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

Working Group on Strategies and Review

Forty-fifth session
Geneva, 31 August–4 September 2009
Item 3 of the provisional agenda

**OPTIONS FOR REVISING THE 1998 PROTOCOL ON
PERSISTENT ORGANIC POLLUTANTS**

Note by the secretariat

1. The present document was prepared by the secretariat in consultation with the Chair of the Working Group on Strategies and Review as requested by the Working Group at its forty-third session¹. It reflects the outcomes of the discussions on options for revising the Protocol on Persistent Organic Pollutants (POPs) and its annexes I, II, III, VI, VII and VIII as well as possible amendments to annexes IV and V² prepared by the ad hoc group of technical experts in parallel to the Working Group's forty-first, forty-second and forty-third sessions. The options discussed by the Working Group included the proposed amendments by the French Presidency of the European Council and the European Commission on behalf of the European Community

¹ See ECE/EB.AIR/WG.5/94, para. 22 (d).

² For technical reasons, possible amendments to annex V are presented in annex II to the present document and issued in English only.

and the European Union (EU) Member States that are Parties to the Protocol, and by Norway, in line with the of article 14, paragraph 2, to the Protocol, as well as the informal proposals put forward.

2. The document presents the options for revising the Protocol in the form of suggested amendments in the text of the Protocol's annexes. Proposed amendments are presented in square brackets and proposed new text is indicated in bold. .
3. The ad hoc group of legal experts will conduct legal scrutiny of the relevant amendment proposals in order to ensure that these proposals work from a legal point of view and to identify any necessary consequential amendments. The legal experts will report on this work to the Working Group at its forty-fifth session.
4. In annex to the document is an informal proposal on options for revising article 3 of the Protocol by the Co-Chair of the Task Force on POPs, as announced at the forty-third session of the Working Group in March 2009.
5. The Working Group is invited to discuss and agree on the options for revising the Protocol and to report on the results to the Executive Body at its twenty-seventh session in December 2009.

I. OPTIONS FOR REVISING ANNEX I ON SUBSTANCES SCHEDULED FOR ELIMINATION

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

| Substance | Implementation requirements | |
|------------------------------|-----------------------------|---|
| | Elimination of | Conditions |
| Aldrin CAS: 309-00-2 | Production | None |
| | Use | None |
| Chlordane CAS: 57-74-9 | Production | None |
| | Use | None |
| Chlordecone CAS: 143-50-0 | Production | None |
| | Use | None |
| DDT CAS: 50-29-3 | Production | <p>[Option 1: None, without exemptions. <u>Delete:</u></p> <p>1. Elimination 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.</p> <p>2. With a view to eliminating the production of DDT at the earliest opportunity, the Parties shall, no later than one year after the data 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.]</p> <p>[Option 2: Keep the specific uses exemptions as they are listed in annexes I and II:</p> <p>1. Elimination 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.</p> <p>2. With a view to eliminating the production of DDT at the earliest opportunity, the Parties shall, no later than one year after the data 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</p> |

| Substance | Implementation requirements | |
|---|-----------------------------|--|
| | Elimination of | Conditions |
| | | 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: 60-51-1 | 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.- <u>deleted</u>] |
| Hexabromobiphenyl CAS: 36355-01-8 | Production | None |
| | Use | None |
| Hexachlorobenzene CAS: 118-74-1 | Production | None. [except for production for a limited purpose as specified in a statement deposited by a country with an economy in transition upon signature or accession. – <u>deleted</u>] |
| | 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. - <u>deleted</u>] |
| Hexachlorobutadiene | Production | None |
| | Use | None |
| Hexachlorocyclohexane CAS: 608-73-1 | Production | None |
| | Use | None, except for use as topical insecticide for public health purposes. Such uses shall be re-evaluated under this Protocol no later than 2012 |
| Commercial Octabromodiphenyl ether, including hexaBDE congeners, individually [and heptaBDE congeners] | Production | None |
| | Use | None. [Parties must take appropriate measures to ensure that recycling processes of articles manufactured or in use by the implementation date do not result in recovered material containing 0.1% or more of penta/octa by weight]; [Use in recycled articles] |

| Substance | Implementation requirements | |
|---|-----------------------------|--|
| | Elimination of | Conditions |
| Commercial-Pentabromodiphenyl ether , including tetraBDE, pentaBDE and hexaBDE congeners individually | Production | None |
| | Use | [Use: None. Parties must take appropriate measures to ensure that recycling processes of articles manufactured or in use by the implementation date do not result in recovered material containing 0.1% or more of penta/octa by weight]; [Use in recycled articles]. |
| Mirex CAS: 2385-85-5 | Production | None |
| | Use | None |
| Pentachlorobenzene ^{a/} | Production | None |
| | Use | None |
| Option 1: [Perfluoronate sulfonates, including the 96 congeners (perfluorooctane sulfonates)] Option 2: [List in annex II.] Definitions: C8F17SO2X (X=OH, metal salt, halide, amide or other derivatives including polymers); [United States: (Perfluorooctane sulfonic acid C8F17SO2X (X=OH))]; | Production | None, with exemption for the following uses |
| | Use | None, except for the following uses: (a) Photo-resists or anti-reflective coatings for photolithography processes; (b) Photographic coatings applied to films, papers or printing plates; (c) Mist suppressants for non-decorative hard chromium (VI) plating and wetting agents for use in controlled electroplating systems; (d) Hydraulic fluids for aviation; (e) [Firefighting foams that have been placed on the market before the ban can be used until [2011][2014]]; (f) Chromium electroplating, chromium anodizing and reverse etching until [2014]; (g) Electroless nickel-polytetrafluoroethylene plating until [2014]; (h) Etching of plastic substrates prior to their metalization until [2014]. [Add conditions of stockpiles of firefighting foam containing more than 0.005% PFOS by weight to be identified, collected and destroyed.] Restricted uses of PFOS shall be reassessed no later than |

