ECONOMIC COMMISSION FOR EUROPE

Handbook for the

1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION AND ITS PROTOCOLS

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HANDBOOK FOR THE 1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION AND ITS PROTOCOLS

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NOTE

Symbols of United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

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[*] As amended ECE/EB.AIR/79/Add.2, annex XIV.

[**] The amendments concern the technical annex and were adopted by the Executive Body for the Convention on Long-range Transboundary Air Pollution at its fourteenth session held on 25-28 November 1996 (ECE/EB.AIR/49, paras. 13-14).

[***] The amendment concerns annex III and was adopted by the Executive Body for the Convention on Long-range Transboundary Air Pollution at its fourteenth session held on 25-28 November 1996 (ECE/EB.AIR/49, para. 17).

FOREWORD

The Convention on Long-range Transboundary Air Pollution, adopted 25 years ago, is the oldest of the UNECE environmental conventions. As a result of the Convention's work our environment is already beginning to recover from the effects of sulphur deposition of the 1980s and 1990s, and further benefits are expected in the coming years as the Convention's protocols are fully implemented. With its three most recent protocols entering or about to enter into force, this is a good time to take stock of the achievements and to make strategic plans for the future.

This Handbook provides a current overview of the Convention, bringing together all the legal texts as well as the ministerial statements made at the time of adoption of protocols and important decisions taken by the Convention's Executive Body. It thus provides an historic view of the work of the Convention and the thinking behind what was done. It also provides up-to-date information on the structure of the Convention and the status of ratification of its protocols.

The environmental conventions are an important part of UNECE work. They bring States together with a common purpose and provide an important forum for solving issues that cannot be addressed by countries or subregions alone. During the Convention's lifetime there have often been political differences between countries and the period has seen many political changes. However, throughout the 25 years the awareness of the need to tackle air pollution has remained unchanged, and the participation of so many UNECE States is an indication of the importance that they attach to the work.

With the recent protocols coming into force we are entering a period of review and assessment. We know that we have some way to go before we solve all our air pollution problems. Increasingly we are taking a holistic approach to our environmental problems and there is a need to consider future controls in relation to global issues such as climate change and sustainable development. For doing so, our starting point must be what has already been agreed, and this Handbook provides the necessary information to support our future work.

BRIGITA SCHMÖGNEROVÁ
Executive Secretary
United Nations Economic Commission for Europe

LIST OF ABBREVIATIONS

Currencies

DM	Deutsche mark
ECU	European currency unit
US$	United States dollar

Organizations, centres and programmes

CEN	Comité européen de normalisation
CCMS	Committee on the Challenges of Modern Society
ECE	Economic Commission for Europe
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
ISO	International Organization for Standardization
MSC-W	Meteorological Synthesizing Centre-West
NATO	North Atlantic Treaty Organization
PARCOM	Commission for the Prevention of Marine Pollution from Land-based Sources
SAPRC	Statewide Air Pollution Research Center, Los Angeles, United States of America
UNEP	United Nations Environment Programme

Weights and measures

°C	degree Celsius
g	gram
GJ	gigajoule
h	gour
K	kelvin
kg	kilogram
km	kilometre
km^2	square kilometre
kPa	kilopascal
kt	kiloton
kW_{el}	kilowatt (electric)
kWh	kilowatt-hour
m^2	square metre
m^3	cubic metre
mg	milligram
Mg	megagram
MW	megawatt
MW_{el}	megawatt (electric)
MW_{th}	megawatt (thermal)
P	net power
Pa	pascal
t	metric ton

Technical and scientific abbreviations

AC	Activated carbon process
AD	Air dried
AL	Lignite coke
AS	Ammonia scrubbing
BAF	Bioaccumulation factor
BaP	Benzo(a)pyrene
BAT	Best available techniques
BBF	Biased-burner-firing
BCF	Bioconcentration factor
BE	Bitumen emulsion
BFBC	Bubbling fluidized bed combustion
BOOS	Burner-out-of-service
BOF	Basic oxygen furnace
CAS	Chemical Abstracts Service
CCGT	Combined cycle gas turbine
CFBC	Circulating fluidized bed combustion
CFC	Chlorofluorocarbon
CI	Compression ignition
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
DBB	Dry bottom boiler
EAF	Electric arc furnace
EBDS	Electron beam dry scrubbing
EGR	Exhaust gas recirculation
EOS	Emission optimized sintering
ESP	Electrostatic precipitators
F	Furans
FF	Fabric filters
FBC	Fluidized bed combustion
FGD	Flue gas desulphurization
FGR	Flue gas recirculation
HC	Hydrocarbon
HCB	Hexachlorobenzene
HCH	Hexachlorohexane
HDV	Heavy-duty vehicle
IC engine	Internal combustion engine
IFNR	In-furnace-NO_x - reduction reburning
IGCC	Integrated gasification combined cycle
IS	Imperial Smelting
LEA	Low excess air combustion
LNB	Low NO_x burner
LPG	Liquefied petroleum gas
LWS	Lime/limestone wet scrubbing
MIR	Maximum incremental reactivity

NH_3	Ammonia
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
N_2O	Dinitrogen monoxide
O_3	Ozone
OBD	On-board diagnostic system
OFA	Over fire air combustion
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PF	Pulverized fuel
PFBC	Pressurized fluidized bed combustion
POCP	Photochemical ozone creation potential
POPs	Persistent organic pollutants
ppb	Parts per billion
ppmv	Parts per million by volume
PM	Particulate matter
PVC	Polyvinyl chloride
RAP	Reduced air preheat
RVP	Reid vapour pressure
SCR	Selective catalytic reduction
SDA	Spray dry absorption
SNCR	Selective non-catalytic reduction
SO_2	Sulphur dioxide
SO_3	Sulphur trioxide
SO_x	Sulphur oxides
SOMA	Sulphur oxides management area
STP	Standard temperature (0° C) and pressure (1.013×10^5 Pa)
TCDD	Tetrachlorodibenzodioxin
TE	Toxicity equivalents
THC	Total hydrocarbons
TOMA	Tropospheric ozone management area
UV	Ultraviolet
VOC	Volatile organic compound
WBB	Wet bottom boiler
WL	Wellman Lord process
WSA	Wet sulphuric acid catalytic process

INTRODUCTION

For 25 years the Convention on Long-range Transboundary Air Pollution has been one of the central means for protecting our environment in the UNECE region. Over this time it has served as a bridge between different political systems and as a factor of stability in years of political change. It has substantially contributed to the development of international environmental law and has created the essential framework for controlling and reducing the damage to human health and the environment caused by transboundary air pollution. It is a successful example of what can be achieved through intergovernmental cooperation.

This handbook brings together all of the major documents that have made the Convention what it is today. It also provides information on the current structure of the Convention and the status of the Convention and its protocols. It incorporates:

(i) The Convention and its protocols in full;
(ii) Ministerial statements and declarations, usually made at the time of adoption of protocols;
(iii) Important decisions of the Executive Body, such as those related to the establishment of mandates for bodies under the Convection;
(iv) The structure of the Convention indicating subsidiary bodies and programme centres;
(v) Lists of Parties and Signatories to the Convention and its protocols.

THE CONVENTION

The history of the Convention can be traced back to the 1960s, when scientists demonstrated the link between sulphur emissions in continental Europe and the acidification of Scandinavian lakes. The 1972 United Nations Conference on the Human Environment held in Stockholm marked the start of active international cooperation to combat acidification. Between 1972 and 1977 several studies confirmed the hypothesis that air pollutants could travel several thousands of kilometres before deposition and damage occurred. This also implied that cooperation at the international level was necessary to solve problems such as acidification.

In response to these acute problems, a high-level ministerial meeting on the protection of the environment was held within the framework of UNECE in November 1979 in Geneva. It resulted in the signature of the Convention on Long-range Transboundary Air Pollution by 34 Governments and the European Community. The Convention was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. Besides laying down the general principles of international cooperation for air pollution abatement, the Convention set up an institutional framework bringing together research and policy.

Over the past 25 years the Convention has developed its scientific base through its Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and through the International Cooperative Programmes of its Working Group on Effects. Cooperation with the World Health Organization, more recently through the joint Task Force on the Health Aspects of Air Pollution, has provided the Convention with the necessary information on human health effects. In addition, technical bodies under the Convention have developed information and databases on the technologies available for emissions controls. All this scientific and technical information has been used to underpin the negotiation of agreements as well as the consideration of the review of existing agreements and the general development of abatement strategies, largely the remit of the Convention's Working Group on Strategies and Review. (See section XIII for the structure of the Convention.)

In the past 10 years some agreements (protocols) under the Convention and discussions related to their review have focused upon effects-based approaches. For this the Convention has drawn upon its three core areas of scientific and technical work – effects, atmospheric modelling and integrated assessment modelling (IAM). IAM has provided the key to bringing together knowledge on emissions, on the movement of pollutants between countries, on the effects of pollutants on people and the environment and on the technology to control emissions. For emissions of sulphur, nitrogen and volatile organic compounds, IAM has calculated national emission cuts that optimize spending against the environmental benefits achieved from emission controls.

THE PROTOCOLS

The Convention on Long-range Transboundary Air Pollution, ratified as of 1 October 2004 by 49 Parties, has, since its entry into force in 1983, been extended by eight specific protocols:

(i) The 1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), which entered into force on 28 January 1988;
(ii) The 1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, which entered into force on 2 September 1987;
(iii) The 1988 Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, which entered into force on 14 February 1991;
(iv) The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, which entered into force on 29 September 1997;
(v) The 1994 Protocol on Further Reduction of Sulphur Emissions, which entered into force on 5 August 1998;
(vi) The 1998 Protocol on Persistent Organic Pollutants, which entered into force on 23 October 2003;
(vii) The 1998 Protocol on Heavy Metals, which entered into force on 29 December 2003;
(viii) The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, which has not yet entered into force.

ACTIVITIES UNDER THE CONVENTION

At its seventeenth session in 1999 the Convention's Executive Body agreed (decision 1999/2, ECE/EB.AIR/68, annex III) that its priorities for the next few years would be:

(i) Review and extension of existing protocols;
(ii) Implementation of and compliance with existing agreements.

Since then technical preparations for the reviews of the most recent protocols have continued and, now that they have entered into force or are about to do so, the formal review processes are being initiated. These will rely much on the expertise of national experts and the programme centres of the Convention's technical bodies, though ultimately decisions on the reviews and any proposed extensions will be negotiated and decided upon by the Parties to the respective instruments.

To promote effective implementation of the Convention's protocols, the Executive Body for the Convention established an Implementation Committee to consider the activities of Parties in meeting their obligations under the Convention and its protocols. Instances of non-compliance are drawn to the attention of the Executive Body and Parties in non-compliance are encouraged to take action to meet their obligations.

SECRETARIAT

As stipulated in article 11 of the Convention, the Executive Secretary of the Economic Commission for Europe provides the secretariat for the Executive Body of the Convention. It does so within the UNECE Environment and Human Settlements Division.

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SECTION I

1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

The Parties to the present Convention,

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

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

Recognizing the contribution of the Economic Commission for Europe to the multilateral implementation of the pertinent provisions of the Final Act of the Conference on Security and Cooperation in Europe,

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

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

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

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

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

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

Have agreed as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Convention:

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

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

FUNDAMENTAL PRINCIPLES

Article 2:

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

Article 3:

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

Article 4:

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

Article 5:

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

Article 6: AIR QUALITY MANAGEMENT

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

Article 7: ***RESEARCH AND DEVELOPMENT***

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

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

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

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

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

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

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

Article 8: ***EXCHANGE OF INFORMATION***

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

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

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

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

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

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

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

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

Article 9: *IMPLEMENTATION AND FURTHER DEVELOPMENT OF THE COOPERATIVE PROGRAMME FOR THE MONITORING AND EVALUATION OF THE LONG-RANGE TRANSMISSION OF AIR POLLUTNATS IN EUROPE*

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

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

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

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

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

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

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

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

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

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

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

Article 10: EXECUTIVE BODY

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

2. The Executive Body shall:

(a) Review the implementation of the present Convention;

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

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

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

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

Article 11: SECRETARIAT

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

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

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

(c) To discharge the functions assigned by the Executive Body.

Article 12: AMENDMENTS TO THE CONVENTION

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

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

3. An amendment to the present Convention shall be adopted by consensus of the representatives of the Contracting Parties, and shall enter into force for the Contracting Parties which have accepted it on the ninetieth day after the date on which two-thirds of the Contracting Parties have deposited their

instruments of acceptance with the depositary. Thereafter, the amendment shall enter into force for any other Contracting Party on the ninetieth day after the date on which that Contracting Party deposits its instrument of acceptance of the amendment.

Article 13: ***SETTLEMENT OF DISPUTES***

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

Article 14: ***SIGNATURE***

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

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

Article 15: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

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

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

Article 16: ***ENTRY INTO FORCE***

1. The present Convention shall enter into force on the ninetieth day after the date of deposit of the twenty-fourth instrument of ratification, acceptance, approval or accession.

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

Article 17: WITHDRAWAL

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

Article 18: AUTHENTIC TEXTS

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

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

DONE at Geneva, this thirteenth day of November, one thousand nine hundred and seventy-nine.

SECTION II

1984 PROTOCOL ON LONG-TERM FINANCING OF THE COOPERATIVE PROGRAMME FOR MONITORING AND EVALUATION OF THE LONG-RANGE TRANSMISSION OF AIR POLLUTANTS IN EUROPE

(EMEP)

1984 PROTOCOL ON LONG-TERM FINANCING OF THE COOPERATIVE PROGRAMME FOR MONITORING AND EVALUATION OF THE LONG-RANGE TRANSMISSION OF AIR POLLUTANTS IN EUROPE (EMEP)

The Contracting Parties,

Recalling that the Convention on Long-range Transboundary Air Pollution (hereinafter referred to as "the Convention") entered into force on 16 March 1983,

Aware of the importance of the "Cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe" (hereinafter referred to as EMEP), as provided for in Articles 9 and 10 of the Convention,

Cognizant of the positive results achieved so far in the implementation of EMEP,

Recognizing that the implementation of EMEP has hitherto been made possible by financial means provided by the United Nations Environment Programme (UNEP) and by voluntary contributions from Governments,

Bearing in mind that since the UNEP contribution will continue only until the end of 1984, and that since this contribution together with the voluntary contributions from Governments have been inadequate to support fully the EMEP work plan, it will therefore be necessary to provide for long-term funding after 1984,

Considering the appeal of the Economic Commission for Europe to ECE member Governments, contained in its decision B (XXXVIII), to make available, on a basis to be agreed at the first meeting of the Executive Body for the Convention (hereinafter referred to as the "Executive Body"), the financial resources to enable the Executive Body to carry out its activities, in particular as regards the work of EMEP,

Noting that the Convention does not contain any provisions for financing EMEP and that it is, therefore, necessary to make appropriate arrangements regarding this matter,

Considering the elements to guide the drafting of a formal instrument supplementing the Convention, as listed in recommendations adopted by the Executive Body at its first session (7-10 June 1983),

Have agreed as follows:

Article 1: *DEFINITIONS*

For the purposes of the present Protocol:

1. "UN assessment rate" means a Contracting Party's rate for the financial year in question in the scale of assessments for the apportionment of the expenses of the United Nations.

2. "Financial year" means the financial year of the United Nations; and "annual basis" and "annual costs" shall be construed accordingly.

3. "General Trust Fund" means the General Trust Fund for the Financing of the Implementation of the Convention on Long-range Transboundary Air Pollution, which has been established by the Secretary-General of the United Nations.

4. "Geographical scope of EMEP" means the area within which, co-ordinated by the international centres of EMEP, [*] monitoring is carried out.

Article 2: ***FINANCING OF EMEP***

The financing of EMEP shall cover the annual costs of the international centres cooperating within EMEP for the activities appearing in the work programme of the Steering Body of EMEP.

Article 3: ***CONTRIBUTIONS***

1. In accordance with the provisions of this article the financing of EMEP shall consist of mandatory contributions, supplemented by voluntary contributions. Contributions may be made in convertible currency, non-convertible currency, or in kind.

2. Mandatory contributions shall be made on an annual basis by all Contracting Parties to the present Protocol which are within the geographical scope of EMEP.

3. Voluntary contributions may be made by the Contracting Parties or Signatories to the present Protocol, even if their territory lies outside the geographical scope of EMEP, as well as, subject to approval by the Executive Body, on the recommendation of the Steering Body of EMEP, by any other country, organization or individual which wishes to contribute to the work programme.

4. The annual costs of the work programme shall be covered by the mandatory contributions. Contributions in cash and in kind, such as those provided by host countries for international centres, shall be specified in the work programme. Voluntary contributions may, subject to the approval by the Executive Body, on the recommendation of the Steering Body, be utilized either for reducing the mandatory contributions or for financing specific activities within the scope of EMEP.

