 2005	13 Feb 2006
Spain	Signature	24 Jun 1998	
Sweden	Signature	24 Jun 1998	
	Ratification	19 Jan 2000	19 Apr 2000
Switzerland	Signature	24 Jun 1998	
	Ratification	14 Nov 2000	12 Feb 2001
Ukraine	Signature	24 Jun 1998	

United Kingdom of Great Britain and Northern Ireland	Signature	24 Jun 1998	
	Ratification	02 Sep 2005	01 Dec 2005
United States of America	Signature	24 Jun 1998	

DECLARATIONS AND RESERVATIONS

(Unless otherwise indicated, the declarations were made upon ratification,acceptance, approval or accession.)

Austria

Declarations:

“The Republic of Austria declares in accordance with Article 3 Paragraph 5 (a) and Annex III of the Protocol the year 1987 as a reference year for the obligations of this Paragraph.

The Republic of Austria declares in accordance with Article 12 of the Protocol that it accepts both of the means of dispute settlement mentioned in Paragraph 2 as compulsory in relation to any party accepting an obligation concerning one or both of these means of disputes settlement.”

Estonia

Declaration:

“. . . the Republic of Estonia informs that in accordance with the Article 3 paragraph 5 subparagraph a of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants the Republic of Estonia chose reference years as follows:

1. Polycyclic aromatic hydrocarbons (PAHs)—1995;

2. Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF)—1990;

3. Hexaclorobenzene (HCB)—1995.”

Finland

Declaration:

“Pursuant to article 3 (5) of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants, the Republic of Finland specifies 1994 as its reference year in accordance with annex III of the said Protocol.”

Liechtenstein

Declaration:

“The Principality of Liechtenstein declares in accordance with Article 12, paragraph 2, of the Protocol that it accepts both of the means of dispute settlement mentioned in this paragraph as compulsory in relation to any party accepting an obligation concerning one or both of these means of dispute settlement.”

Luxembourg

Declaration:

Article 3, paragraph 5, of [the Protocol], provides that each Party shall 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. Annex III sets as the reference year 1990, or an alternative year from 1985 to 1995 inclusive specified by a Party upon ratification, acceptance, approval or accession.

[The Government of Luxembourg hereby declares] that the Grand Duchy of Luxembourg intends to choose 1990 as the reference year.

Norway

Declarations:

"1. With reference to Article 3 no 5 Litra (a) and Annex III, Norway hereby declares that the reference year should be 1990.

2. With reference to Article 12 no 2, Norway hereby declares that, in respect of any dispute concerning the interpretation or application of the Protocol, it recognizes only 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."

Romania

Romania declares that the reference year set in accordance with Article 3, paragraph 5 (a), and Annex III of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants is the year 1989.

Slovakia

Declaration:

"Pursuant to Article 3, paragraph 5 (a), and Annex III of the Protocol on Persistent' Organic Pollutants, the Slovac Republic hereby declares the year 1990 as its reference year."

NOTES

[1] For the Kingdom in Europe.

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