| Substance | Implementation requirements | |
|--|-----------------------------|--|
| | Elimination of | Conditions |
| | | two years after the entry into force of the amendment to the Protocol; |
| PCB ^{b/, c/} Polychlorinated biphenyls | 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. – deleted] |
| | Use | <p>[None, except as identified in annex II. – deleted]</p> <p>None. Concerning PCBs in use by the implementation date, Parties shall make determined efforts designed to lead to:</p> <p>(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 dm³ and having a concentration of 0.05% PCBs or greater, as soon as possible but no later than 3 December 2010, or 31 December 2015 for countries with economies in transition;</p> <p>Parties shall endeavour to:</p> <p>(b) Identify and remove from use equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) containing greater than 0.005% PCBs and volumes greater than 0.05 dm³, as soon as possible but no later than 31 December 2025;</p> <p>Parties shall make determined efforts designed to lead to:</p> <p>(c) The destruction or decontamination in an environmentally sound manner of:</p> <ul style="list-style-type: none"> - 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; - All liquid PCBs referred to in subparagraph (b) no later than [31 December [2025]][2029]; <p>(d) The decontamination or disposal of equipment referred in subparagraphs (a) and (b) in an environmentally sound manner.</p> <p>Parties shall:</p> <p>(e) Ensure that equipment containing PCBs, as described in subparagraphs (a) and (b), shall not be exported or imported except for the purpose of environmentally sound waste management;</p> <p>(f) Endeavour to identify other articles containing more than 0.005% PCBs (e.g. cable sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 3 of article 3;</p> |

| Substance | Implementation requirements | |
|---|-----------------------------|---|
| | Elimination of | Conditions |
| | | (g) Promote the following measures to reduce exposures and risk to control the use of PCBs: (i) Use PCBs only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimized and quickly remedied; (ii) Not use PCBs in equipment in areas associated with the production or processing of food or feed; (iii) When PCBs are used in populated areas, including schools and hospitals, take all reasonable measures to prevent electrical failures that could result in a fire, and regularly inspect equipment for leaks. |
| Polychlorinated naphthalenes (PCN) | Production | None |
| | Use | None |
| Option 1 [Short-chained chlorinated paraffins] Option 2 [List in annex II] | Production | None, [except for the following uses] |
| | Use | None, except for the following uses [United States: Include the following restricted uses: “Metalworking fluids and non-emissive applications e.g. as a plasticizer or flame retardant in paints, inks, coatings and sealants, rubber, textiles and plastics, and insulation fibre”.] |
| Toxaphene CAS: 8001-35-2 | Production | None |
| | Use | None |

a/ [PeCB may be present in PCBs as additives, therefore similar conditions as for PCBs may be necessary]. To be reformulated by experts.

b/ [The Parties agree to reassess under the Protocol by 31 December 2004 the production and use of polychlorinated terphenyls and "ugilec" – ~~deleted~~]

c/ PCBs are defined as follows: “Polychlorinated biphenyls” means aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced up to 10 chlorine atoms (as defined in the Stockholm Convention on POPs);

[For countries within the geographical scope of EMEP³, PCBs include: polychlorinated biphenyls; polychlorinated terphenyls (PCT); ugilecs (monomethyl-tetrachlorodiphenyl methane, monomethyl-dichlorodiphenyl methane, monomethyl-dibromo-diphenyl methane); and any mixture containing any of the above-mentioned substances in a total of more than 0.005% by weight.]

³The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

II. OPTIONS FOR REVISING ANNEX II ON SUBSTANCES SCHEDULED FOR RESTRICTIONS ON USE

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

| Substance | Implementation requirements | |
|--|---|---|
| | Restricted to uses | Conditions |
| <u>Option 1</u> [DDT CAS: 50-29-3] <u>Option 2</u> [Alternatively list in annex I only] | 1. For public health protection from diseases such as malaria and encephalitis. [2. As a chemical intermediate to produce Dicofol.- deleted] | 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. Such use shall be reassessed no later than two years after the date of entry into force of the present Protocol [Eliminate production and use without exemption. List in annex I only] |
| [HCH CAS: 608-73-1 – deleted] | [Technical HCH (i.e. HCH mixed isomers) is restricted to use as an intermediate in chemical manufacturing. – deleted] | |
| | [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 - deleted] | [All restricted uses of lindane shall be reassessed under the Protocol no later than two years after the date of entry into force – deleted] |