5. Mandatory and voluntary contributions in cash shall be deposited in the General Trust Fund.

Article 4: ***SHARING OF COSTS***

1. Mandatory contributions shall be made in accordance with the terms of the Annex to the present Protocol.

2. The Executive Body shall consider the need to amend the Annex:

(a) If the annual budget of EMEP increases by a factor of two and a half times the level of the annual budget adopted for the year of entry into force of the present Protocol or for the year of last amendment of the Annex, whichever is later; or
(b) If the Executive Body, on the recommendation of the Steering Body, designates a new international centre; or
(c) Six years after the entry into force of the present Protocol, or six years after last amendment to the Annex, whichever is later.

3. Amendments to the annex shall be adopted by consensus of the Executive Body.

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[*] The international centres are at present: the Chemical Co-ordinating Centre, the Meteorological Synthesizing Centre-East and the Meteorological Synthesizing Centre-West.

Article 5: ***ANNUAL BUDGET***

An annual budget for EMEP shall be drawn up by the Steering Body of EMEP, and shall be adopted by the Executive Body not later than one year in advance of the financial year to which it applies.

Article 6: ***AMENDMENTS TO THE PROTOCOL***

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

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

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

Article 7: ***SETTLEMENT OF DISPUTES***

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

Article 8: ***SIGNATURE***

1. The present Protocol shall be open for signature at the United Nations Office in Geneva from 28 September 1984 until 5 October 1984 inclusive, then at the Headquarters of the United Nations in New York until 4 April 1985, by the member States of the Economic Commission for Europe as well as States having consultative status with the Economic Commission for Europe, pursuant to paragraph 8 of Economic and Social Council resolution 36(IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Economic Commission for Europe, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the present Protocol, provided that the States and organizations concerned are parties to the Convention.

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

Article 9: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 5 October 1984 by the States and Organizations referred to in Article 8, paragraph 1.

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

Article 10: ENTRY INTO FORCE

1. The present Protocol shall enter into force on the ninetieth day following the date on which:

(a) Instruments of ratification, acceptance, approval or accession have been deposited by at least nineteen States and Organizations referred to in article 8 paragraph 1 which are within the geographical scope of EMEP; and

(b) The aggregate of the UN assessment rates for such States and Organizations exceeds forty per cent.

2. For each State and Organization referred to in article 8, paragraph 1, which ratifies, accepts or approves the present protocol or accedes thereto after the requirements for entry into force laid down in paragraph 1 above have been met, the Protocol shall enter into force on the ninetieth day after the date of deposit by such State or Organization of its instrument of ratification, acceptance, approval or accession.

Article 11: WITHDRAWAL

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

2. Withdrawal shall not affect the financial obligations of the withdrawing Party until the date on which the withdrawal takes effect.

Article 12: AUTHENTIC TEXTS

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

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

DONE at Geneva, this twenty-eighth day of September one thousand nine hundred and eighty-four.

Annex referred to in article 4 of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

*Mandatory contributions for sharing of costs for financing the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), shall, from 2004 onwards, be calculated according to the following scale: **

Parties	EMEP scale of contributions (%)
Belarus	0.0442
Bosnia and Herzegovina	0.0093
Bulgaria	0.0303
Canada	voluntary
Croatia	0.0908
Cyprus	0.0885
Czech Republic	0.4727
Estonia	0.0233
Hungary	0.2794
Latvia	0.0233
Liechtenstein	0.0140
Malta	0.0349
Monaco	0.0093
Norway	1.5041
Poland	0.8801
Romania	0.1350
Russian Federation	2.7940
Serbia and Montenegro	0.0466
Slovakia	0.1001
Slovenia	0.1886
Switzerland	2.9663
Turkey	1.0245
Ukraine	0.1234
United States	voluntary
Austria	2.2050
Belgium	2.6287
Denmark	1.7439
Finland	1.2154
France	15.0552
Germany	22.7457
Greece	1.2550
Ireland	0.6845
Italy	11.7926
Luxembourg	0.1863
Netherlands	4.0467
Portugal	1.0757
Spain	5.8646
Sweden	2.3906
United Kingdom	12.8898
European Community	3.3376
Total	100.0000

* The order in which the Contracting Parties are listed in this annex is specifically made in relation to the cost-sharing system agreed upon by the Executive Body for the Convention. Accordingly, the listing is a feature which is specific to the Protocol on the Financing of EMEP.

SECTION III

1985 PROTOCOL ON THE REDUCTION OF SULPHUR EMISSIONS OR THEIR TRANSBOUNDARY FLUXES BY AT LEAST 30 PER CENT

1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent

The Parties,

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

Concerned that the present emissions of air pollutants are causing widespread damage, in exposed parts of Europe and North America, to natural resources of vital environmental and economic importance, such as forests, soils and waters, and to materials (including historical monuments) and, under certain circumstances, have harmful effects on human health,

Aware of the fact that the predominant sources of air pollution contributing to the acidification of the environment are the combustion of fossil fuels for energy production, and the main technological processes in various industrial sectors, as well as transport, which lead to emissions of sulphur dioxide, nitrogen oxides, and other pollutants,

Considering that high priority should be given to reducing sulphur emissions, which will have positive results environmentally, on the overall economic situation and on human health,

Recalling the decision of the United Nations Economic Commission for Europe (ECE) at its thirty-ninth session, which stresses the urgency of intensifying efforts to arrive at coordinated national strategies and policies in the ECE region to reduce sulphur emissions effectively at national levels,

Recalling the recognition by the Executive Body for the Convention at its first session of the need to decrease effectively the total annual emissions of sulphur compounds or their transboundary fluxes by 1993-1995, using 1980 levels as the basis for calculations of reductions,

Recalling that the Multilateral Conference on the Causes and Prevention of Damage to Forests and Water by Air Pollution in Europe (Munich, 24-27 June 1984) had requested that the Executive Body for the Convention, as a matter of highest priority, adopt a proposal for a specific agreement on the reduction of annual national sulphur emissions or their transboundary fluxes by 1993 at the latest,

Noting that a number of Contracting Parties to the Convention have decided to implement reductions of their national annual sulphur emissions or their transboundary fluxes by at least 30 per cent as soon as possible and at the latest by 1993, using 1980 levels as the basis for calculation of reductions,

Recognizing, on the other hand, that some Contracting Parties to the Convention, while not signing the present Protocol at the time of its opening for signature, will nevertheless contribute significantly to the reduction of transboundary air pollution, or will continue to make efforts to control sulphur emissions, as stated in the document annexed to the report of the Executive Body at its third session,

Have agreed as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Protocol,

1. "Convention" means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. "Executive Body" means the Executive Body for the Convention constituted under article 10, paragraph 1 of the Convention;

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

5. "Parties" means, unless the context otherwise requires, the Parties to the present Protocol.

Article 2: ***BASIC PROVISIONS***

The Parties shall reduce their national annual sulphur emissions or their transboundary fluxes by at least 30 per cent as soon as possible and at the latest by 1993, using 1980 levels as the basis for calculation of reductions.

Article 3: ***FURTHER REDUCTIONS***

The Parties recognize the need for each of them to study at the national level the necessity for further reductions, beyond those referred to in article 2, of sulphur emissions or their transboundary fluxes when environmental conditions warrant.

Article 4: ***REPORTING OF ANNUAL EMISSIONS***

Each Party shall provide annually to the Executive Body its levels of national annual sulphur emissions, and the basis upon which they have been calculated.

Article 5: ***CALCULATIONS OF TRANSBOUNDARY FLUXES***

EMEP shall in good time before the annual meetings of the Executive Body provide to the Executive Body calculations of sulphur budgets and also of transboundary fluxes and depositions of sulphur compounds for each previous year within the geographical scope of EMEP, utilizing appropriate models. In areas outside the geographical scope of EMEP, models appropriate to the particular circumstances of Parties therein shall be used.

Article 6: ***NATIONAL PROGRAMMES, POLICIES AND STRATEGIES***

The Parties shall, within the framework of the Convention, develop without undue delay national programmes, policies and strategies which shall serve as a means of reducing sulphur emissions or their transboundary fluxes, by at least 30 per cent as soon as possible and at the latest by 1993, and shall report thereon as well as on progress towards achieving the goal to the Executive Body.

Article 7: AMENDMENTS TO THE PROTOCOL

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

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

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

Article 8: SETTLEMENT OF DISPUTES

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

Article 9: SIGNATURE

1. The present Protocol shall be open for signature at Helsinki (Finland) from 8 July 1985 until 12 July 1985 inclusive, by the member States of the Economic Commission for Europe as well as States having consultative status with the Economic Commission for Europe, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Economic Commission for Europe, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the present Protocol, provided that the States and organizations concerned are Parties to the Convention.

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

Article 10: RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION

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

2. The present Protocol shall be open for accession as from 13 July 1985 by the States and organizations referred to in article 9, paragraph 1.

3. A State or organization acceding to the present Protocol after its entry into force shall implement Article 2 at the latest by 1993. However, if the Protocol is acceded to after 1990, Article 2 may be

implemented later than 1993 by the Party concerned but not later than 1995, and such a Party shall implement Article 6 correspondingly.

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

Article 11: ENTRY INTO FORCE

1. The present Protocol shall enter into force on the ninetieth day following the date on which the sixteenth instrument of ratification, acceptance, approval or accession has been deposited.

2. For each State and organization referred to in article 9, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval, or accession, the Protocol shall enter into force on the ninetieth day after the date of deposit by such Party of its instrument of ratification, acceptance, approval, or accession.

Article 12: WITHDRAWAL

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

Article 13: AUTHENTIC TEXTS

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

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

DONE at Helsinki this eighth day of July one thousand nine hundred and eighty-five.

SECTION IV

1988 PROTOCOL CONCERNING THE CONTROL OF EMISSIONS OF NITROGEN OXIDES OR THEIR TRANSBOUNDARY FLUXES

1988 PROTOCOL CONCERNING THE CONTROL OF EMISSIONS OF NITROGEN OXIDES OR THEIR TRANSBOUNDARY FLUXES

The Parties,

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

Concerned that present emissions of air pollutants are causing damage, in exposed parts of Europe and North America, to natural resources of vital environmental and economic importance,

Recalling that the Executive Body for the Convention recognized at its second session the need to reduce effectively the total annual emissions of nitrogen oxides from stationary and mobile sources or their transboundary fluxes by 1995, and the need on the part of other States that had already made progress in reducing these emissions to maintain and review their emission standards for nitrogen oxides,

Taking into consideration existing scientific and technical data on emissions, atmospheric movements and effects on the environment of nitrogen oxides and their secondary products, as well as on control technologies,

Conscious that the adverse environmental effects of emissions of nitrogen oxides vary among countries,

Determined to take effective action to control and reduce national annual emissions of nitrogen oxides or their transboundary fluxes by, in particular, the application of appropriate national emission standards to new mobile and major new stationary sources and the retrofitting of existing major stationary sources,

Recognizing that scientific and technical knowledge of these matters is developing and that it will be necessary to take such developments into account when reviewing the operation of this Protocol and deciding on further action,

Noting that the elaboration of an approach based on critical loads is aimed at the establishment of an effect-oriented scientific basis to be taken into account when reviewing the operation of this Protocol and at deciding on further internationally agreed measures to limit and reduce emissions of nitrogen oxides or their transboundary fluxes,

Recognizing that the expeditious consideration of procedures to create more favourable conditions for exchange of technology will contribute to the effective reduction of emissions of nitrogen oxides in the region of the Commission,

Noting with appreciation the mutual commitment undertaken by several countries to implement immediate and substantial reductions of national annual emissions of nitrogen oxides,

Acknowledging the measures already taken by some countries which have had the effect of reducing emissions of nitrogen oxides,

Have agreed as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Protocol,

1. "Convention" means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. "Executive Body" means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

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

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

6. "Commission" means the United Nations Economic Commission for Europe;

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

8. "Major existing stationary source" means any existing stationary source the thermal input of which is at least 100 MW;

9. "Major new stationary source" means any new stationary source the thermal input of which is at least 50 MW;

10. "Major source category" means any category of sources which emit or may emit air pollutants in the form of nitrogen oxides, including the categories described in the Technical Annex, and which contribute at least 10 per cent of the total national emissions of nitrogen oxides on an annual basis as measured or calculated in the first calendar year after the date of entry into force of the present Protocol, and every fourth year thereafter;

11. "New stationary source" means any stationary source the construction or substantial modification of which is commenced after the expiration of two years from the date of entry into force of this Protocol;

12. "New mobile source" means a motor vehicle or other mobile source which is manufactured after the expiration of two years from the date of entry into force of the present Protocol.

Article 2: ***BASIC OBLIGATIONS***

1. The Parties shall, as soon as possible and as a first step, take effective measures to control and/or reduce their national annual emissions of nitrogen oxides or their transboundary fluxes so that these, at the latest by 31 December 1994, do not exceed their national annual emissions of nitrogen oxides or

transboundary fluxes of such emissions for the calendar year 1987 or any previous year to be specified upon signature of, or accession to, the Protocol, provided that in addition, with respect to any Party specifying such a previous year, its national average annual transboundary fluxes or national average annual emissions of nitrogen oxides for the period from 1 January 1987 to 1 January 1996 do not exceed its transboundary fluxes or national emissions for the calendar year 1987.

2. Furthermore, the Parties shall in particular, and no later than two years after the date of entry into force of the present Protocol:

(a) Apply national emissions standards to major new stationary sources and/or source categories, and to substantially modified stationary sources in major source categories, based on the best available technologies which are economically feasible, taking into consideration the Technical Annex;

(b) Apply national emission standards to new mobile sources in all major source categories based on the best available technologies which are economically feasible, taking into consideration the Technical Annex and the relevant decisions taken within the framework of the Inland Transport Committee of the Commission; and

(c) Introduce pollution control measures for major existing stationary sources, taking into consideration the Technical Annex and the characteristics of the plant, its age and its rate of utilization and the need to avoid undue operational disruption.

3. *(a)* The Parties shall, as a second step, commence negotiations, no later than six months after the date of entry into force of the present Protocol, on further steps to reduce national annual emissions of nitrogen oxides or transboundary fluxes of such emissions, taking into account the best available scientific and technological developments, internationally accepted critical loads and other elements resulting from the work programme undertaken under article 6;

(b) To this end, the Parties shall cooperate in order to establish:

(i) Critical loads;
(ii) Reductions in national annual emissions of nitrogen oxides or transboundary fluxes of such emissions as required to achieve agreed objectives based on critical loads; and
(iii) Measures and a timetable commencing no later than 1 January 1996 for achieving such reductions.

4. Parties may take more stringent measures than those required by the present article.

Article 3: ***EXCHANGE OF TECHNOLOGY***

1. The Parties shall, consistent with their national laws, regulations and practices, facilitate the exchange of technology to reduce emissions of nitrogen oxides, particularly through the promotion of:

(a) Commercial exchange of available technology;

(b) Direct industrial contacts and cooperation, including joint ventures;

(c) Exchange of information and experience; and

(d) Provision of technical assistance.

2. In promoting the activities specified in subparagraphs (a) to (d) above, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

3. The Parties shall, no later than six months after the date of entry into force of the present Protocol, commence consideration of procedures to create more favourable conditions for the exchange of technology to reduce emissions of nitrogen oxides.

Article 4: ***UNLEADED FUEL***

The Parties shall, as soon as possible and no later than two years after the date of entry into force of the present Protocol, make unleaded fuel sufficiently available, in particular cases as a minimum along main international transit routes, to facilitate the circulation of vehicles equipped with catalytic converters.

Article 5: ***REVIEW PROCESS***

1. The Parties shall regularly review the present Protocol, taking into account the best available scientific substantiation and technological development.

2. The first review shall take place no later than one year after the date of entry into force of the present Protocol.

Article 6: ***WORK TO BE UNDERTAKEN***

The Parties shall give high priority to research and monitoring related to the development and application of an approach based on critical loads to determine, on a scientific basis, necessary reductions in emissions of nitrogen oxides. The Parties shall, in particular, through national research programmes, in the work plan of the Executive Body and through other cooperative programmes within the framework of the Convention, seek to:

(a) Identify and quantify effects of emissions of nitrogen oxides on humans, plant and animal life, waters, soils and materials, taking into account the impact on these of nitrogen oxides from sources other than atmospheric deposition;

(b) Determine the geographical distribution of sensitive areas;

(c) Develop measurements and model calculations including harmonized methodologies for the calculation of emissions, to quantify the long-range transport of nitrogen oxides and related pollutants;

(d) Improve estimates of the performance and costs of technologies for control of emissions of nitrogen oxides and record the development of improved and new technologies; and

(e) Develop, in the context of an approach based on critical loads, methods to integrate scientific, technical and economic data in order to determine appropriate control strategies.