| Substance | Implementation requirements | |
|--|---|--|
| | Restricted to uses | Conditions |
| <p><u>Option 1</u> Perfluoronate sulfonates Including the 96 congeners (perfluorooctane sulfonates)</p> <p><u>Option 2</u> Alternatively list in annex I.</p> <p><u>Definitions:</u> C8F17SO2X (X=OH, metal salt, halide, amide or other derivatives including polymers);</p> <p>[United States: (Perfluorooctane sulfonic acid C8F17SO2X (X=OH)];</p> | Same uses as specified in annex I. | Same conditions as specified in annex I. |
| <p>[PCB a/ - deleted] Remove from annex II</p> | <p>[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. – deleted]</p> | <p>[Parties shall make determined efforts designed to lead to:</p> <p>(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 dm³ and having a concentration of 0.05% PCBs or greater, as soon as possible, but no later than 31 December 2010, or 31 December 2015 for countries with;</p> <p>(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</p> <p>(c) The decontamination or disposal of equipment referred in subparagraph (a) in an environmentally sound manner . -</p> |

| Substance | Implementation requirements | |
|--|-----------------------------------|-----------------------------------|
| | Restricted to uses | Conditions |
| | | deleted] |
| Commercial-Pentabromodiphenyl ether, including tetraBDE, pentaBDE and hexaBDE congeners individually | [Use of imported articles]. | |
| <u>Option 1</u> Short-chained chlorinated paraffins <u>Option 2</u> Alternatively list in annex I | Same uses as specified in annex I | Same uses as specified in annex I |

[a/ The Parties agree to reassess under the Protocol by 31 December 2004 the production and use of polychlorinated terphenyls and "ugilec". – deleted]

**III. OPTIONS FOR REVISING ANNEX III ON
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, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party , and as specified by [a – deleted] that Party upon ratification, acceptance, approval or accession |
| Dioxins/furans ^{b/} | 1990; or an alternative year from 1985 to 1995 inclusive, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party , and as specified by [a – deleted] that Party upon ratification, acceptance, approval or accession. |
| Hexachlorobenzene | 1990; or an alternative year from 1985 to 1995 inclusive, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party , and as specified by [a – deleted] that Party upon ratification, acceptance, approval or accession. |
| PCBs | 2005; or an alternative year from 1995 to 2010 inclusive, or for countries with economies in transition, an alternative year from 1995 to the year of the entry into force of the Protocol for a Party, and as specified by a that Party upon ratification, acceptance, approval or accession. |

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

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

IV. OPTIONS FOR REVISING ANNEX IV ON 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/m³ or mg/m³ under standard conditions (273.15 K, 101.3 kPa, [and – ~~delete~~] dry gas, [**and for a given oxygen content**]).
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 – ~~delete~~]. [**For instance in batch operation, limit values relate to the whole batch process – including for example pre-heating, heating and cooling.**]
4. Sampling and analysis of all pollutants shall be carried out according to the [**most up to date**] standards^[4] 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. – ~~delete~~]
5. For verification purposes, the interpretation of measurement results in relation to the limit value must also take into account the inaccuracy of the measurement method. A limit value is considered to be met if the result of the measurement, from which the inaccuracy of the measurement method is subtracted, does not exceed it.
6. [Emissions of different congeners of PCDD/F are given in toxicity equivalents (TE) in comparison to 2,3,7,8-TCDD using the system proposed by the NATO Committee on the Challenges of Modern Society (NATO-CCMS) in 1988. – ~~delete~~] [**Emissions of PCDD/F are given in toxicity equivalents (TEQ). The toxic equivalence factor values to be used for the purposes of this Convention shall be consistent with accepted international standards, including the World Health Organisation 2005 mammalian toxic equivalence factor values for polychlorinated dibenzo-p-dioxins and dibenzofurans.**^{5]}

^[4] Current CEN measurement standards are EN 1948-1, EN 1948-2 and EN 1948-3, for PCDD/Fs sampling, extraction /purification and analysis, respectively. A new TS 1948-4 was issued in 2007 with regard to PCB-DL measurements.]

^[5] Reference: van den Berg, M et al., 2006. The 2005 World Health Organisation Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Tox. Sci 93(2), 223-241]

II. LIMIT VALUES FOR MAJOR STATIONARY SOURCES

[Transition periods can be found in annex VI]

7. The following limit values, which refer to 11% O₂ concentration in flue gas, apply to the following incinerator types:

Municipal solid waste [(burning more than 3 tonnes per hour) – ~~delete~~]; [(existing stationary source burning more than 3 tonnes per hour and every new stationary source)]

0.1 ng TE[Q]/m³

Medical solid waste [(burning more than 1 tonne per hour) – ~~delete~~] [(existing stationary source burning more than 1 tonne per hour and every new stationary source)]

[0.5 ng TE/m³ – ~~delete~~]

[0.1 ng TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.5 ng TEQ/m³ – option-2]

Hazardous waste [(burning more than 1 tonne per hour) – ~~delete~~]; [(existing stationary source burning more than 1 tonne per hour and every new stationary source)]

[0.2 ng TE/m³ – ~~delete~~]

[0.1 ng TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.2 ng TEQ/m³ – option-2]

[Non hazardous industrial waste⁶

[0.1 ng TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.5 ng TEQ/m³ – option-2]

[8. The following limit value[s], which refer to 16% O₂ concentration in flue gas, apply to sinter-plants:

[0.1 TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.5 ng TEQ/m³ – option-2]

[0.5 TEQ/m³ – option-3]

[New stationary source: 0.5 ng TEQ/m³

Existing stationary source: [0.5 - 1.0 – one value in this range] ng TEQ/m³ (with the

[⁶ Excluding incinerators treating only biomass waste with the exception of biomass waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood-preservatives or coating, and which includes in particular such biomass waste originating from construction and demolition waste.]

purpose to achieve an average emission of 0.5 TEQ/m³) – option-4, taking into account an additional margin between ELV and BAT-AEL, if found necessary]]

[9. The following limit value[s], which refer to the actual O₂ concentration in flue gas, apply to the following sources:

[Secondary steel production – Electric arc furnaces:

[0.1 TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.5 ng TEQ/m³ – option-2]

[0.5 TEQ/m³ – option-3]

[New stationary source: 0.5 ng TEQ/m³

Existing stationary source: [0.5 - 1.0 – one value in this range] ng TEQ/m³ (with the purpose to achieve an average emission of 0.5 TEQ/m³) – option-4, taking into account an additional margin between ELV and BAT-AEL, if found necessary]]

[Secondary production of aluminum and copper:

[0.1 TEQ/m³ – option-1]

[New stationary source: 0.1 ng TEQ/m³

Existing stationary source: 0.5 ng TEQ/m³ – option-2]

[0.5 TEQ/m³ – option-3]

[New stationary source: 0.5 ng TEQ/m³

Existing stationary source: [0.5 - 1.0 – one value in this range] ng TEQ/m³ (with the purpose to achieve an average emission of 0.5 TEQ/m³) – option-4, taking into account an additional margin between ELV and BAT-AEL, if found necessary]]

**V. OPTIONS FOR REVISING ANNEX VI ON
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.

2. The timescales for the application of limit values and best available techniques that have been updated or introduced as a result of amendment of this Protocol shall be:

- (a) for new stationary sources, [two] years after the date of entry into force of the relevant amendment for a Party; and
- (b) for existing stationary sources:
 - (i) [eight] years after the date of entry into force of the relevant amendment for a Party; or
 - (ii) for a Party that is [a country with an economy in transition], [fifteen] years after the date of entry into force of the relevant amendment for a Party.

**VI. OPTIONS FOR REVISING ANNEX VII ON
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. [Annex VII is deleted]

The reasons for deleting annex VII: As a result of the phase-out of leaded petrol in most parts of the UNECE region, petrol-fuelled vehicles are no longer a relevant source of PCDD/PCDF. Furthermore, diesel-powered engines, which are formally a main source of fine particulates, with PAHs as a major component, are subject to stricter controls for particulate matter (PM) under regulations outside of the Protocol (see EB.AIR/WG.5/2005/1, paras. 33–37).

VII. OPTIONS FOR REVISING ANNEX VIII ON 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, of municipal, hazardous or medical waster, or of sewage sludge [or of non-hazardous industrial waste]* |
| 2 | Sinter plants. |
| 3 | Primary and secondary production of copper. [3bis: Other processes used in the metallurgical industry"; chlorine based methods;] |
| 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) |
| [13] | [Specific chemical production processes.] |
| [14] | [Installations for recycling or shredding of municipal and industrial waste.] |

* The square bracketed amendments to annex VIII were proposed by the French Presidency of the European Council and the European Commission and communicated to the Parties 90 days in advance to the twenty-sixth session of the Executive Body in 2008.

Annex I

Informal proposal for revising article 3 of the 1998 Protocol on Persistent Organic Pollutants by the Co-chair of the Task Force on POPs, Mr. J. Sliggers (the Netherlands)

Article 3 Basic obligations

5. Each Party shall

(a) (unchanged)

(b) Within the timescales specified in annex VI, apply:

- (i) The best available techniques to each new stationary source within a major stationary source category in annex V, taking into account guidance document I, which identifies best available techniques, adopted by the Executive Body at its twenty-seventh session (decision 2009/1) and any amendments thereto;
- (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 account guidance document I adopted by the Executive Body at its twenty-seventh session (decision 2009/1) and any amendments thereto. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;
- (iii) The best available techniques, insofar as this is technically and economically feasible, to each existing stationary source within a major stationary source category in annex V, taking into account guidance document I, which identifies best available techniques, adopted by the Executive Body at its twenty-seventh session (decision 2009/1) and any amendments thereto. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;
- (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 account guidance document I adopted by the Executive Body at its twenty-seventh session (decision 2009/1) and any amendments thereto. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;
- (v) (delete)

It is proposed that the contents of annex VIII be covered by annex V. This would imply the following further adjustments to the articles of the Protocol:

- Article 1, para 11 could be deleted or alternatively the term “annex VIII” be replaced by “annex V”;

- In article 1, para 12: replace “annex III or VIII” by “annex IV”;
- In article 13: delete last sentence.