Article 7: *NATIONAL PROGRAMMES, POLICIES AND STRATEGIES*

The Parties shall develop without undue delay national programmes, policies and strategies to implement the obligations under the present Protocol that shall serve as a means of controlling and reducing emissions of nitrogen oxides or their transboundary fluxes.

Article 8: *INFORMATION EXCHANGE AND ANNUAL REPORTING*

1. The Parties shall exchange information by notifying the Executive Body of the national programmes, policies and strategies that they develop in accordance with article 7 and by reporting to it annually on progress achieved under, and any changes to, those programmes, policies and strategies, and in particular on:

(a) The levels of national annual emissions of nitrogen oxides and the basis upon which they have been calculated;

(b) Progress in applying national emission standards required under article 2, subparagraphs 2 (a) and 2 (b), and the national emission standards applied or to be applied, and the sources and/or source categories concerned;

(c) Progress in introducing the pollution control measures required under article 2, subparagraph 2 (c), the sources concerned and the measures introduced or to be introduced;

(d) Progress in making unleaded fuel available;

(e) Measures taken to facilitate the exchange of technology; and

(f) Progress in establishing critical loads.

2. Such information shall, as far as possible, be submitted in accordance with a uniform reporting framework.

Article 9: *CALCULATIONS*

EMEP shall, utilizing appropriate models and in good time before the annual meetings of the Executive Body, provide to the Executive Body calculations of nitrogen budgets and also of transboundary fluxes and deposition of nitrogen oxides within the geographical scope of EMEP. In areas outside the geographical scope of EMEP, models appropriate to the particular circumstances of Parties to the Convention therein shall be used.

Article 10: *TECHNICAL ANNEX*

The Technical Annex to the present Protocol is recommendatory in character. It shall form an integral part of the Protocol.

Article 11: ***AMENDMENTS TO THE PROTOCOL***

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

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

3. Amendments to the Protocol, other than amendments to its Technical Annex, shall be adopted by consensus of the Parties present at a meeting of the Executive Body, and shall enter into force for the Parties which have accepted them on the ninetieth day after the date on which two thirds of the Parties have deposited their instruments of acceptance thereof. Amendments shall enter into force for any Party which has accepted them after two thirds of the Parties have deposited their instruments of acceptance of the amendment, on the ninetieth day after the date on which that Party deposited its instrument of acceptance of the amendments.

4. Amendments to the Technical Annex shall be adopted by consensus of the Parties present at a meeting of the Executive Body and shall become effective thirty days after the date on which they have been communicated in accordance with paragraph 5 below.

5. Amendments under paragraphs 3 and 4 above shall, as soon as possible after their adoption, be communicated by the Executive Secretary to all Parties.

Article 12: ***SETTLEMENT OF DISPUTES***

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

Article 13: ***SIGNATURE***

1. The present Protocol shall be open for signature at Sofia from 1 November 1988 until 4 November 1988 inclusive, then at the Headquarters of the United Nations in New York until 5 May 1989, by the member States of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organizations concerned are Parties to the Convention.

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

Article 14: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 6 May 1989 by the States and organizations referred to in article 13, paragraph 1.

3. A State or organization which accedes to the present Protocol after 31 December 1993 may implement articles 2 and 4 no later than 31 December 1995.

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

Article 15: ***ENTRY INTO FORCE***

1. The present Protocol shall enter into force on the ninetieth day following the date on which the sixteenth instrument of ratification, acceptance, approval or accession has been deposited.

2. For each State and organization referred to in article 13, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval, or accession, the Protocol shall enter into force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval, or accession.

Article 16: ***WITHDRAWAL***

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

Article 17: ***AUTHENTIC TEXTS***

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

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

DONE at Sofia this thirty-first day of October one thousand nine hundred and eighty-eight.

TECHNICAL ANNEX

1. The purpose of this annex is to provide guidance to the Parties to the Convention in identifying NO_x control options and techniques in the implementation of their obligations under the Protocol.

2. It is based on information on options and techniques for NO_x emission reduction and their performance and costs contained in official documentation of the Executive Body and its subsidiary bodies; and in documentation of the ECE Inland Transport Committee and its subsidiary bodies; and on supplementary information provided by governmentally designated experts.

3. The annex addresses the control of NO_x emissions considered as the sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2 and lists a number of NO_x reduction measures and techniques spanning a wide range of costs and efficiencies. Unless otherwise indicated these techniques are considered to be well established on the basis of substantial operating experience, which in most cases has been gained over five years or more. It cannot, however, be considered as an exhaustive statement of control options; its aim is to provide guidance to Parties in identifying best available technologies which are economically feasible as a basis for national emission standards and in the introduction of pollution control measures.

4. The choice of pollution control measures for any particular case will depend on a number of factors, including the relevant legislative and regulatory provisions, primary energy pattern, industrial infrastructure and economic circumstances of the Party concerned and, in the case of stationary sources, the specific circumstances of the plant. It should be borne in mind also that sources of NO_x are often sources of other pollutants as well, such as sulphur oxides (SO_x), volatile organic compounds (VOCs), and particulates. In the design of control options for such sources, all polluting emissions should be considered together in order to maximize the overall abatement effect and minimize the impact of the source on the environment.

5. The annex reflects the state of knowledge and experience of NO_x control measures, including retrofitting, which has been achieved by 1992, in the case of stationary sources, and by 1994 in the case of mobile sources. As this knowledge and this experience continuously expand, particularly with new vehicles incorporating low-emission technology and the development of alternative fuels, as well as with retrofitting and other strategies for existing vehicles, the annex needs to be updated and amended regularly.

I. CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM STATIONARY SOURCES

6. Fossil fuel combustion is the main source of anthropogenic NO_x emissions from stationary sources. In addition, some non-combustion processes may contribute considerably to the emissions. The major stationary source categories of NO_x emissions, based on EMEP/CORINAIR 90, include:

(a) Public power, cogeneration and district heating plants:
  (i) Boilers;
  (ii) Stationary combustion turbines and internal combustion engines;

(b) Commercial, institutional and residential combustion plants:
  (i) Commercial boilers;
  (ii) Domestic heaters;

(c) Industrial combustion plants and processes with combustion:
  (i) Boilers and process heaters (no direct contact between flue gas and products);

(ii) Processes (direct contact); (e.g. calcination processes in rotary kilns, production of cement, lime, etc., glass production, metallurgical operation, pulp production);

(d) Non-combustion processes, e.g. nitric acid production;

(e) Extraction, processing and distribution of fossil fuels;

(f) Waste treatment and disposal, e.g. incineration of municipal and industrial waste.

7. For the ECE region, combustion processes (categories (a), (b), (c)), account for 85% of NO_x emissions from stationary sources. Non-combustion processes, e.g. production processes, account for 12%, and extraction, processing and distribution of fossil fuels for 3% of total NO_x emissions. Although in many ECE countries, power plants in category (a) are the largest stationary contributor to NO_x emissions, road traffic is usually the largest single overall source of NO_x emissions, but the distribution does vary between Parties to the Convention. Furthermore, industrial sources should be kept in mind.

GENERAL OPTIONS FOR REDUCING NO_X EMISSIONS FROM COMBUSTION

8. General options for NO_x reduction are:

(a) Energy management measures:[1/]
  (i) Energy saving;
  (ii) Energy mix;

(b) Technical options:
  (i) Fuel switching/cleaning;
  (ii) Other combustion technologies;
  (iii) Process and combustion modifications;
  (iv) Flue gas treatment.

9. To achieve the most efficient NO_x reduction programme, beyond the measures listed in (a), a combination of technical options identified in (b) should be considered. Furthermore, the combination of combustion modification and flue gas treatment needs site specific evaluation.

10. In some cases, options for reducing NO_x emissions may also result in the reduction of emissions of CO_2 and SO_2 and other pollutants.

Energy saving

11. The rational use of energy (improved energy efficiency/process operation, cogeneration and/or demand-side management) usually results in a reduction in NO_x emissions.

Energy mix

12. In general, NO_x emissions can be reduced by increasing the proportion of non-combustion energy sources (i.e. hydro, nuclear, wind, etc.) to the energy mix. However, further environmental impacts have to be considered.

[1/] Options (a) (i) and (ii) are integrated in the energy structure/policy of a Party. Implementation status, efficiency and costs per sector are not considered here.

Fuel switching/cleaning

13. Table I shows the uncontrolled NO_x emission levels to be expected during fossil fuel combustion for the different sectors.

14. Fuel switching (e.g. from high- to low-nitrogen fuels or from coal to gas) can lead to lower NO_x emissions but there may be certain restrictions, such as the availability of low NO_x emitting fuels (e.g. natural gas on plant level) and adaptability of existing furnaces to different fuels. In many ECE countries, some coal or oil combustion plants are being replaced by gas-fired combustion plants.

15. Fuel cleaning for fuel nitrogen removal is not a commercial option. Increasing the application of cracking technology in refineries, however, also brings about a reduction in the nitrogen content of the end-product.

Other combustion technologies

16. These are combustion technologies with improved thermal efficiency and reduced NO_x emissions. They include:

(a) Cogeneration using gas turbines and engines;

(b) Fluidized bed combustion (FBC): bubbling (BFBC) and circulating (CFBC);

(c) Integrated gasification combined cycle (IGCC);

(d) Combined cycle gas turbines (CCGT).

17. The emission levels for these techniques are summarized in table I.

18. Stationary combustion turbines can also be integrated into existing conventional power plants (known as topping). The overall efficiency can increase by 5% to 6%, but achievable NO_x reduction will depend on site and fuel specific conditions. Gas turbines and gas engines are widely applied in cogeneration applications. Typically some 30% energy saving can be attained. Both have made significant progress in reducing NO_x emissions through new concepts in combustion and system technology. However, major alterations to the existing boiler system become necessary.

19. FBC is a combustion technology for burning hard coal and brown coal but it can also burn other solid fuels such as petroleum coke and low-grade fuels such as waste, peat and wood. In addition, emissions can be reduced by integrated combustion control in the system. A newer concept of FBC is pressurized fluidized bed combustion (PFBC) presently being commercialized for the generation of electricity and heat. The total installed capacity of FBC has approached approximately 30,000 MW_{th} (250 to 350 plants), including 8,000 MW_{th} in the capacity range of > 50 MW_{th}.

20. The IGCC process incorporates coal gasification and combined cycle power generation, in a gas and steam turbine. The gasified coal is burned in the combustion chamber of the gas turbine. The technology also exists for heavy oil residue and bitumen emulsion. The installed capacity is presently about 1,000 MW_{el} (5 plants).

21. Combined cycle gas power stations using advanced gas turbines with an energy efficiency of 48%-52% and with reduced NO_x emissions are currently being planned.

Process and combustion modifications

22. These are measures applied during combustion to reduce the formation of NO_x. They include the control of combustion air ratio, flame temperature, fuel to air ratio, etc. The following combustion techniques, either singly or in combination, are available for new and existing installations. They are widely implemented in the power plant sector and in some areas of the industrial sector:

(a) Low excess air combustion (LEA)[2/];
(b) Reduced air preheat (RAP)[2/];
(c) Burner-out-of-service (BOOS)[2/];
(d) Biased-burner-firing (BBF)[2/];
(e) Low NO_x burners (LNB)[2/, 3/];
(f) Flue gas recirculation (FGR)[3/];
(g) Over fire air combustion (OFA)[2/, 3/];
(h) In-furnace-NO_x-reduction reburning (IFNR)[4/];
(i) Water/steam injection and lean/premixed combination[5/].

23. The emission levels due to the application of these techniques are summarized in table I (based mainly on experience in power plants).

24. Combustion modifications have been under continuous development and optimization. In-furnace-NO_x-reduction is being tested in some large-scale demonstration plants, whereas basic combustion modifications are incorporated mainly into boiler and burner design. For example, modern furnace designs incorporate OFA ports, and gas/oil burners are equipped for flue gas recirculation. The latest generation of LNBs combines both air-staging and fuel-staging. A remarkable increase in full-scale retrofit of combustion modifications in ECE member countries has been recorded in the last years. By 1992 a total of about 150,000 MW was installed.

Flue gas treatment processes

25. Flue gas treatment processes aim at removing already formed NO_x and are also referred to as secondary measures. Wherever possible it is usual to apply primary measures as a first stage of NO_x reduction before applying flue gas treatment processes. The state-of-the-art flue gas treatment processes are all based on the removal of NO_x by dry chemical processes.

26. They are the following:

(a) Selective Catalytic Reduction (SCR);

(b) Selective Non-catalytic Reduction (SNCR);

(c) Combined NO_x/SO_x removal processes:
    (i) Activated Carbon Process (AC);
    (ii) Combined catalytic NO_x/SO_x removal.

27. The emission levels for SCR and SNCR are summarized in table I. Data are based on the practical experience gathered from a large number of implemented plants. By 1991 in the European part

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[2/] Typical retrofit measures, with limited efficiency and applicability.
[3/] State-of-the-art in new plants.
[4/] Implemented in single large commercial plants; operational experience still limited.
[5/] For combustion turbines.

of the ECE about 130 SCR plants corresponding to 50,000 MW_{el}, 12 SNCR installations (2,000 MW_{el}), 1 AC plant (250 MW_{el}) and 2 combined catalytic processes (400 MW_{el}) were erected. The NO_x removal efficiency of AC and combined catalytic processes are similar to SCR.

28. Table I also summarizes the costs of applying the NO_x abatement technologies.

CONTROL TECHNIQUES FOR OTHER SECTORS

29. Unlike most combustion processes, the application of combustion and/or process modifications in the industrial sector has many process specific limitations. In cement kilns or glass melting furnaces, for example, certain high temperatures are necessary to ensure the product quality. Typical combustion modifications being used are staged combustion/low NO_x burners, flue gas recirculation and process optimization (e.g. precalcination in cement kilns).

30. Some examples are given in table I.

SIDE-EFFECTS/BY-PRODUCTS

31. The following side-effects will not prevent the implementation of any technology or method, but should be considered when several NO_x abatement options are possible. However, in general, these side-effects can be limited by proper design and operation:

(a) Combustion modifications:
- Possible decrease in overall efficiency;
- Increased CO formation and hydrocarbon emissions;
- Corrosion due to reducing atmosphere;
- Possible N_20 formation in FBC systems;
- Possible increase of carbon fly ash;

(b) SCR:
- NH_3 on the fly ash;
- Formation of ammonium salts on downstream facilities;
- Deactivation of catalyst;
- Increased conversion of SO_2 to SO_3;

(c) SNCR:
- Increased NH_3 slip
- NH_3 on the fly ash;
- Formation of ammonium salts on downstream facilities;
- Possible formation of N_20.

32. Generally, existing NO_x reduction technologies do not produce environmentally harmful by-products. The only direct by-products are spent catalysts, for which various recycling options based on grinding these are available. There is no need to dispose of the crushed fraction, which is of high quality, as it can be used as an additive in the production of new catalysts, ceramics or building material. Due to the long lifetime of catalysts (low activity loss), the amount of spent catalysts is low. The main problem is the ammonia slip.

33. In high-dust SCR facilities the by-product most affected by ammonia slip is fly ash. Fly ash can be utilized for its characteristic applications, if given quality requirements concerning maximum loads of ammonia in the fly ash for the specific application are fulfilled exactly. Otherwise dumping of the charge is in general inevitable due to the prohibitive processing costs.

34. In low-dust SCR facilities the ammonia slip may have an influence on the by-product from the flue gas desulphurization (FGD) installation. Especially for the marketable by-products gypsum, sulphur and pure sulphuric acid, an excessive ammonia slip may lead to problems in maintaining quality standards.

35. The ammonia slip may react with sulphur trioxide to form corrosive layers of ammonium sulphate on downstream facilities. The amount of by-products resulting from removing these layers by means of periodical cleaning is very small, so processing to secondary raw material is uneconomical and they are generally dumped. In general, problems with ammonia can be avoided if the ammonia slip is below 3 mg/m^3, or 50 mg/kg of NH_3 on the fly ash, which can be met easily with SCR systems. However, with SNCR systems the NH_3 slip may be significantly higher. In this case the direct utilization of fly ash is not possible.

MONITORING AND REPORTING

36. The measures taken to carry out national strategies and policies for the abatement of air pollution include legislation and regulatory provisions, economic incentives and disincentives, as well as technological requirements (best available technology).

37. In general emission limiting standards may be set per emission source according to plant size, operating mode, combustion technology, fuel type and whether it is a new or existing plant. An alternative approach also used is to set a target for the reduction of total NO_x emissions from a group of existing sources and to allow the Parties to choose where to take action to reach this target (bubble concept).

38. The limiting of the NO_x emissions to the levels set out in the national framework legislation has to be controlled by a permanent monitoring and reporting system and reported to the supervising authorities.

39. Several monitoring systems, using both continuous and discontinuous measurement methods, are available. However quality requirements vary among Parties. Measurements are to be carried out by qualified institutes and approved measuring/monitoring systems. To this end a certification system would provide the best assurance.

40. In the framework of modern automated monitoring systems and process control equipment, reporting creates no problems. The collection of data for further use is a state-of-the-art technique. However, data to be reported to competent authorities differ from Party to Party. To obtain better comparability, data sets and prescribing regulations should be harmonized. Harmonization is also desirable for quality assurance of measuring/monitoring systems. This should be taken into account when comparing data from different Parties.

41. To avoid discrepancies and inconsistencies, key issues and parameters including the following, must be well-defined:

- Definition of the standards expressed as ppmv, mg/m^3, g/GJ, kg/h or kg/t of products. Most of these units need to be calculated and need specification in terms of gas temperature, humidity, pressure, oxygen content or heat input value;

- Definition of time over which standards may be averaged, expressed as hours, months or a year;

- Definition of failure times and corresponding emergency regulations regarding bypass of monitoring systems or shut-down of the installation;

- Definition of methods for backfilling of data missed or lost as a result of equipment failure;

- Definition of the parameter set to be measured. Depending on the type of industrial process, the necessary information may differ. This also involves the location of the measurement point within the system.

42. Quality control of measurements must be ensured.

II. CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM MOBILE SOURCES

MAJOR NO_X EMITTERS FROM MOBILE SOURCES

43. Primary mobile sources of anthropogenic NO_x emissions include:

Road vehicles:
- Petrol-fuelled and diesel-fuelled passenger cars;
- Light commercial vehicles;
- Heavy-duty vehicles (HDV);
- Motor cycles and mopeds;
- Tractors (agricultural and forestry).

Non-road engine applications:
- Agricultural, mobile industrial and construction machinery.

Other mobile sources:
- Rail transport;
- Ships and other marine craft;
- Aircraft.

44. Road transport is a major source of anthropogenic NO_x emission in many ECE countries, contributing up to two thirds of the total national emissions. Current petrol-fuelled vehicles contribute up to two thirds of total national road NO_x emissions. In a few cases, however, the NO_x emissions from HDV traffic will exceed the decreasing emissions from passenger cars.

45. Many countries have enacted regulations that limit the emission of pollutants from road vehicles. For non-road applications, emission standards including NO_x have been enacted by some ECE countries and are under preparation in the ECE itself. NO_x emissions from these other sources may be substantial.

46. Until other data become available this annex concentrates on road vehicles only.

GENERAL ASPECTS OF CONTROL TECHNOLOGY FOR NO_X EMISSIONS FROM ON-ROAD VEHICLES

47. The road vehicles considered in this annex are passenger cars, light commercial vehicles, motor cycles, mopeds and heavy-duty vehicles.

48. This annex deals with both new and in-use vehicles, with the attention primarily focused on NO_x emission control for new vehicle types.

49. Cost figures for the various technologies given are expected production costs rather than retail prices.

50. It is important to ensure that new-vehicle emission standards are maintained in service. This can be done through inspection and maintenance programmes, ensuring conformity of production, full useful-life durability, warranty of emission-control components, and recall of defective vehicles.

51. Fiscal incentives can encourage the accelerated introduction of desirable technology. Retrofit is of limited benefit for NO_x reduction, and may be difficult to apply to more than a small percentage of the vehicle fleet.

52. Technologies that incorporate catalytic converters with spark-ignited petrol engines require the use of unleaded fuel, which should be made generally available. The use of after-treatment technologies in diesel engines like oxidation catalysts or particulate traps requires the use of low-sulphur fuels (maximum 0.05% S content).

53. The management of urban and long-distance traffic, though not elaborated in this annex, is important as an efficient additional approach to reducing emissions including NO_x. Measures to reduce NO_x emissions and other air pollutants may include enforcement of speed limits and efficient traffic management. Key measures for traffic management aim at changing the modal split of public and long-range transport especially in sensitive areas like cities or the Alps by transferring transport from road to rail through tactical, structural, financial and restrictive elements and also by optimizing the logistics of the delivery systems. They will also be beneficial for other harmful effects of traffic expansion such as noise, congestion, etc.

54. A variety of technologies and design options are available making simultaneous control of different pollutants possible. For some applications reverse effects have been experienced when reducing NO_x emissions (e.g. non-catalyst petrol or diesel engines). This may change with the employment of new technologies (e.g. after-treatment cleaning devices and electronics). Reformulated diesel fuel and fuel containing post-combustion NO_x reducing additives may also have a role in a strategy to combat diesel vehicle NO_x.

CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM ROAD VEHICLES

Petrol- and diesel-fuelled passenger cars and light commercial vehicles

55. The main technologies for controlling NO_x emissions are listed in table II.

56. The basis for comparison in table II is technology option B, representing non-catalytic technology designed in response to the requirements of the United States for 1973/74 or of ECE Regulation 15-04[6/] pursuant to the 1958 Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts. The table also presents typical emission levels for open- and closed-loop catalytic control as well as their cost.

57. The “uncontrolled” level (A) in table II refers to the 1970 situation in the ECE region, but may still prevail in certain areas.

[6/] Replaced by Regulation No. 83.

58. The emission level in table II reflects emissions measured with standard test procedures. Emissions from vehicles on the road may differ because of the effect of, inter alia, ambient temperature, operating conditions (especially at higher speed), fuel properties, and maintenance. However, the reduction potential indicated in table II is considered representative of reductions achievable in use.

59. The most efficient currently available technology for NO_x reduction is option E. This technology achieves large reductions of NO_x, volatile organic compounds (VOC), and CO emissions.

60. In response to regulatory programmes for further NO_x emission reductions (e.g. low-emission vehicles in California), advanced closed-loop three-way catalyst systems are being developed (option F). These improvements will focus on engine management, very precise control of air-fuel ratio, heavier catalyst loading, on-board diagnostic systems (OBD) and other advanced control measures.

Motor cycles and mopeds

61. Although actual NO_x emissions of motor cycles and mopeds are very low (e.g. with two-stroke engines), their NO_x emissions should be considered. While VOC emissions of these vehicles are going to be limited by many Parties to the Convention, their NO_x emissions may increase (e.g. with four-stroke engines). Generally the same technology options as described for petrol-fuelled passenger cars are applicable. In Austria and Switzerland strict NO_x emission standards are already implemented.

Heavy-duty diesel-fuelled vehicles

62. In table III three technology options are summarized. The baseline engine configuration is the turbocharged diesel engine. The trend is towards turbocharged engines with intercooling, advanced fuel injection systems and electronic control. This trend may have the potential to improve baseline fuel consumption performance. Comparative estimates of fuel consumption are not included.

CONTROL TECHNIQUES FOR IN-USE VEHICLES

Full useful life, recall and warranties

63. To promote durable emission-control systems, consideration should be given to emission standards that may not be exceeded for the "full useful life" of the vehicle. Surveillance programmes are needed to enforce this requirement. Under such programmes, manufacturers are responsible for recalling vehicles that fail to meet the required standards. To ensure that the owner has no production-related problems, manufacturers should provide warranties for emission-control components.

64. There should not be any devices to reduce the efficiency or switch off the emission control systems during any operating conditions except conditions, which are indispensable for trouble-free running (e.g. cold start).

Inspection and maintenance

65. The inspection and maintenance programme has an important secondary function. It may encourage regular maintenance and discourage vehicle owners from tampering with or disabling the emission controls, both through direct enforcement and public information. Inspection should verify that emission controls are in their original working order. It should also ensure that emission control systems have not been removed.

66. Improved monitoring of emission control performance can be achieved by on-board diagnostic systems (OBD) which monitor the functioning of emission control components, store fault codes for further interrogation and call the attention of the driver to ensure the repair in case of malfunction.

67. Inspection and maintenance programmes can be beneficial for all types of control technology by ensuring that new-vehicle emission levels are maintained. For catalyst-controlled vehicles it is essential to ensure that the new-vehicle specifications and settings are maintained to avoid deterioration of all major pollutants, including $NO_{x.}$

GENERAL ASPECTS OF CONTROL TECHNOLOGIES FOR OFF-ROAD VEHICLES AND MACHINES

68. This section of the technical annex considers all mobile or portable machines excluding passenger cars, light-duty vehicles, heavy-duty vehicles, motorcycles and mopeds. Emissions from ships and aircraft are discussed in the sections below. Examples of such vehicles and machinery include agricultural and forestry tractors, construction equipment, lawnmowers, chain-saws, etc.

69. NO_x emissions from off-road vehicles and machines are important and account for 10 to 20 per cent of national totals in the ECE region. Diesel-fuelled engines are the largest single source category. The proportion of emissions from off-road vehicles and machinery will increase as emissions from on-road vehicles and stationary sources are reduced.

70. Estimating emission rates from some off-road sources can be time-consuming when the information required to compile the inventory is lacking.

71. Substantial progress has been achieved in the development of diesel-engine, fuel and after-treatment technologies, making it possible to reduce NO_x emissions from off-road vehicles and machines at reasonable cost.

72. It is important to ensure that new engine-emission standards are maintained in service. This can be done through inspection and maintenance programmes, ensuring conformity of production, full useful-life durability, warranty of emission-control components, and recall of defective vehicles and machines.

73. Enforcement, maintenance and inspection programmes for off-road vehicles and machines will be more difficult to implement than for road vehicles.

74. Fiscal incentives can encourage the introduction of desirable, lower-emission technology.

CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM OFF-ROAD VEHICLES AND MACHINES

75. State-of-the-art control technology options for off-road diesel engines are: improved combustion chamber design, exhaust gas recirculation, electronic engine management, improved injection systems and turbocharging and intercooling.

76. Limit values for agricultural and forestry tractors and other off-road vehicle/machine engines are listed in table IV. Stage I is based on the ECE regulation 96 "Uniform provisions concerning the approval of compression - ignition (C.I.) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by engine". A second stage with lower emission limit values has also been proposed.

77. The limit values contained in table IV are based on lower-emission engine technology only. Vehicles which already comply with stage II are commercially available. However, if best available technology without exhaust gas after treatment is applied, the lower limit for diesel engine emissions is 3.5 g NO_x/kWh and 0.05 g particulate/kWh. Beyond these limits alternative-fuel engines or new after-treatment technologies will be required.

78. Many alternative fuels for diesel-engine applications have been proposed and investigated such as: methanol, ethanol, vegetable oils, compressed natural gas (CNG), liquefied petroleum gas (LPG), and dimethyl ether (DME). The last shows the lowest emission rates for NO_x and particulate matter. Highly reformulated diesel fuels, such as the Swedish Class I fuel, can bring about modest reductions in NO_x emissions of the order of 5-10%.

79. According to the estimates available from international organizations, the additional investment costs required to develop new engines which meet stage I and stage II emission limits are ECU 1400 and ECU 2600 for 1 tonne of abated pollutants (of which $^2/_3$ are NO_x emissions). Retail prices would increase by up to 3 per cent and up to 8 per cent for stage I and II respectively. In general, the marginal costs associated with developing new, cleaner engines are lower for larger engines.

GENERAL ASPECTS OF CONTROL TECHNOLOGY FOR NO_X EMISSIONS FROM SHIPS

80. The NO_x emission estimates from maritime activities are steadily growing and those from the North-East Atlantic alone are comparable to some larger countries' national totals. In some countries the emissions from inland waterways are also significant. Although maritime traffic emissions are dispersed over large areas, they contribute significantly to acidic deposition. National and international studies have clearly demonstrated the benefits of controlling marine NO_x sources as compared to other major NO_x source categories.

81. The location of emissions from shipping (with respect to sensitive areas) and their contribution to acidification should be taken into account when defining control areas.

82. Uncontrolled ship diesel engines generate the highest NO_x emissions per unit of energy used. If control measures are not applied to ships, their relative importance will grow within NO_x emission inventories as emissions from land-based sources are reduced progressively.

83. Reducing the sulphur content of fuel oil for ships has two possible benefits. The first is to reduce the direct impact of sulphur with respect to acidification. The second is to allow the use of cleaner, more environmentally sound engine technology and support the implementation of NO_x reduction after treatment.

84. Due to the long lifetime of ship engines, marine NO_x emissions will decrease by only one per cent per year, if NO_x control measures are applied only to new engines. In order to reduce emissions more rapidly, measures to reduce emissions should also be applied to existing engines.

85. Fiscal incentives can encourage the introduction of lower-emission technologies.

CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM SHIPS

86. The selected technologies for controlling NO_x emissions from diesel engines with a power output of more than 100 kW installed on ships are listed in table V. These include primary measures, after treatment, and fuel technology and relate to both existing and new engines. The control measures are economically feasible as their cost, depending on the measure, varies between ECU 0.5 and 2/kg of

reduced NO_x. Therefore, their implementation and in-service compliance may be viewed as a political issue. Key figures concerning marine selective catalytic reduction (SCR) are given in table VI.

87. The appropriate technology should be selected for each individual case. There is no universal solution.

88. Emissions of NO_x from small petrol engines (e.g. outboard motors) are less significant than those from diesel engines but are expected to increase as 4-stroke engines replace their 2-stroke counterparts in order to reduce volatile organic compound (VOC) emissions.

89. The survey of engines and control equipment applied in accordance with this annex shall be harmonized and conducted according to the technical guidance developed by a competent international organization, e.g. the International Maritime Organization (IMO).

GENERAL ASPECTS OF CONTROL TECHNOLOGY FOR NO_X EMISSIONS FROM AIRCRAFT

90. This section deals with all aircraft engines.

91. The limits on aircraft engine emissions of oxides of nitrogen as contained in Annex 16, volume II to the Convention on International Civil Aviation (the Chicago Convention) and as may be amended from time to time, may be used for controlling the NO_x emissions from turbo-jet and turbofan engines during landing and take-off (LTO) cycles within the Convention on Long-range Transboundary Air Pollution.

92. Only LTO emissions have so far been covered by the Convention on Long-range Transboundary Air Pollution with respect to emission inventories as part of national totals. Cruise emissions from domestic flights can also be considered as another part of national totals. Cruise level emissions may be more harmful. However, emission factors from the cruise phase are more uncertain than from LTO cycles.

93. Aircraft engines (other than turbo-jets and turbofans) and all aircraft with engines smaller than 26.7 kW/thrust are included in emission inventories but are not subject to international regulation at present. If they become subject to regulation, it should be borne in mind that an aircraft's lifetime is about 30 years and, therefore, new technology penetrates slowly. Retrofitting should therefore be considered when changing engines.

94. Fiscal incentives can encourage the introduction of lower-emission technology.

CONTROL TECHNOLOGIES FOR NO_X EMISSIONS FROM AIRCRAFT

95. State-of-the-art control technology for aircraft engine emissions encompasses fuel-air management optimization for existing engine types (NO_x reduction potential of 10-20 per cent) and two staged fuel combustion concepts for some medium to high-thrust subsonic aircraft engine types (NO_x reduction potential of 30-40 per cent), which are beginning to enter into service.

Other combustion concepts such as lean/premixed/prevaporized (LPP) and rich burn/quick mix/lean burn (RQL) are being investigated for application to a second generation of supersonic aircraft engines. The target is a cruise NO_X level of 5g/kg of fuel burnt, which corresponds to a reduction of at least 80% of NO_X as compared to conventional combustion. However, such engines are not expected to enter into service until at least 2006.