Annex II

OPTIONS FOR REVISING ANNEX V ON BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONAER SOURCES

I. INTRODUCTION

1. The purpose of this annex is to provide the Parties to the Convention with guidance in identifying best available techniques to allow them to meet the obligations in article 3, 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.
- [(d) Residential combustion sources]**

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 – delete]** **[composition of the raw-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 – delete][Cost-efficiency]** 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. **[Cost-efficiency considerations should take into account that the measures to reduce emissions of POPs also will reduce emissions of other pollutants, like Heavy Metals or acidifying agents. The cost-efficiency of measures should be established in relation to the effects on all pollutants, and not be based on reduction of only the amount of POPs.]** 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 **[,non-hazardous industrial 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, O₂ 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. –**

~~delete]~~**[The environmentally sound design and operation of waste incinerators requires the use of both best available techniques and best environmental practices (which are to some extent overlapping). Primary measures for municipal or hazardous waste incineration are not sufficient. It is most effective to modify the incineration process and to install secondary measures for flue gas cleaning. Best environmental practices for waste management can be are useful primary measures. These practices are focused on environmentally sound waste management for instance waste minimization; recycling; waste inspection; removal of ferrous and non-ferrous metals; proper waste handling, storage and pretreatment; minimizing storage times; and proper waste loading.**

Primary measures involving management of feed material by reducing halogenated substances and replacing them by non-halogenated substances are not technically effective appropriate for municipal or hazardous waste incineration]

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 – **[above]** 850°C for **[ca. –delete][more than]** 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.

[If hazardous wastes with a content of more than 1 % of halogenated organic substances, expressed as chlorine, are incinerated, the temperature has to be raised to 1 100 °C for at least two seconds].

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; – delete]**
- (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~~ **[separators]** for the reduction of particle-bound PCDD/F [, **e.g. electrostatic precipitators (ESP) or fabric filters (bag houses)**];
- (b) **[Oxidising organohalogens through]** Selective catalytic reduction (SCR) [or selective non-catalytic reduction (SNCR) – ~~delete~~];
- (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) H₂O₂-oxidation; and – delete]**
- [(e) Destruction using catalytic filter bags; and]**
- (f) Catalytic combustion methods using different types of catalysts (i.e. Pt/A₁₂O₃ 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 – delete~~][~~below~~] 0.1 ng TE[Q]/m³ 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.

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; [~~and~~]
- (d) Further methods of immobilization; [~~and – delete~~]
- (e) [The application of plasma technology. – ~~delete~~]

Table I: 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 materials; 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 – delete][sufficient]; 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 | | | Retrofitting of the whole process needed. |

- Cyclones; and

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|---|----------------------------------|---|---|
| <p>- Electrostatic precipitation.</p> <p>[- Catalytic oxidation.</p> <p>Gas quenching.</p> <p>High-performance adsorption unit with added activated charcoal particles (electrodynamic venturi).</p> <p>Selective catalytic reduction (SCR).</p> <p>Different types of wet and dry adsorption methods with mixtures of activated charcoal, open-hearth coke, lime and limestone</p> | Medium efficiency | High investment and low operating costs | <p>[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. – delete][Formation of PCDD/F risk if used in the range 450-200 °C]</p> <p>Use at temperatures of 800-1000°C. Separate gas phase abatement necessary. – delete]</p> <p>NO_x reduction if NH₃ 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.</p> |

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|---|--|---|--|
| 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[Q]/m ³) | High in-vestment, 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[Q]/m ³) | Low in-vestment, medium operating costs | Removal of residuals. |
| [Addition of H ₂ O ₂ . | < 2 - 5 (0.1 ng TE/m ³) | Low in-vestment, low operating costs – <u>delete;</u>] | |
| [Destruction using catalytic filter bags | <0.5 (0.1 ng TEQ/m ³) | High investment] | |
| [Use of carbon impregnated materials of PCDD/F adsorption in the wet scrubbers | 30 | Low investment | Only applicable to wet scrubbers especially if there is evidence of dioxin built up. Can be used in combination with subsequent dioxin management options] |

a/ Remaining emission compared to unreduced mode.

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 – delete]**, 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 – delete][<0.1 – 0.5]** ng TEQ/m³ (if waste gas volume flow > 5000 m³/h) using control measures. **[EU BREFs describe for non-ferrous metallurgy, iron and steel production, (sinter plants and electric arc furnaces), that BAT associated emission levels are <0.1 – 0.5 ng TEQ/m³].**

Table II: [Options for] Emission reduction of PCDD/F [from thermal processes] in the metallurgical industry

| MANAGEMENT OPTIONS | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|------------------------------------|--|----------------------------|
| <p>Sinter plants</p> <p><u>Primary measures:</u></p> <p>- Optimization/encapsulation of sinter conveying belts;</p> <p>- 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 Nm³/h;</p> <p><u>Secondary measures:</u></p> <p>[- Electrostatic precipitation + molecular sieve;</p> | <p>40</p> <p>Medium efficiency</p> | <p>Low</p> <p>[Low – delete] [Medium]</p> <p>Medium- delete]</p> | <p>Not 100% achievable</p> |

| MANAGEMENT OPTIONS | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|---|-----------------|--|
| - Addition of limestone/activated carbon mixtures. [Followed by dust separation preferably by fabric filters]; | High efficiency (0.1 [– 0.5] ng TE[Q]/m ³) | Medium | 0.1 ng TE[Q]/m ³ could be reached with higher energy demand; no existing installation |
| - High-performance scrubbers - existing installation: AIRFINE (Voest Alpine Stahl Linz) since 1993 for 600 000 Nm ³ /h; second installation [planned – delete][in use since 1997] in the Netherlands [(Hoogoven) for 1998][(Corus plant IJmuiden)] . | High efficiency emission reduction to 0.2-0.4 ng TE[Q]/m ³ | Medium | |
| Non-ferrous production (e.g. copper) | | | |
| <u>Primary measures:</u> - Pre-sorting of scrap, avoidance of feed material like plastics and PVC-contaminated scrap, stripping of coatings and use of chlorine-free insulating materials | High efficiency 5 - 7 (1.5-2 TE[Q]/m ³) (0.1 ng TE[Q]/m ³) (0.1 ng TE[Q]/m ³) | Low | |
| <u>Secondary measures:</u> - Quenching the hot waste gases; | | Low | |
| - Use of oxygen or of oxygen-enriched air in firing, oxygen injection in the shaft kiln (providing complete combustion and minimization of waste gas volume); | | High | |
| - Fixed bed reactor or fluidized jet stream reactor by adsorption with activated charcoal or open-hearth coal dust; [Single- and multi-stage fabric filter with injection of limestone/activated carbon upstream of the filter] | | High | |
| - Catalytic oxidation; and | (0.1 ng TE[Q]/m ³) | High | |

| MANAGEMENT OPTIONS | Emission level (%) ^{a/} | Estimated costs | Management risks |
|---|----------------------------------|--|---|
| - Reduction of residence time in the critical region of temperature in the waste gas system. | | | |
| Iron and steel production | | | |
| <u>Primary measures:</u> - Cleaning of the scrap from oil prior to charging of production vessels; - Elimination of organic tramp materials such as oils, emulsions, greases, paint and plastics from feedstock cleaning; - Lowering of the specific high waste gas volumes; [But maximum capture of potentially PCDD/F contaminated waste gases is desirable.] [- Separate collection and treatment of emissions from loading and discharging; <u>Secondary measures:</u> - Separate collection and treatment of emissions from loading and discharging; and | | Low Low Medium Low – delete Low | [Cleaning solvents have to be used. – delete] |

| MANAGEMENT OPTIONS | Emission level (%) ^{a/} | Estimated costs | Management risks |
|---|--|---|------------------|
| <p>- Fabric filtre in combination with coke injection.</p> <p>[- Use of an optimal temperature profile during cool-down of waste gas</p> <p>- Use of Combustion chamber for treatment of the waste gas]</p> | <p>< 1</p> <p>[($<0.1 \text{ ng TE[Q]/m}^3$)]</p> | Medium | |
| Secondary aluminium production | | | |
| <p><u>Primary measures:</u></p> <p>- Avoidance of halogenated material (hexachloroethane);</p> <p>- Avoidance of chlorine-containing lubricants (for instance chlorinated paraffins); and</p> <p>- Clean-up and sorting of dirty scrap charges, e.g. by swarf decoating and drying, swim-sink separation techniques and whirling stream deposition;</p> <p><u>Secondary measures:</u></p> <p>- Single- and multi-stage fabric filter with added activation of limestone/ activated carbon [in front – delete][up stream] of the filter;</p> <p>- Minimization and separate removal and purification of differently contaminated waste gas flows;</p> <p>- Avoidance of particulate deposition from the waste gas and promotion of rapid passing of the critical temperature range; and</p> | <p>< 1</p> <p>(0.1 ng TE[Q]/m^3)</p> | <p>Low</p> <p>Low</p> <p>Medium/ high</p> <p>Medium/ high</p> <p>Medium/ high</p> | |

| MANAGEMENT OPTIONS | Emission level (%) ^{a/} | Estimated costs | Management risks |
|---|----------------------------------|-----------------|------------------|
| - 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[Q]/m³. A single measurement at one plant without any control measures showed an emission concentration of 43 ng TE[Q]/m³.

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[Q]/m³ can be achieved. By adding suitable adsorption agents like lignite coal cokes/coal slack, an emission concentration of 0.1 ng TE[Q]/m³ can be reached.

[(d) Advanced ESPs are available (e.g moving electrode ESP, ESP pulse system, high voltage operation of ESP)].