TABLE I

Energy source	**Uncontrolled Emissions**		**Process and Combustion Modifications**			**Flue Gas Treatment**					
						(a) Non-catalytic			**(b) Catalytic (after primary measures)**		
	mg/m^3 [1/]	**g/GJ [1/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**
Source category (i): Public power, cogeneration and district heating											
Boilers:											
Coal, WBB [4/]	1 500-2 200	530-770	1000-1800	350-630	3-25	no data		no data	< 200	< 70	50-100(125-200) [12/]
Coal, DBB [5/]	800-1 500	280-530	300-850	100-300	3-25	200-400	70-140	9-11	< 200	< 70	50-100(125-200) [12/]
Brown coal [5/]	450-750	189-315	190-300	80-126	30-40	< 200	< 84		< 200	< 85	80-100
Heavy oil [6/]	700-1 400	140-400	150-500	40-140	up to 20	175-250	50-70	6-8	< 150	< 40	50-70
Light oil [6/]	350-1 200	100-332	100-350	30-100	up to 20	no data		6-8	< 150	< 40	50-70
BE[14/]	800		no data		no data	no data					no data
Natural gas [6/]	150-600	40-170	50-200	15-60	3-20	no data		5-7	< 100	< 30	
FBC	200-700		180-400		1400-1600 [7/]	< 130			no data		
PFBC	150-200	50-70			1 100 [7/]	60			< 140	< 50	
IGCC [13/]	< 600		< 100						no data		
Gas turbines + CCGT: [13/, 18/]					**Investment Cost:**						
Natural gas	165-310	140-270	30-150	26-130	Dry: 50-100 ECU/kW$_{el}$	NA			20	17	
Diesel oil	235-430	230-370	50-200	45-175	Wet: 10-50 ECU/kW$_{el}$	NA			120-180	70	
IC Engines [4/]	4 800-6 300	1500-2000	320-640	100-200							
(natural gas < 1 MW$_{el}$)											
Source category (ii): Commercial, institutional and residential combustion plants											
Coal	110-500	40-175									
Brown coal	70-400	30-160									
Light oil	180-440	50-120	130-250	35-70							
Gas	140-290	40-80	60-150	16-40	2-10						
Wood [15/]	85-200	50-120	70-140	40-80							
Source category (iii): Industrial combustion plants and processes with combustion											
Industrial combustion plants:											
Coal, PF [8/]	600-2 200	200-770	up to 700	up to 245							
Coal, grates [3/]	150-600	50-200	up to 500	up to 175							
Brown coal	200-800	80-340									
Heavy oil [6/]	400-1 000	110-280	up to 650	up to 180							
Light oil [6/]	150-400	40-110	up to 250	up to 70							
Natural gas [6/]	100-300	30-80	up to 150	up to 42	2-10						

Energy source	**Uncontrolled Emissions**		**Process and Combustion Modifications**			**Flue Gas Treatment**					
						(a) Non-catalytic			**(b) Catalytic (after primary measures)**		
	mg/m^3 [1/]	**g/GJ [1/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**
Gas turbines + CCGT:[13/, 18/]					**Invest. Cost:**						
Natural gas	165-310	140-270	30-150	26-130	Dry: 50-100 ECU/kW$_{el}$	NA			20	17	
Diesel oil	235-430	200-370	50-200	45-175	Wet: 10-50 ECU/kW$_{el}$	NA			120-180	70	
FBC [8/]	100-700		100-600								
IC Engines (natural gas < 1 MW$_{el}$) [4/]	4800-6300	1500-2000	320-640	100-200							
Industrial processes:											
Calcination	1000-2000		500-800								
Glass:											
Plate glass		6 kg/t	500-2000						<500		
Containers		2.5 kg/t									
Fibreglass		0.5 kg/t									
Industrial		4.2 kg/t									
Metals:											
Sintering	300-500 [16/]	1.5 kg/t							<500		
Coke ovens	1 000	1 kg/t									
Baked carbon fuels	< 3 000										
Electric arc furnaces	50-200										
Paper and pulp:											
Black liquor	170 [17/]	(50-80 g/GJ)		(20-40 g/GJ)		60					13-20

Energy source	**Uncontrolled Emissions**		**Process and Combustion Modifications**			**Flue Gas Treatment**					
						(a) Non-catalytic			**(b) Catalytic (after primary measures)**		
	mg/m^3 [1/]	**kg/t [9/]**	**mg/m^3 [1/]**	**kg/t [9/]**	**ECU/t [2/]**	**mg/m^3 [1/]**	**kg/t**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**kg/t [9/]**	**ECU/kW$_{el}$ [2/]**
Source category (iv): Non-combustion processes											
Nitric acid:											
Low pressure (1-2.2 bar)	5 000	16.5									
Medium pressure (2.3-8 bar)	approx.1 000	3.3									
High pressure (8-15 bar)	< 380	< 1.25								0.01-0.8	
HOKO (-50 bar)	< 380	< 1.25									

Energy source	**Uncontrolled Emissions**		**Process and Combustion Modifications**			**Flue Gas Treatment**					
						(a) Non-catalytic			**(b) Catalytic (after primary measures)**		
	mg/m^3 [1/]	**kg/t [9/]**	**mg/m^3 [1/]**	**kg/t [9/]**	**ECU/t [2/]**	**mg/m^3 [1/]**	**kg/t**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**kg/t [9/]**	**ECU/kW$_{el}$ [2/]**
Pickling:											
Brass		25 [10/]									
Stainless steel		0.3									
Carbon steel		0.1									

Energy source	**Uncontrolled Emissions**		**Process and Combustion Modifications**			**Flue Gas Treatment**					
						(a) Non-catalytic			**(b) Catalytic (after primary measures)**		
	mg/m^3 [1/]	**g/GJ [1/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**	**mg/m^3 [1/]**	**g/GJ [1/]**	**ECU/kW$_{el}$ [2/]**
Source category (v): Extraction, processing and distribution of fossil fuels											
Refineries [5/]	~1 000		100-700								
Source category (vi): Waste treatment and disposal											
Incineration [11/]	250-500		200-400						< 100		

[1/] Emissions in mg/m^3 NO2 (STP dry) resp. g/GJ thermal input. Conversion factors (mg/m^3 to g/GJ) for NO_x emissions from coal (hard coal): 0.35, coal (lignite): 0.42, oil/gas: 0.277, peat: 0.5, wood + bark: 0.588 [1 g/GJ = 3.6 mg/kWh].

[2/] Total investments 1 ECU = 2 DM.

[3/] Reduction generally achieved in combination with primary measures. Reduction efficiency between 80 and 95 per cent.

[4/] At 5 per cent O_2.

[5/] At 6 per cent O_2..

[6/] At 3 per cent O_2..

[7/] Incl. costs for boiler.

[8/] At 7 per cent O_2.

[9/] Emissions from industrial processes are generally expressed as kg/t of product.

[10/] g/m^2 surface area.

[11/] At 11 per cent O_2.

[12/] Tail gas SCR configuration as opposed to high dust.

[13/] At 15 per cent O_2.

[14/] Bitumen emulsion.

[15/] Untreated wood only.

[16/] Heat recovery and gas recirculation.

[17/] For dry substance <75%.

[18/] With supplementary firing; approximate additional thermal NO_x: 0-20 g/GJ.

NA: not applicable

No data: technology applied, but no data available

TABLE II

Emission control technologies for petrol- and diesel-fuelled passenger cars and light commercial vehicles

Technology option	NO_x emission level (%)	Estimated additional production cost[1/] (US$)
Petrol-fuelled		
A. Uncontrolled situation	100	-
B. Engine modifications (engine design, carburation and ignition systems, air injection)	70	[2/]
C. Open-loop catalyst	50	150-200
D. Closed-loop three-way catalyst	25	250-450[3/]
E. Advanced closed-loop three-way catalyst	10	350-600[3/]
F. Californian low-emission vehicles (advanced option E)	6	>700[3/]
Diesel-fuelled		
G. Conventional indirect injection diesel engine	40	
H. Indirect injection engine with secondary injection, high injection pressures electronically controlled	30	1 000-1 200[4/]
I. Direct injection engine with turbocharging	50	1 000-1 200[4/]

Note: Options C, D, E, F require the use of unleaded petrol; options H and I require the use of low-sulphur diesel fuel.

1/ Per vehicle, relative to technology option B. NO_x requirements may have an effect on fuel prices and refinery production costs, but this is not included in the estimated additional production cost.

2/ Costs for engine modifications from options A to B are estimated at US$ 40-100.

3/ Under technology options D, E and F, CO and VOC emissions are also substantially reduced, in addition to NO_x reductions. Technology options B and C result also in CO and VOC control.

4/ Fuel consumption is reduced as compared to option G, while particulate emissions of technology option G are considerably higher.

TABLE III

Heavy-duty vehicle technologies, emission performance and costs

Technology option	NO_x emission level (%)	Expected additional production cost [1] (US$)
A. Turbocharged diesel engine (EURO I)	100	0
B. Turbocharged diesel engine with intercooling (EURO II)	85	1 500-3 000
C. Turbocharged diesel engine with intercooling, high pressure fuel injection, electronically controlled fuel pump, combustion chamber and port optimalization, exhaust gas recirculation (EGR)	50-60	3 000-6 000
D. Shift to spark ignition engine with three-way-catalytic converter working on LPG, CNG or oxygenated fuels	10-30	up to 10 000

Note: Option C requires the use of low-sulphur diesel fuel.

[1] Per vehicle, and depending on engine size relative to baseline technology A. NO_x requirements may have an effect on fuel prices and refinery production costs, but this is not included in the estimated additional production cost.

TABLE IV

Limit values (stage I) for agricultural and forestry tractors and other non-road mobile machine engines (ECE regulation 96)

Net power (P) (kW)	Carbon monoxide (CO) (g/kWh)	Oxides of nitrogen (NO_X) (g/kWh)	Particulates (PT) (g/kWh)
$130 \leq P < 560$	5	9.2	0.54
$75 \leq P < 130$	5	9.2	0.70
$37 \leq P < 75$	6.5	9.2	0.85

Note: The emissions of carbon monoxide, oxides of nitrogen and particulates obtained shall not exceed the amount shown in the table. These limits are engine-out limits and shall be achieved before any exhaust after-treatment device.

Limit values (stage II) for non-road mobile machine engines

Net power (P) (kW)	**Carbon monoxide (CO) (g/kWh)**	**Oxides of nitrogen (NO_X) (g/kWh)**	**Particulates (PT) (g/kWh)**
$130 \leq P < 560$	3.5	6.0	0.2
$75 \leq P < 130$	5.0	6.0	0.3
$37 \leq P < 75$	5.0	7.0	0.4
$18 \leq P < 37$	5.5	8.0	0.8

TABLE V

Evaluation of selected technologies to reduce NO_x emissions from ships with diesel engines

Measure	**NO_X-reduction**	**Remarks**	**Applicable to existing engines?**	**Availability**
Conventional (injection, swirl, etc.)	30%-40%	Penalty in specific fuel consumption and smoke	Conditionally yes	State of the art
Common-rail-injection	30%-40%		No	Under development
Heavy fuel oil-water emulsion	30%	Visible smoke reduction	Yes, but reduction in power output	Available
>10% EGR (exhaust gas recirculation)	10%-40%	Further development of high temperature filter and small penalty in specific fuel consumption	Conditionally yes	Under development
Direct water injection	25%-50%	Requires large amounts of clean water	No	Field testing
Humidified low temperature air intake	30%-60%	Sea water could be used	Yes	Under development
SCR (selective catalytic reduction)	>90%	Also reduces hydrocarbons	Yes	Available

TABLE VI

Marine SCR in combination with oxidation catalyst - Key figures (1995)

NO_X reduction	95-99% at 10-100% maximum continuous rating (MCR)
HC reduction	75-95% at 10-100% MCR
CO reduction	20-50% at 10-50% MCR
PM reduction	0-50% at 10-100% MCR

Noise reduction	>25 dB(A)
NH3 Slip	<5 ppmv at 95% NO_X reduction
Temp span	270-500°C (200°C)
Fuel	MDO, HFO (preferably low sulphur content 0.5-1.0%)

Weight	Silencer + 30%
Space	Same or smaller than Silencer (30 dB(A))
Cost	kUS$ 50-100/MW prime mover power
Operating cost	US$ 4/MWh (reagent and catalyst wear, etc.)
Total cost	US$ 1/kg NO_X (including capital cost)
Urea consumption	6 kg/MWh, at 10 g NO_X/kWh and 90% NO_X reduction
Urea solution	15 litre/MWh, at 40% solution
Typical lifetime	20 000-40 000h, before replacement of one catalyst layer

Note: The above-mentioned methods may be used in parallel to achieve the most cost-effective solution, i.e. matching of lower NO_x engines in combination with SCR technique decreases the need for NO_x-reducing agents.

SECTION V

1991 PROTOCOL ON THE CONTROL OF EMISSIONS OF VOLATILE ORGANIC COMPOUNDS OR THEIR TRANSBOUNDARY FLUXES

1991 PROTOCOL CONCERNING THE CONTROL OF EMISSIONS OF VOLATILE ORGANIC COMPOUNDS OR THEIR TRANSBOUNDARY FLUXES

The Parties,

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

Concerned that present emissions of volatile organic compounds (VOCs) and the resulting secondary photochemical oxidant products are causing damage, in exposed parts of Europe and North America, to natural resources of vital environmental and economic importance and, under certain exposure conditions, have harmful effects on human health,

Noting that under the Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, adopted in Sofia on 31 October 1988, there is already agreement to reduce emissions of oxides of nitrogen,

Recognizing the contribution of VOCs and nitrogen oxides to the formation of tropospheric ozone,

Recognizing also that VOCs, nitrogen oxides and resulting ozone are transported across international boundaries, affecting air quality in neighbouring States,

Aware that the mechanism of photochemical oxidant creation is such that the reduction of emissions of VOCs is necessary in order to reduce the incidence of photochemical oxidants,

Further aware that methane and carbon monoxide emitted by human activities are present at background levels in the air over the ECE region and contribute to the formation of episodic peak ozone levels; that, in addition, their global-scale oxidation in the presence of nitrogen oxides contributes to the formation of the background levels of tropospheric ozone upon which photochemical episodes are superimposed; and that methane is expected to become the subject of control actions in other forums,

Recalling that the Executive Body for the Convention identified at its sixth session the need to control emissions of VOCs or their transboundary fluxes, as well as to control the incidence of photochemical oxidants, and the need for Parties that had already reduced these emissions to maintain and review their emission standards for VOCs,

Acknowledging the measures already taken by some Parties which have had the effect of reducing their national annual emissions of nitrogen oxides and VOCs,

Noting that some Parties have set air quality standards and/or objectives for tropospheric ozone and that standards for tropospheric ozone concentrations have been set by the World Health Organization and other competent bodies,

Determined to take effective action to control and reduce national annual emissions of VOCs or the transboundary fluxes of VOCs and the resulting secondary photochemical oxidant products, in particular by applying appropriate national or international emission standards to new mobile and new stationary sources and retrofitting existing major stationary sources, and also by limiting the content of components in products for industrial and domestic use that have the potential to emit VOCs,

Conscious that volatile organic compounds differ greatly from each other in their reactivity and in their potential to create tropospheric ozone and other photochemical oxidants and that, for any individual compounds, potential may vary from time to time and from place to place depending on meteorological and other factors, *Recognizing* that such differences and variations should be taken into consideration if action to control and reduce emissions and transboundary fluxes of VOCs is to be as effective as possible in minimizing the formation of tropospheric ozone and other photochemical oxidants,

Taking into consideration existing scientific and technical data on emissions, atmospheric movements and effects on the environment of VOCs and photochemical oxidants, as well as on control technologies,

Recognizing that scientific and technical knowledge of these matters is developing and that it will be necessary to take such developments into account when reviewing the operation of the present Protocol and deciding on further action,

Noting that the elaboration of an approach based on critical levels is aimed at the establishment of an effect-oriented scientific basis to be taken into account when reviewing the operation of the present Protocol, and at deciding on further internationally agreed measures to limit and reduce emissions of VOCs or the transboundary fluxes of VOCs and photochemical oxidants,

Have agreed as follows:

Article 1: DEFINITIONS

For the purposes of the present Protocol,

1. "Convention" means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. "Executive Body" means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

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

5. "Tropospheric ozone management area" (TOMA) means an area specified in annex I under conditions laid down in article 2, paragraph 2 (b);

6. "Parties" means, unless the context otherwise requires, the Parties to the present Protocol;

7. "Commission" means the United Nations Economic Commission for Europe;

8. "Critical levels" means concentrations of pollutants in the atmosphere for a specified exposure time below which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials do not occur according to present knowledge;

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

10. "Major source category" means any category of sources which emit air pollutants in the form of VOCs, including the categories described in annexes II and III, and which contribute at least 1per cent of the total national emissions of VOCs on an annual basis, as measured or calculated in the first calendar year after the date of entry into force of the present Protocol, and every fourth year thereafter;

11. "New stationary source" means any stationary source of which the construction or substantial modification is commenced after the expiry of two years from the date of entry into force of the present Protocol;

12. "New mobile source" means any on-road motor vehicle which is manufactured after the expiry of two years from the date of entry into force of the present Protocol;

13. "Photochemical ozone creation potential" (POCP) means the potential of an individual VOC, relative to that of other VOCs, to form ozone by reaction with oxides of nitrogen in the presence of sunlight, as described in annex IV.

Article 2: **BASIC OBLIGATIONS**

1. The Parties shall control and reduce their emissions of VOCs in order to reduce their transboundary fluxes and the fluxes of the resulting secondary photochemical oxidant products so as to protect human health and the environment from adverse effects.