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[Q]/m³ after flue-gas cleaning. A single copper shaft furnace emitted up to 29 ng TE[Q]/m³ 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[, **injection of activated carbon in combination with a fabric filter**]; 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 – delete]~~**[may be]** significantly lower than 0.1 ng TE[Q]/m³. 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[Q]/m³ if the following measures are used:

- (a) Separate collection of emissions from loading and discharging; ~~[and – delete]~~
- (b) Use of a fabric filter or an electrostatic precipitator in combination with coke injection;
- [(c) Use of an optimal temperature profile during cool-down of waste gas; and]**
- [(d) Use of Combustion chamber for treatment of the waste gas.]**

[A possibility to further reduce PCDD/F emissions is the injection of activated carbon upstream of the fabric filter]

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[Q]/m³. 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 – delete][up-stream]** of the filter meet the emission concentration of 0.1 ng TE[Q]/m³, 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[Q]/m³ was measured (as compared to values of > 1 ng TE[Q]/m³ for treatment with chlorine only). Chlorine is required for the removal of magnesium and other undesired components.

C. Combustion of fossil fuels in utility and industrial boilers

40. In the combustion of fossil fuels in utility and industrial boilers (>50 MW thermal capacity), improved energy efficiency and energy conservation will result in a decline in the emissions of all pollutants because of reduced fuel requirements. This will also result in a reduction in PCDD/F emissions. It would not be cost-effective to remove chlorine from coal or oil, but in any case the trend towards gas-fired stations will help to reduce PCDD/F emissions from this sector.

**[The feasibility of fuel switching is dominated by local circumstances.
The use of coal or biomass rich organohalogen compounds or halogenated compounds should be avoided where possible in installations that are not equipped with emission abatement technologies.]**

The waste should only be combusted in installations equipped with proper emission abatement technologies

Fuel switch from waste, coal, or biomass containing organohalogen compounds to natural gas will reduce the formation of organohalogen compounds in the off-gases. This can result in a significant decrease of PCDD/F emissions from small installations that are not equipped with emission abatement technologies.]

[40bis. Fossil fired utility boilers in power plants may use fuels based on biomass together with fossil fuels to reduce emissions of greenhouse gases.

The burning of biomass containing high levels of organohalogen compounds or halogenated compounds should only be performed in installations equipped with proper emission abatement techniques.

Fuel switch from waste, coal, or biomass containing organohalogen compounds to natural gas will reduce the formation of organohalogen compounds in the off-gases. This can result in a significant decrease of PCDD/F emissions from small installations that are not equipped with emission abatement technologies

The feasibility of fuel switching is dominated by local circumstances.]

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.

[Emission of PCDD/F from industrial boilers are generally low and emission levels associated from the sector can be below 0.1 ng TEQ/m³]

D. Residential combustion

43. **Residential combustion appliances can have a noticeable contribution to total emissions of PCDD/F.] [The contribution of residential combustion appliances to total emissions of PCDD/F is – delete][This contribution 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. [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[Q]/m³.

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[Q]/m³ (exclusively wood) to 8 ng TE[Q]/m³ (relative to 11% O₂ by volume). These results have been confirmed by investigations in several countries in which up to 114 ng TE[Q]/m³ (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[Q]/m³ 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 III: Quantity-related emission concentrations and factors for wood-firing installations

| Fuel | Emission concentration (ng TE[Q]/m³) | Emission factor (ng TE[Q]/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.

[Biomass fuels can have a high chloride content e.g. straw, or wood from a saline environment, which can lead to an increased formation of PCDD/F when these biomass are incinerated as fuel. Fuel switch to fuels with a low chlorine content for dedicated combustion plants firing biomass will have a large impact on PCDD/F emissions.]

[If needed Installations firing biomass can be equipped with abatement techniques to reduce emissions of particulate matter, like fabric filters or electrostatic precipitators; this will reduce emission of PCDD/F significantly.]

[Post combustion abatement technologies might be economically viable or feasible on plant biomass above 0.5MW, and then could be limited to simple cyclone type abatement. For smaller plant fuel quality and burner design may have greater influence on 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 – ~~delete~~] [by retro fitting or reducing the coke consumption in iron and steel production, by replacing part of the coke with high value coal or waste oil etc.]** 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, e.g. dry coke cooling. The replacement of a wet quenching process by dry coke cooling should be preferred, so long as the generation of waste water is avoided by using a closed circulation system. The dusts generated when dry quenched coke is handled should be reduced.

53. A coke-making process referred to as "non-recovery coke-making" emits significantly less PAH than the more conventional by-product recovery process. This is because the ovens operate under negative pressure, thereby eliminating leaks to the atmosphere from the coke oven doors. During coking, the raw coke oven gas is removed from the ovens by a natural draught, which maintains a negative pressure in the ovens. These ovens are not designed to recover the chemical by-products from raw coke oven gas. Instead, the offgases from the coking process (including PAH) are burned efficiently at high temperatures and with long residence times. The waste heat from this incineration is used to provide the energy for coking, and excess heat may be used to generate steam. The economics of this type of coking operation may require a cogeneration unit to produce electricity from the excess steam. Currently there is only one non-recovery coke plant operating in the United States, and one is in operation in Australia. The process is basically a horizontal sole-flue non-recovery coke oven with an incineration chamber adjoining two ovens. The process provides for alternate charging and coking schedules between the two ovens. Thus, one oven is always providing the incineration chamber with coke gases. The coke gas combustion in the incineration chamber provides the necessary heat source. The

incineration chamber design provides the necessary dwell time (approximately 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 IV: 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 waste is reused in a closed cycle. |
| - Evacuation and after-burning of the filling gases during charging of ovens or passing the gases into the | 5 | (Amortization of investment costs, taking into account energy recovery, heated water, | |