2. Each Party shall, in order to meet the requirements of paragraph 1 above, control and reduce its national annual emissions of VOCs or their transboundary fluxes in any one of the following ways to be specified upon signature:

(a) It shall, as soon as possible and as a first step, take effective measures to reduce its national annual emissions of VOCs by at least 30 per cent by the year 1999, using 1988 levels as a basis or any other annual level during the period 1984 to 1990, which it may specify upon signature of or accession to the present Protocol; or

(b) Where its annual emissions contribute to tropospheric ozone concentrations in areas under the jurisdiction of one or more other Parties, and such emissions originate only from areas under its jurisdiction that are specified as TOMAs in annex I, it shall, as soon as possible and as a first step, take effective measures to:

(i) Reduce its annual emissions of VOCs from the areas so specified by at least 30 per cent by the year 1999, using 1988 levels as a basis or any other annual level during the period 1984-1990, which it may specify upon signature of or accession to the present Protocol; and
(ii) Ensure that its total national annual emissions of VOCs by the year 1999 do not exceed the 1988 levels; or

(c) Where its national annual emissions of VOCs were in 1988 lower than 500,000 tonnes and 20 kg/inhabitant and 5 tonnes/km^2, it shall, as soon as possible and as a first step, take effective measures to ensure at least that at the latest by the year 1999 its national annual emissions of VOCs do not exceed the 1988 levels.

3. *(a)* Furthermore, no later than two years after the date of entry into force of the present Protocol, each Party shall:

(i) Apply appropriate national or international emission standards to new stationary sources based on the best available technologies which are economically feasible, taking into consideration annex II;
(ii) Apply national or international measures to products that contain solvents and promote the use of products that are low in or do not contain VOCs, taking into consideration annex II, including the labelling of products specifying their VOC content;
(iii) Apply appropriate national or international emission standards to new mobile sources based on the best available technologies which are economically feasible, taking into consideration annex III; and
(iv) Foster public participation in emission control programmes through public announcements, encouraging the best use of all modes of transportation and promoting traffic management schemes.

(b) Furthermore, no later than five years after the date of entry into force of the present Protocol, in those areas in which national or international tropospheric ozone standards are exceeded or where transboundary fluxes originate or are expected to originate, each Party shall:

(i) Apply the best available technologies that are economically feasible to existing stationary sources in major source categories, taking into consideration annex II;
(ii) Apply techniques to reduce VOC emissions from petrol distribution and motor vehicle refuelling operations, and to reduce volatility of petrol, taking into consideration annexes II and III.

4. In carrying out their obligations under this article, Parties are invited to give highest priority to reduction and control of emissions of substances with the greatest POCP, taking into consideration the information contained in annex IV.

5. In implementing the present Protocol, and in particular any product substitution measures, Parties shall take appropriate steps to ensure that toxic and carcinogenic VOCs, and those that harm the stratospheric ozone layer, are not substituted for other VOCs.

6. The Parties shall, as a second step, commence negotiations, no later than six months after the date of entry into force of the present Protocol, on further steps to reduce national annual emissions of volatile organic compounds or transboundary fluxes of such emissions and their resulting secondary photochemical oxidant products, taking into account the best available scientific and technological developments, scientifically determined critical levels and internationally accepted target levels, the role of nitrogen oxides in the formation of photochemical oxidants and other elements resulting from the work programme undertaken under article 5.

7. To this end, the Parties shall cooperate in order to establish:

(a) More detailed information on the individual VOCs and their POCP values;

(b) Critical levels for photochemical oxidants;

(c) Reductions in national annual emissions or transboundary fluxes of VOCs and their resulting secondary photochemical oxidant products, especially as required to achieve agreed objectives based on critical levels;

(d) Control strategies, such as economic instruments, to obtain overall cost-effectiveness to achieve agreed objectives;

(e) Measures and a timetable commencing no later than 1 January 2000 for achieving such reductions.

8. In the course of these negotiations, the Parties shall consider whether it would be appropriate for the purposes specified in paragraph 1 to supplement such further steps with measures to reduce methane.

Article 3: ***FURTHER MEASURES***

1. Measures required by the present Protocol shall not relieve Parties from their other obligations to take measures to reduce total gaseous emissions that may contribute significantly to climate change, to the formation of tropospheric background ozone or to the depletion of stratospheric ozone, or that are toxic or carcinogenic.

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

3. The Parties shall establish a mechanism for monitoring compliance with the present Protocol. As a first step based on information provided pursuant to article 8 or other information, any Party which has reason to believe that another Party is acting or has acted in a manner inconsistent with its obligations under this Protocol may inform the Executive Body to that effect and, simultaneously, the Parties concerned. At the request of any Party, the matter may be taken up at the next meeting of the Executive Body.

Article 4: ***EXCHANGE OF TECHNOLOGY***

1. The Parties shall, consistent with their national laws, regulations and practices, facilitate the exchange of technology to reduce emissions of VOCs, particularly through the promotion of:

(a) The commercial exchange of available technology;

(b) Direct industrial contacts and cooperation, including joint ventures;

(c) The exchange of information and experience;

(d) The provision of technical assistance.

2. In promoting the activities specified in paragraph 1 of this article, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

3. The Parties shall, no later than six months after the date of entry into force of the present Protocol, commence consideration of procedures to create more favourable conditions for the exchange of technology to reduce emissions of VOCs.

Article 5: ***RESEARCH AND MONITORING TO BE UNDERTAKEN***

The Parties shall give high priority to research and monitoring related to the development and application of methods to achieve national or international tropospheric ozone standards and other goals to protect human health and the environment. The Parties shall, in particular, through national or international research programmes, in the work-plan of the Executive Body and through other cooperative programmes within the framework of the Convention, seek to:

(a) Identify and quantify effects of emissions of VOCs, both anthropogenic and biogenic, and photochemical oxidants on human health, the environment and materials;

(b) Determine the geographical distribution of sensitive areas;

(c) Develop emission and air quality monitoring and model calculations including methodologies for the calculation of emissions, taking into account, as far as possible, the different VOC species, both anthropogenic and biogenic, and their reactivity, to quantify the long-range transport of VOCs, both anthropogenic and biogenic, and related pollutants involved in the formation of photochemical oxidants;

(d) Improve estimates of the performance and costs of technologies for control of emissions of VOCs and record the development of improved and new technologies;

(e) Develop, within the context of the approach based on critical levels, methods to integrate scientific, technical and economic data in order to determine appropriate rational strategies for limiting VOC emissions and obtain overall cost-effectiveness to achieve agreed objectives;

(f) Improve the accuracy of inventories of emissions of VOCs, both anthropogenic and biogenic, and harmonize the methods of their calculation or estimation;

(g) Improve their understanding of the chemical processes involved in the creation of photochemical oxidants;

(h) Identify possible measures to reduce emissions of methane.

Article 6: REVIEW PROCESS

1. The Parties shall regularly review the present Protocol, taking into account the best available scientific substantiation and technological development.

2. The first review shall take place no later than one year after the date of entry into force of the present Protocol.

Article 7: NATIONAL PROGRAMME, POLICIES AND STRATEGIES

The Parties shall develop without undue delay national programmes, policies and strategies to implement the obligations under the present Protocol that shall serve as a means of controlling and reducing emissions of VOCs or their transboundary fluxes.

Article 8: INFORMATION EXCHANGE AND ANNUAL REPORTING

1. The Parties shall exchange information by notifying the Executive Body of the national programmes, policies and strategies that they develop in accordance with article 7, and by reporting to it progress achieved under, and any changes to, those programmes, policies and strategies. In the first year after entry into force of this Protocol, each Party shall report on the level of emissions of VOCs in its territory and any TOMA in its territory, by total and, to the extent feasible, by sector of origin and by

individual VOC, according to guidelines to be specified by the Executive Body for 1988 or any other year taken as the base year for article 2.2 and on the basis upon which these levels have been calculated.

2. Furthermore each Party shall report annually:

(a) On the matters specified in paragraph 1 for the previous calendar year, and on any revision which may be necessary to the reports already made for earlier years;

(b) On progress in applying national or international emission standards and the control techniques required under article 2, paragraph 3;

(c) On measures taken to facilitate the exchange of technology.

3. In addition, Parties within the geographical scope of EMEP shall report, at intervals to be specified by the Executive Body, information on VOC emissions by sector of origin, with a spatial resolution, to be specified by the Executive Body, appropriate for purposes of modelling the formation and transport of secondary photochemical oxidant products.

4. Such information shall, as far as possible, be submitted in accordance with a uniform reporting framework.

Article 9: CALCULATIONS

EMEP shall, utilizing appropriate models and measurements, provide to the annual meetings of the Executive Body relevant information on the long-range transport of ozone in Europe. In areas outside the geographical scope of EMEP, models appropriate to the particular circumstances of Parties to the Convention therein shall be used.

Article 10: ANNEXES

The annexes to the present Protocol shall form an integral part of the Protocol. Annex I is mandatory while annexes II, III and IV are recommendatory.

Article 11: AMENDMENTS TO THE PROTOCOL

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

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

3. Amendments to the Protocol, other than amendments to its annexes, shall be adopted by consensus of the Parties present at a meeting of the Executive Body, and shall enter into force for the Parties which have accepted them on the ninetieth day after the date on which two thirds of the Parties have deposited their instruments of acceptance thereof. Amendments shall enter into force for any Party which has accepted them after two thirds of the Parties have deposited their instruments of acceptance of the amendment, on the ninetieth day after the date on which that Party deposited its instrument of acceptance of the amendments.

4. Amendments to the annexes shall be adopted by consensus of the Parties present at a meeting of the Executive Body and shall become effective 30 days after the date on which they have been communicated, in accordance with paragraph 5 of this article.

5. Amendments under paragraphs 3 and 4 of this article shall, as soon as possible after their adoption, be communicated by the Executive Secretary to all Parties.

Article 12: SETTLEMENT OF DISPUTES

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

Article 13: SIGNATURE

1. The present Protocol shall be open for signature at Geneva from 18 November 1991 until 22 November 1991 inclusive, then at the United Nations Headquarters in New York until 22 May 1992, by the States members of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organizations concerned are Parties to the Convention.

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

Article 14: RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION

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

2. The present Protocol shall be open for accession as from 22 May 1992 by the States and organizations referred to in article 13, paragraph 1.

Article 15: DEPOSITARY

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

Article 16: ENTRY INTO FORCE

1. The present Protocol shall enter into force on the ninetieth day following the date on which the sixteenth instrument of ratification, acceptance, approval or accession has been deposited.

2. For each State and organization referred to in article 13, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of

ratification, acceptance, approval or accession, the Protocol shall enter into force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 17: WITHDRAWAL

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

Article 18: AUTHENTIC TEXTS

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

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

DONE at Geneva this eighteenth day of November one thousand nine hundred and ninety-one.

Annex I

DESIGNATED TROPOSPHERIC OZONE MANAGEMENT AREAS (TOMAS)

The following TOMAs are specified for the purposes of this Protocol:

Canada

TOMA No. 1: The Lower Fraser Valley in the Province of British Columbia.

This is a 16,800-km^2 area in the south-western corner of the Province of British Columbia averaging 80 km in width and extending 200 km up the Fraser River Valley from the mouth of the river in the Strait of Georgia to Boothroyd, British Columbia. Its southern boundary is the Canada/ United States international boundary and it includes the Greater Vancouver Regional District.

TOMA No. 2: The Windsor-Quebec Corridor in the Provinces of Ontario and Quebec.

This is a 157,000-km^2 area consisting of a strip of land 1,100 km long and averaging 140 km in width stretching from the City of Windsor (adjacent to Detroit in the United States) in the Province of Ontario to Quebec City in the Province of Quebec. The Windsor-Quebec Corridor TOMA is located along the north shore of the Great Lakes and the St. Lawrence River in Ontario and straddles the St. Lawrence River from the Ontario-Quebec border to Quebec City in Quebec. It includes the urban centres of Windsor, London, Hamilton, Toronto, Ottawa, Montreal, Trois-Rivières and Quebec City.

Norway

The total Norwegian mainland as well as the exclusive economic zone south of 62°N latitude in the region of the Economic Commission for Europe (ECE), covering an area of 466,000 km^2.

Annex II

CONTROL MEASURES FOR EMISSION OF VOLATILE ORGANIC COMPOUNDS (VOCS) FROM STATIONARY SOURCES

INTRODUCTION

1. The aim of this annex is to provide the Parties to the Convention with guidance in identifying best available technologies to enable them to meet the obligations of the Protocol.

2. Information regarding emission performance and costs is based on official documentation of the Executive Body and its subsidiary bodies, in particular documents received and reviewed by the Task Force on Emissions of VOCs from Stationary Sources. Unless otherwise indicated, the techniques listed are considered to be well established on the basis of operational experience.

3. Experience with new products and new plants incorporating low-emission techniques, as well as with the retrofitting of existing plants, is continuously growing; the regular elaboration and amendment of the annex will therefore be necessary. Best available technologies identified for new plants can be applied to existing plants after an adequate transition period.

4. The annex lists a number of measures spanning 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 any existing VOC control implemented.

5. This annex does not, in general, take into account the specific species of VOC emitted by the different sources, but deals with best available technologies for VOC reduction. When measures are planned for some sources, it is worthwhile to consider giving priority to those activities which emit reactive rather than non-reactive VOCs (e.g. in the solvent-using sector). However, when such compound-specific measures are designed, other effects on the environment (e.g. global climate change) and on human health should also be taken into account.

I. MAJOR SOURCES OF VOC EMISSIONS FROM STATIONARY SOURCES

6. The major sources of anthropogenic non-methane VOC emissions from stationary sources are the following:

(a) Use of solvents;
(b) Petroleum industry including petroleum-product handling;
(c) Organic chemical industry;
(d) Small-scale combustion sources (e.g. domestic heating and small industrial boilers);
(e) Food industry;
(f) Iron and steel industry;
(g) Handling and treatment of wastes;
(h) Agriculture.

7. The order of the list reflects the general importance of the sources subject to the uncertainties of emission inventories. The distribution of VOC emissions according to different sources depends greatly on the fields of activity within the territory of any particular Party.

II. GENERAL OPTIONS FOR VOC EMISSION REDUCTION

8. There are several possibilities for the control or prevention of VOC emissions. Measures for the reduction of VOC emissions focus on products and/or process modifications (including maintenance and operational control) and on the retrofitting of existing plants. The following list gives a general outline of measures available, which may be implemented either singly or in combination:

(a) Substitution of VOCs; e.g. the use of water-based degreasing baths, and paints, inks, glues or adhesives which are low in or do not contain VOCs;

(b) Reduction by best management practices such as good housekeeping, preventive maintenance programmes, or by changes in processes such as closed systems during utilization, storage and distribution of low-boiling organic liquids;

(c) Recycling and/or recovery of efficiently collected VOCs by control techniques such as adsorption, absorption, condensation and membrane processes; ideally, organic compounds can be reused on-site;

(d) Destruction of efficiently collected VOCs by control techniques such as thermal or catalytic incineration or biological treatment.

9. The monitoring of abatement procedures is necessary to ensure that appropriate control measures and practices are properly implemented for an effective reduction of VOC emissions. Monitoring of abatement procedures will include:

(a) The development of an inventory of those VOC-emission reduction measures, identified above, that have already been implemented;

(b) The characterization and quantification of VOC emissions from relevant sources by instrumental or other techniques;

(c) Periodic auditing of abatement measures implemented to ensure their continued efficient operation;

(d) Regularly scheduled reporting on (a), (b) and (c), using harmonized procedures, to regulatory authorities;

(e) Comparison, with the objectives of the Protocol, of VOC-emission reductions achieved in practice.

10. The investment/cost figures have been collected from various sources. On account of the many influencing factors, investment/cost figures are highly case-specific. If the unit "cost per tonne of VOC abated" is used for cost-efficient strategy considerations, it must be borne in mind that such specific figures are highly dependent on factors such as plant capacity, removal efficiency and raw gas VOC concentration, type of technology, and the choice of new installations as opposed to retrofitting. Illustrative cost figures should also be based on process-specific parameters, e.g. mg/m^2 treated (paints), kg/m^3 product or kg/unit.

11. Cost-efficient strategy considerations should be based on total costs per year (including capital and operational costs). VOC-emission reduction costs should also be considered within the framework of the overall process economics, e.g. the impact of control measures and costs on the costs of production.

III. CONTROL TECHNIQUES

12. The major categories of available control techniques for VOC abatement are summarized in table 1. Those techniques chosen for inclusion in the table have been successfully applied commercially and are now well established. For the most part, they have been applied generally across sectors.

13. Sector-specific techniques, including the limitation of the solvent content of products, are given in sections IV and V.

14. Care should be taken to ensure that the implementation of these control techniques does not create other environmental problems. If incineration has to be used, it should be combined with energy recovery, where appropriate.

15. Using such techniques, concentrations of below 150 mg/m^3 (as total carbon, standard conditions) can usually be achieved in exhaust air flows. In most cases, emission values of 10-50 mg/m^3 can be achieved.

16. Another common procedure for destroying non-halogenated VOCs is to use VOC-laden gas streams as secondary air or fuel in existing energy-conversion units. However, this usually requires site-specific process modifications and therefore it too is excluded from the following table.

17. Data on efficiency are derived from operational experience and are considered to reflect the capabilities of current installations.

18. Cost data are more subject to uncertainty due to interpretation of costs, accountancy practices and site-specific conditions. Therefore the data provided are case-specific. They cover the cost ranges for the different techniques. The costs do, however, accurately reflect the relationships between the costs of the different techniques. Differences in costs between new and retrofit applications may in some cases be significant but do not differ sufficiently to change the order in table I.

19. The choice of a control technique will depend on parameters such as the concentration of VOCs in the raw gas, gas volume flow, the type of VOCs, and others. Therefore, some overlap in the fields of application may occur; in that case, the most appropriate technique must be selected according to case-specific conditions.

TABLE I

A summary of available VOC control techniques, their efficiencies and costs

Technique	**Lower concentration in air flow**		**Higher concentration in air flow**		**Application**
	Efficiency	**Cost**	**Efficiency**	**Cost**	
Thermal incineration**	High	High	High	Medium	Wide for high concentration flows
Catalytic incineration**	High	Medium	Medium	Medium	More specialized for lower concentration flows
Adsorption (activated carbon filters)*	High	High	Medium	Medium	Wide for low concentration flows
Absorption (Waste gas washing)	-	-	High	Medium	Wide for high concentration flows

Technique	Lower concentration in air flow		Higher concentration in air flow		Application
Condensation*	-	-	Medium	Low	Special cases of high concentration flows only
Biofiltration	Medium to high	Low	Low***	Low	Mainly in low concentration flows, including odour control

Concentration:	Lower	<3 g/m^3 (in many cases <lg/m3);
	Higher	>5g/m^3
Efficiency:	High	>95%
	Medium	80-95%
	Low	<80%
Total cost:	High	>500 ECU/t VOC abated
	Medium	150-500 ECU/t VOC abated
	Low	<150 ECU/t VOC abated

* These processes can be combined with solvent recovery systems. Cost savings then ensue.
** Savings due to energy recovery are not included; these can reduce the costs considerably.
*** With buffering filters to dampen emission peaks, medium to high efficiencies are achieved at medium to low costs.

IV. SECTORS

20. In this section, each VOC-emitting sector is characterized by a table containing the main emission sources, control measures including the best available technologies, their specific reduction efficiency and the related costs.

21. An estimate is also provided of the overall potential within each sector for reducing its VOC emissions. The maximum reduction potential refers to situations in which only a low level of control is in place.

22. Process-specific reduction efficiencies should not be confused with the figures given for the reduction potential of each sector. The former are technical feasibilities, while the latter take into account the likely penetration and other factors affecting each sector. The process-specific efficiencies are given only qualitatively, as follows:

I = > 95 per cent; II = 80-95 per cent; III = < 80 per cent

23. Costs depend on capacity, site-specific factors, accountancy practices and other factors. Consequently, costs may vary greatly; therefore, only qualitative information (medium, low, high) is provided, referring to comparisons of costs of different technologies mentioned for specific applications.

A. *Industrial use of solvents*

24. The industrial use of solvents is in many countries the biggest contributor to VOC emissions from stationary sources. Main sectors and control measures, including best available technologies and reduction efficiencies, are listed in table II, and the best available technology is specified for each sector.

There may be differences between small and large or new and old plants. For this reason, the estimated overall reduction potential quoted is below the values implied in table II. The estimated overall reduction potential for this sector is up to 60 per cent. A further step to reduce episodic ozone formation potential can include the reformulation of the remaining solvents.

25. With respect to the industrial use of solvents, three approaches can in principle be used: a product-oriented approach which, for instance, leads to a reformulation of the product (paint, degreasing products, etc.); process-oriented changes; and add-on control technologies. For some industrial uses of solvents only a product-oriented approach is available (in the case of painting constructions, painting buildings, the industrial use of cleaning products, etc.). In all other cases, the product-oriented approach deserves priority, inter alia, because of the positive spin-off effects on the solvent emission of the manufacturing industry. Furthermore, the environmental impact of emissions can be reduced by combining best available technology with product reformulation to replace solvents by less harmful alternatives. According to a combined approach of this kind, the maximum emissions reduction potential of up to 60 per cent could lead to an improvement in environmental performance that is significantly higher.

26. There is rapid ongoing development towards low-solvent or solvent-free paints, which are among the most cost-effective solutions. For many plants, a combination of low-solvent and adsorption/incineration techniques are chosen. VOC-emission control for large-scale, industrial painting (e.g. of cars, domestic appliances) could be implemented relatively quickly. Emissions have been reduced as far as 60 g/m^2 in several countries. The technical possibility of reducing emissions from new plants to below 20 g/m^2 has been recognized by several countries.

27. For the degreasing of metal surfaces, alternative solutions are water-based treatment or closed machines with activated carbon for recovery, with low emissions.

28. For the different printing techniques, several methods to reduce VOC emissions are employed. These mainly involve the changing of inks, changes within the printing process using other printing methods, and gas cleaning techniques. Waterborne ink instead of solvent-based ink is used for flexographic printing on paper and is under development for printing on plastic. Waterborne inks for screen and rotogravure printing are available for some applications. The use of electron beam cured ink in offset eliminates VOCs and is used in the package printing industry. For some printing methods, UV-cured inks are available. Best available technology for publication rotogravure is the gas cleaning technique using carbon adsorbers. In packaging, the rotogravure recovery of solvent by adsorption (zeolites, active carbon) is practised, but incineration and absorption are also used. For heatset, the web offset thermal or catalytic incineration of exhaust gases is used. The incineration equipment often includes a unit for heat recovery.

TABLE II

VOC-emission control measures, reduction and efficiency and costs for the solvent-using sector

Source of emission	Emission control measures	Reduction efficiency	Abatement costs and savings
Industrial surface coating	Conversion to:		
	- powder paints	I	Savings
	- low in/not containing VOCs	I - III	Low costs
	- high solids	I - III	Savings
	Incineration:		
	- thermal	I - II	Medium to high costs
	- catalytic	I - II	Medium costs
	Activated carbon adsorption	I - II	Medium costs

Source of emission	**Emission control measures**	**Reduction efficiency**	**Abatement costs and savings**
Paper surface coating	Incinerator	I - II	Medium costs
	Radiation cure/waterborne inks	I - III	Low costs
Car manufacturing	Conversion to:		
	- powder paints	I	
	- water-based systems	I - II	Low costs
	- high solid coating	II	
	Activated carbon adsorption	I - II	Low costs
	Incineration with heat recovery:		
	- thermal	I - II	
	- catalytic	I - II	
Commercial painting	Low in/not containing VOCs	I - II	Medium costs
	Low in/not containing VOCs	II - III	Medium costs
Printing	Low-solvent/water-based inks	II - III	Medium costs
	Letterpress: radiation cure	I	Low costs
	Activated carbon adsorption	I - II	High costs
	Absorption		
	Incineration:	I - II	
	- thermal		
	- catalytic		
	Biofiltration including buffer filter	I	Medium costs
Metal degreasing	Change-over to systems low in/not containing VOCs		
	Closed machines		
	Activated carbon adsorption	II	Low to high costs
	Cover, chilled freeboards	III	Low costs
Dry-cleaning	Recovery dryers and good house-keeping (closed cycles)	II - III	Low to medium costs
	Condensation	II	Low costs
	Activated carbon adsorption	II	Low costs
Flat wood panelling	Coatings low in/not containing VOCs	I	Low costs

I = > 95 per cent; II = 80-95 per cent; III = < 80 per cent

29. For dry-cleaning, the best available technology consists of closed machines and treatment of the exhaust ventilation air by activated carbon filters.

B. *Petroleum industry*

30. The petroleum industry is one of the major contributors to VOC emissions from stationary sources. Emissions are from both refineries and distribution (including transportation and filling-stations). The following comments refer to table 3; the measures mentioned also include best available technology.

31. Refinery process emissions arise from fuel combustion, flaring of hydrocarbons, vacuum-system discharges and fugitive emissions from process units, such as flanges and connectors, opened lines and sampling systems. Other major VOC emissions within refineries and related activities result from storage, waste-water treatment processes, loading/discharging facilities such as harbours, truck- and railway-racks, pipeline terminals, and periodic operations such as shut-downs, servicing and start-ups (process-unit turnarounds).

32. Process-unit turnaround emissions may be controlled by venting vessel vapours to vapour recovery systems or controlled flaring.

33. Vacuum-system discharges may be controlled by condensation or by piping to boilers or heaters.

34. Fugitive emissions from process equipment in gas/vapour or light liquid service (e.g. automatic control valves, manual valves, pressure relief devices, sampling systems, pumps, compressors, flanges and connectors) can be reduced or prevented by regularly performing leak detection, repair programmes and preventive maintenance. Equipment with substantial leaks (e.g. valves, gaskets, seals, pumps, etc.) can be replaced by equipment that is more leakproof. For example, manual and automatic control valves can be changed for corresponding valves with bellow gaskets. Pumps in gas/vapour and light liquid service can be fitted with dual mechanical seals with controlled degassing vents. Compressors can be equipped with seals with a barrier fluid system that prevents leakage of the process fluid to the atmosphere, and leakage from compressors seals directed to the flares.

35. Pressure relief valves for media that may contain VOCs can be connected to a gas-collecting system and the gases collected burnt in process furnaces or flares.

TABLE III

VOC-emission control measures, reduction efficiency and costs for the petroleum industry

Source of emission	**Emission control measures**	**Reduction efficiency**	**Abatement costs and savings**
Petroleum refineries			
Fugitive emissions	Regular inspection and maintenance	III	Medium costs
Process-unit turnarounds	Flares/process furnace vapour recovery	I	Not available
Waste-water separator	Floating cover	II	Medium costs/savings
Vacuum process system	Surface contact condensers Non-condensable VOCs piped to heaters or furnaces	I	
Incineration of sludge	Thermal incineration	I	
Storage of crude oil and products			
Petrol	Internal floating roofs with secondary seals	I - II	Savings
	Floating roof tanks with secondary seals	II	Savings
Crude oil	Floating roof tanks with secondary seals	II	Savings
Petrol marketing terminals (loading and unloading of trucks, barges and trains)	Vapour recovery unit	I - II	Savings
Petrol service stations	Vapour balance on tank trucks (Stage I)	I - II	Low costs/savings
	Vapour balance during refuelling (refuelling nozzles) (Stage II)	I (- II**)	Medium costs*

I = > 95 per cent; II = 80-95 per cent; III = < 80 per cent.

* Depending on capacity (station size), retrofitting or new service stations.

** Will increase with increasing penetration of standardization of vehicle filling pipes.

36. VOC emissions from the storage of crude oil and products can be reduced by equipping fixed-roof tanks with internal floating roofs or by equipping floating-roof tanks with secondary seals.

37. VOC emissions from the storage of petrol and other light liquid components can be reduced by several means. Fixed-roof tanks can be equipped with internal floating roofs with primary and secondary seals or connected to a closed vent system and an effective control device, e.g. vapour

recovery, flaring or combustion in process heaters. External floating-roof tanks with primary seals can be equipped with secondary seals, and/or supplemented with tight, fixed roofs, with pressure relief valves which can be connected to the flare.

38. VOC emissions in connection with waste-water handling and treatment can be reduced by several means. Water-seal controls can be installed, as can junction boxes, equipped with tight-fitting covers, in drain systems. Sewer lines can be covered. Alternatively, the drain system can be completely closed to the atmosphere. Oil-water separators, including separation tanks, skimmers, weirs, grit chambers, sludge hoppers and slop-oil facilities, can be equipped with fixed roofs and closed vent systems that direct vapours to a control device, designed either for the recovery or destruction of the VOC vapours. Alternatively, oil-water separators can be equipped with floating roofs with primary and secondary seals. The effective reduction of VOC emissions from waste-water treatment plants can be achieved by draining oil from process equipment to the slop-oil system, thus minimizing the oil-flow into the waste-water treatment plant. The temperature of incoming water can also be controlled in order to lower emissions to the atmosphere.

39. The petrol storage and distribution sector has a high reduction potential. Emission control covering the loading of petrol at the refinery (via intermediate terminals) up to its discharge at petrol service stations is defined as Stage I; control of emissions from the refuelling of cars at service stations is defined as Stage II (see para. 33 of annex III on Control Measures for Emissions of Volatile Organic Compounds (VOCs) from on-road Motor Vehicles).

40. Stage I control consists of vapour balancing and vapour collection at the loading of petrol, and recovering the vapour in recovery units. Furthermore, vapour collected at service stations from the discharge of petrol from trucks can be returned and recovered in vapour recovery units.

41. Stage II control consists of vapour balancing between the vehicle fuel tank and the service station's underground storage tank.

42. Stage II together with Stage I is the best available technology for reducing evaporative emissions during petrol distribution. A complementary means of reducing VOC emissions from fuel storage and handling is to reduce fuel volatility.

43. The overall reduction potential in the petroleum industry sector is up to 80 per cent. This maximum could be reached only where the current level of emission control is low.

C. *Organic chemical industry*

44. The chemical industry also makes a considerable contribution to VOC emissions from stationary sources. The emissions are of different characters with a wide range of pollutants, because of the variety of products and production processes. Process emissions can be divided into the following major subcategories: reactor-process emissions, air-oxidation emissions and distillation, and other separation processes. Other significant emission sources are from leaks, storage and product transfer (loading/unloading).

45. For new plants, process modifications and/or new processes often reduce emissions considerably. So-called "add-on" or "end-of-pipe" techniques such as adsorption, absorption, thermal and catalytic incineration in many cases represent alternative or complementary technologies. To reduce evaporation losses from storage tanks and emissions from loading and unloading facilities, the control measures recommended for the petroleum industry (table 3) can be applied. Control measures including best available technologies and their process-related reduction efficiencies are given in table IV.

46. The feasible overall reduction potential in the organic chemical industry is up to 70 per cent, depending on the industry mix and the extent to which control technologies and practices are in place.

TABLE IV

VOC-emission control measures, reduction efficiency and costs for the organic chemical industry

Source of emission	**Emission control measures**	**Reduction efficiency**	**Abatement costs and savings**
Fugitive emissions	Leak detection and repair programme - regular inspection	III	Low costs
Storage and handling	- See table III		
	General measures:		
Process emissions	- carbon adsorption - incineration: - thermal - catalytic	I - II I - II I - II	n.a. Medium to high costs n.a.
	- absorption - biofiltration - flaring	n.a.	n.a. n.a.
- Formaldehyde production	- incineration: - thermal - catalytic	I I	High costs
- Polyethylene production	- flaring - catalytic incineration	I I - II	Medium costs
- Polystyrene production	- thermal incineration - flaring	I	Medium costs
	Process modifications (examples):		
-Vinyl chloride production	- substitution of air by oxygen in the oxychlorination step - flaring	II I	n.a. Medium costs
- Polyvinylchloride production	- slurry stripping of monomer -Nitro-2-methyl-l-propanol-1 absorption	II I	n.a. Savings
- Polypropylene production	- high yield catalyst	I	n.a.
- Ethylene oxide production	- substitution of air by oxygen	I	n.a.

I = > 95 per cent; II = 80-95 per cent; III = < 80 per cent
N. A. = not applicable

D. Stationary combustion

47. Optimal VOC-emission reduction from stationary combustion depends on the efficient use of fuel at the national level (table V). It is also important to ensure the effective combustion of fuel by the use of good operational procedures, efficient combustion appliances and advanced combustion-management systems.

48. For small systems in particular, there is still a considerable reduction potential, especially in the burning of solid fuels. VOC reduction in general is achievable by the replacement of old stoves/boilers and/or fuel-switching to gas. The replacement of single room stoves by central heating systems and/or the replacement of individual heating systems in general reduces pollution; however, overall energy efficiency has to be taken into account. Fuel-switching to gas is a very effective control measure, provided the distribution system is leakproof.

49. For most countries, the VOC-reduction potential for power plants is negligible. On account of the uncertain replacement/fuel-switch involved, no figures can be given regarding the overall reduction potential and the related costs.

TABLE V

VOC-emission control measures for stationary combustion sources

Source of emission	Emission control measures
Small-scale combustion sources	Energy savings, e.g. insulation Regular inspection Replacement of old furnaces Natural gas and fuel oil instead of solid fuels Central heating system District heating system
Industrial and commercial sources	Energy savings Better maintenance Fuel-type modification Change of furnace and load Change of burning conditions
Stationary internal combustion sources	Catalytic converters Thermal reactors

E. *Food industry*

50. The food industry sector covers a wide range of VOC-emitting processes from large and small plants (table VI). The major sources of VOC emissions are:

(a) Production of alcoholic beverages;
(b) Baking;
(c) Vegetable oil extraction using mineral oils;
(d) Animal rendering.