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|----------------------------------|---|---|
| adjacent oven as far as possible; | | 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 | | |
| - Waste gases from pushing operations should be collected and fed to a dedusting device; | < 5 | Higher investment costs than for wet cooling (but lower costs by preheating of coke and use of waste heat.) | |
| - 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 retrofitting 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 aluminum oxide (Al_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 V: PAH emission control for anode production

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|----------------------------------|-----------------|---|
| <p>Modernization of old plants by reducing diffuse emissions with the following measures:</p> <ul style="list-style-type: none"> - 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 | |
| <p>Established technologies for anode production in the Netherlands:</p> <ul style="list-style-type: none"> - New kiln with dry scrubber (with limestone/petroleum cokes or with aluminium) | 45-50 | | Implemented in the Netherlands in 1990. Scrubbing with limestone or petroleum cokes is effective for reducing PAH; with aluminium not know. |

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|----------------------------------|---|--|
| - Effluent recycling in paste unit. | | | |
| BAT: | | | |
| - Electrostatic dust precipitation; and | 2-5 | | Regular cleaning of tar is needed. |
| - Thermal after-burning. | 15 | Lower operating costs in an autothermal 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 VI: 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; |
| - Combination of conventional electrostatic tar filters with electrostatic wet gas cleaning; | > 1 | Medium | Wet gas-cleaning generates waste water. |
| - Thermal after-burning. | | | |
| Pitch use with higher melting | High | Medium | |

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|----------------------------------|-----------------|------------------|
| point (HSS + VSS) | | Low - medium | |
| Use of dry scrubbing in existing HSS + VSS plants. | | Medium - high | |

^{a/} Remaining emission compared to unreduced mode.

[66bis. According to the Non Ferrous Metal EU BREF, the achievable level for PAHs (total – OSPAR11) is < 200 µg / m³.]

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 ~~–delete~~[For example four CEN standards (EN 303-5; EN 13.229; EN 13.240 and EN 12.809) have been published]** for coal- and wood-fired **[boilers – ~~delete~~[appliances] up to 300 kW (see table 7). [These standards set maximum values for CO and THCs and PM.]**

[Table VII: Draft CEN standards in 1997

| Class | | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 |
|-----------|-------------|------|------|-------|-----|-----|------|---------|---------|---------|
| | Effect (kW) | CO | | | CO | | | CO | | |
| 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/m³ at 10% O₂. – ~~delete the table VII and the note~~

70. Emissions from residential wood combustion stoves **[and boilers]** can be reduced **[by the following primary measures]** :

- (a) [For existing stoves, - ~~delete~~] by public information and awareness programmes regarding:
- **the** proper [stove –~~delete~~]operation **[of stoves and boilers –]**,
 - the use of untreated wood only,
 - fuel preparation procedures and the correct seasoning of wood for moisture content; [and – ~~delete~~]
- (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) – ~~delete~~] **[by establishing a programme to promote the replacement of the oldest existing boilers and stoves by modern stoves and boilers.]**

[70bis. Emissions of PAH from residential wood combustion in new stoves and boilers can be reduced by the following secondary measures:

- (a) **reducing the emissions of particulate matter (PM) by equipping stoves and boilers with abatement techniques aimed at reducing emissions of dust**

(b) equipping stoves and boilers with abatement techniques aimed at oxidising PAH

Possible abatement techniques that control the emissions of particulate matter are electrostatic precipitators, ceramic filters, fabric filters using metal filament fabric or retrofitting of an afterburner. The costs and environmental benefits of the use of these techniques on small stoves and boilers have to be evaluated.

Possible abatement techniques that will burn the PAHs are partly re-circulation of the stack gases or catalytic converters that will oxidise the PAHs. The costs and environmental benefits of the use of these techniques on small stoves and boilers has to be evaluated]

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.

**[The feasibility of fuel switching is dominated by local circumstances
Emission of PAHs from domestic heating systems can be reduced by switching the fuels from wood or coal to natural gas.]**

72. Information is summarized in table 8.

Table 8: PAH emission control for residential combustions

| 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. [manually fed installations only] | [High effectiveness] | [Medium] | |

| Management options | Emission level (%) ^{a/} | Estimated costs | Management risks |
|--|----------------------------------|-----------------|--|
| 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. | | | |
| [Secondary measures to reduces emissions of particulates or to burn PAHs | <5 % | Medium to high | Costs are relative to size of the installation and re-use of heat produced] |

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: | Other environmental problems have to be evaluated such as: |
| - Sustainably produced hardwood (riverbanks, fences, gates); | - Availability of suitably produced wood; |
| - Plastics (horticulture posts); | - Emissions caused by the production and disposal of plastics, especially PVC. |
| - 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. | |