Alcohol is the principal VOC from (a) and (b). Aliphatic hydrocarbons are the principal VOC from (c).

51. Other potential sources include:

(a) Sugar industry and sugar use;
(b) Coffee and nut roasting;
(c) Frying (chipped potatoes, crisps, etc.);
(d) Fish meal processing;
(e) Preparation of cooked meats, etc.

52. VOC emissions are typically odorous, of low concentration with high volume flow and water content. For this reason, the use of biofilters has been used as an abatement technique. Conventional techniques such as absorption, adsorption, thermal and catalytic incineration have also been used. The principal advantage of biofilters is their low operational cost compared with other techniques. Nevertheless, periodic maintenance is required.

53. It may be feasible for larger fermentation plants and bakeries to recover alcohol by condensation.

54. Aliphatic hydrocarbon emissions from oil extraction are minimized by using closed cycles and good housekeeping to prevent losses from valves and seals, etc. Different oil seeds require different volumes of mineral oil for extraction. Olive oil can be extracted mechanically, in which case no mineral oil is necessary.

55. The technologically feasible overall reduction potential in the food industry is estimated to be up to 35 per cent.

F. *Iron and steel industry (including ferro-alloys, casting etc.)*

56. In the iron and steel industry, VOC emissions may be from a variety of sources:

(a) Processing of input materials (cokeries; agglomeration plants: sintering, pelletizing, briquetting; scrap-handling);
(b) Metallurgical reactors (submerged arc furnaces; electric arc furnaces; converters, especially if using scrap; (open) cupolas; blast furnaces);
(c) Product handling (casting; reheating furnaces; and rolling mills).

TABLE VI

VOC-emission control measures, reduction efficiency and costs for the food industry

Source of emission	**Emission control measures**	**Reduction efficiency**	**Abatement costs**
In general	Closed cycles		
	Bio-oxidation	II	Low*
	Condensation and treatment	I	High
	Adsorption/absorption		
	Thermal/catalytic incineration		
Vegetable-oil processing	Process-integrated measures Adsorption Membrane technique Incineration in process furnace	III	Low
Animal rendering	Biofiltration	II	Low*

* Owing to the fact that these processes are usually applied to gases with low VOC concentrations, the costs per cubic metre of gas are low, although VOC abatement per tonne is high.

I = > 95 per cent; II = 80-95 per cent; III = < 80 per cent

57. Reducing the carbon carrier in raw materials (e.g. on sintering belts) reduces the potential of VOC emissions.

58. In the case of open metallurgical reactors, VOC emissions may occur especially from contaminated scrap and under pyrolytic conditions. Special attention has to be paid to the collection of gases from charging and tapping operations, in order to minimize fugitive VOC emissions.

59. Special attention has to be paid to scrap which is contaminated by oil, grease, paint, etc., and to the separation of fluff (non-metallic parts) from metallic scrap.

60. The processing of products usually entails fugitive emissions. In the case of casting, emissions of pyrolysis gases occur, chiefly from organically bonded sands. These emissions can be reduced by

choosing low-emission bonding resins and/or minimizing the quantity of binders. Biofilters have been tested on such flue gases. Oil mist in the air from rolling mills can be reduced to low levels by filtration.

61. Coking plants are an important VOC emission source. Emissions arise from: coke oven gas leakage, the loss of VOCs normally diverted to an associated distillation plant, and from the combustion of coke oven gas and other fuel. VOC emissions are reduced mainly by the following measures: improved sealing between oven doors and frames and between charging holes and covers; maintaining suction from ovens even during charging; dry quenching either by direct cooling with inert gases or by indirect cooling with water; pushing directly into the dry quenching unit; and efficient hooding during pushing operations.

G. *Handling and treatment of waste*

62. Concerning municipal solid waste control, the primary objectives are to reduce the amount of waste produced and to reduce the amount to be treated. In addition, the waste treatment should be optimized from an environmental point of view.

63. If landfill processes are used, VOC-emission control measures for the treatment of municipal waste should be linked to an efficient collection of the gases (mostly methane).

64. These emissions can be destroyed (incineration). Another option is the purification of the gas (bio-oxidation, absorption, activated carbon, adsorption) leading to use of the gas for energy production.

65. The landfill of industrial waste containing VOCs leads to VOC emissions. This point has to be taken into account in the definition of waste-management policies.

66. The overall reduction potential is estimated to be 30 per cent, though this figure includes methane.

H. *Agriculture*

67. The principal sources of VOC emissions from agriculture are:

(a) Burning of agricultural waste, particularly straw and stubble;
(b) Use of organic solvents in pesticide formulations;
(c) Anaerobic degradation of animal feeds and wastes.

68. VOC emissions are reduced by:

(a) Controlled disposal of straw as opposed to the common practice of open-field burning;
(b) Minimal use of pesticides with high organic solvent contents, and/or the use of emulsions and water-based formulations;
(c) Composting of waste, combining manure with straw, etc;
(d) Abatement of exhaust gases from animal houses, manure drying plant, etc., by use of biofilters, adsorption, etc.

69. In addition, alterations of feed reduce emissions of gas from animals, and the recovery of gases for use as fuel is a possibility.

70. It is not currently possible to estimate the reduction potential of VOC emissions from agriculture.

V. PRODUCTS

71. In circumstances in which abatement by control techniques is not appropriate, the sole means of reducing VOC emissions is by altering the composition of products used. The main sectors and products concerned are: adhesives used in households, light industry, shops and offices; paints for use in households; household cleaning and personal care products; office products such as correcting fluids and car maintenance products. In any other situation in which products like those mentioned above are used (e.g. painting, light industry), alterations in product composition are highly preferable.

72. Measures aimed at reducing VOC emissions from such products are:

(a) Product substitution;
(b) Product reformulation;
(c) Altering the packaging of products, especially for reformulated products.

73. Instruments designed to influence market choice include:

(a) Labelling to ensure that consumers are well informed of the VOC content;
(b) Active encouragement of low-VOC-content products (e.g. the "Blue Angel" scheme);
(c) Fiscal incentives linked to VOC content.

74. The efficiency of these measures depends on the VOC content of the products involved and the availability and acceptability of alternatives. Reformulation should be checked to ensure that products do not create problems elsewhere (e.g. increased emissions of chlorofluorocarbons (CFCs)).

75. VOC-containing products are used for industrial as well as domestic purposes. In either case the use of low-solvent alternatives may entail changes in application equipment and in work practices.

76. Paints commonly used for industrial and domestic purposes have an average solvent content of about 25 to 60 per cent. For most applications, low-solvent or solvent-free alternatives are available or under development:

(a) Paint for use in the light industry:

Powder paint = 0 per cent VOC content in product
Waterborne paint = 10 per cent VOC content in product
Low-solvent paint = 15 per cent VOC content in product

(b) Paint for domestic use:

Waterborne paint = 10 per cent VOC content in product
Low-solvent paint = 15 per cent VOC content in product

Switching over to alternative paints is expected to result in an overall VOC-emission reduction of about 45 to 60 per cent.

77. Most adhesive products are used in industry, while domestic uses account for less than 10 per cent. About 25 per cent of the adhesives in use contain VOC solvents. For these adhesives, the solvent content varies widely and may constitute half the weight of the product. For several application areas, low-solvent/solvent-free alternatives are available. This source category therefore offers a high reduction potential.

78. Ink is mainly used for industrial printing processes, with solvent contents differing widely, up to 95 per cent. For most printing processes, low-solvent inks are available or under development in particular for printing on paper (see para. 28).

79. About 40 to 60 per cent of VOC emissions from consumer products (including office products and those used in car maintenance) are from aerosols. There are three basic ways of reducing VOC emissions from consumer products:

(a) Substitution of propellants and the use of mechanical pumps;
(b) Reformulation;
(c) Change of packaging.

80. The potential reduction of VOC emissions from consumer products is estimated to be 50 per cent.

Annex III

CONTROL MEASURES FOR EMISSIONS OF VOLATILE ORGANIC COMPOUNDS (VOCS) FROM ON-ROAD MOTOR VEHICLES

INTRODUCTION

1. This annex is based on information on emission control performance and costs contained in official documentation of the Executive Body and its subsidiary bodies; in the report on Volatile Organic Compounds from On-road Vehicles: Sources and Control Options, prepared for the Working Group on Volatile Organic Compounds; in documentation of the Inland Transport Committee of the Economic Commission for Europe (ECE) and its subsidiary bodies (in particular, documents TRANS/SC1/WP.29/R.242, 486 and 506); and on supplementary information provided by governmentally designated experts.

2. The regular elaboration and amendment of this annex will be necessary in the light of continuously expanding experience with new vehicles incorporating low-emission technology and the development of alternative fuels, as well as with retrofitting and other strategies for existing vehicles. The annex cannot be an exhaustive statement of technical options; its aim is to provide guidance to Parties in identifying economically feasible technologies for fulfilling their obligations under the Protocol. Until other data become available, this annex concentrates on on-road vehicles only.

I. MAJOR SOURCES OF VOC EMISSIONS FROM MOTOR VEHICLES

3. Sources of VOC emissions from motor vehicles have been divided into: (a) tailpipe emissions; (b) evaporative and refuelling emissions; and (c) crankcase emissions.

4. Road transport (excluding petrol distribution) is a major source of anthropogenic VOC emissions in most ECE countries and contributes between 30 and 45 per cent of total man-made VOC emissions in the ECE region as a whole. By far the largest source of road transport VOC emissions is the petrol-fuelled vehicle which accounts for 90 per cent of total traffic emissions of VOCs (of which 30 to 50 per cent are evaporative emissions). Evaporative and refuelling emissions result primarily from petrol use, and are considered very low in the case of diesel fuels.

II. GENERAL ASPECTS OF CONTROL TECHNOLOGIES FOR VOC EMISSIONS FROM ON-ROAD MOTOR VEHICLES

5. The motor vehicles considered in this annex are passenger cars, light-duty trucks, on-road heavy-duty vehicles, motor cycles and mopeds.

6. While this annex deals with both new and in-use vehicles, it is primarily focused on VOC-emission control for new vehicle types.

7. This annex also provides guidance on the influence of changes in petrol properties on evaporative VOC emissions. Fuel substitution (e.g. natural gas, liquefied petroleum gas (LPG), methanol) can also provide VOC-emission reductions but this is not considered in this annex.

8. Cost figures for the various technologies given are manufacturing cost estimates rather than retail prices.

9. It is important to ensure that vehicle designs are capable of meeting emission standards in service. This can be done through ensuring conformity of production, full useful-life durability,

warranty of emission-control components, and recall of defective vehicles. For in-use vehicles, continued emission-control performance can also be ensured by an effective inspection and maintenance programme, and measures against tampering and misfuelling.

10. Emissions from in-use vehicles can be reduced through programmes such as fuel volatility controls, economic incentives to encourage the accelerated introduction of desirable technology, low-level oxygenated fuel blends, and retrofitting. Fuel volatility control is the single most effective measure that can be taken to reduce VOC emissions from in-use motor vehicles.

11. Technologies that incorporate catalytic converters require the use of unleaded fuel. Unleaded petrol should therefore be generally available.

12. Measures to reduce VOC and other emissions by the management of urban and long-distance traffic, though not elaborated in this annex, are important as an efficient additional approach to reducing VOC emissions. Key measures for traffic management aim at improving the modal split through tactical, structural, financial and restrictive elements.

13. VOC emissions from uncontrolled motor vehicles contain significant levels of toxic compounds, some of which are known carcinogens. The application of VOC reduction technologies (tailpipe, evaporative, refuelling and crankcase) reduces these toxic emissions in generally the same proportion as the VOC reductions achieved. The level of toxic emissions can also be reduced by modifying certain fuel parameters (e.g. reducing benzene levels in petrol).

III. CONTROL TECHNOLOGIES FOR TAILPIPE EMISSIONS

(a) Petrol-fuelled passenger cars and light-duty trucks

14. The main technologies for controlling VOC emissions are listed in table I.

TABLE I

Tailpipe emission control technologies for petrol-fuelled passenger cars and light-duty trucks

Technology option	Emission level (%)		Cost * (U$D)
	4-stroke	2-stroke	
A. Uncontrolled situation	400	900	-
B. Engine modifications (engine design, carburetion and ignition systems, air injection)	100 (1.8 g/km)	-	**
C. Open-loop catalyst	50	-	150-200
D. Closed-loop three-way catalyst	10-30	-	250-450***
E. Advanced closed-loop three-way catalyst	6	-	350-600***

* Additional production-cost estimates per vehicle, relative to technology option B.

** Costs for engine modifications from options A to B are estimated at US$ 40-100.

*** Under technology options D and E, CO and NO_x emissions are also substantially reduced, in addition to VOC reductions. Technology options B and C can also result in some CO and/or NO_x control.

15. The basis for comparison in table I is technology option B, representing non-catalytic technology designed in response to the requirements of the United States for 1973/1974 or of ECE regulation 15-04 pursuant to the 1958 Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicles Equipment and Parts. The table also presents achievable emission levels for open- and closed-loop catalytic control as well as their cost implications.

16. The "uncontrolled" level (A) in table I refers to the 1970 situation in the ECE region, but may still prevail in certain areas.

17. The emission level in table I reflects emissions measured using standard test procedures. Emissions from vehicles on the road may differ significantly because of the effect, inter alia, of ambient temperature, operating conditions, fuel properties, and maintenance. However, the reduction potential indicated in table I is considered representative of reductions achievable in use.

18. The best currently available technology is option D. This technology achieves large reductions of VOC, CO and NO_x emissions.

19. In response to regulatory programmes for further VOC emission reductions (e.g. in Canada and the United States), advanced closed-loop three-way catalytic converters are being developed (option E). These improvements will focus on more powerful engine-management controls, improved catalysts, on-board diagnostic systems (OBD) and other advances. These systems will become best available technology by the mid-1990s.

20. A special category are two-stroke engine cars which are used in parts of Europe; these cars currently have very high VOC emissions. Hydrocarbon emissions from two-stroke engines are typically between 45.0 and 75.0 grams per test, according to the European driving cycle. Attempts are under way to apply engine modifications and catalytic after-treatment to this type of engine. Data are needed on the reduction potentials and durability of these solutions. Furthermore, different two-stroke engine designs are currently being developed that have the potential for lower emissions.

(b) Diesel-fuelled passenger cars and trucks

2l. Diesel-fuelled passenger cars and light-duty trucks have very low VOC emissions, generally lower than those resulting from closed-loop catalytic control on petrol-fuelled cars. However, their emissions of particulates and NO_x are higher.

22. No ECE country currently has rigorous tailpipe VOC control programmes for heavy-duty diesel-fuelled vehicles, because of their generally low VOC emission rates. However, many countries have diesel particulate control programmes, and the technology that is employed to control particulates (e.g. combustion chamber and injection system improvements) has the net end result of lowering VOC emissions as well.

23. Tailpipe VOC emission rates from heavy-duty diesel-fuelled vehicles are expected to be reduced by two thirds as the result of a vigorous particulate control programme.

24. VOC species emitted from diesel-fuelled engines are different from those emitted by petrol-fuelled engines.

(c) Motor cycles and mopeds

25. VOC emission control technologies for motor cycles are summarized in table II. Current ECE regulations (R.40) can normally be met without requiring reduction technologies. The future standards of Austria and Switzerland may require oxidizing catalytic converters for two-stroke engines in particular.

26. For two-stroke mopeds with small oxidizing catalytic converters, a VOC-emission reduction of 90 per cent is achievable, at additional production costs of US$ 30-50. In Austria and Switzerland, standards requiring this technology are already in force.

TABLE II

Tailpipe emission control technologies and performance for motor cycles

Technology option	Emission level (per cent)		Cost (US$)*
	2-stroke	4-stroke	
A. Uncontrolled	400 (9.6 g/km)	100 (2 g/km)	-
B. Best non-catalyst	200	60	-
C. Oxidizing catalytic converter, secondary air	30-50	20	50
D. Closed-loop three-way catalytic converter	Not applicable	10**	350

* Additional production-cost estimates per vehicle.

** Expected to be available by 1991 for a few specific motor cycle types (prototypes already constructed and tested).

IV. CONTROL TECHNOLOGIES FOR EVAPORATIVE AND REFUELLING EMISSIONS

27. *Evaporative emissions* consist of fuel vapour emitted from the engine and fuel system. They are divided into: (a) diurnal emissions, which result from the "breathing" of the fuel tank as it is heated and cooled over the course of a day; (b) hot-soak emissions produced by the heat from the engine after it is shut down; (c) running losses from the fuel system while the vehicle is in operation; and (d) resting losses such as from open-bottom canisters (where used) and from some plastic fuel-system materials which are reportedly subject to permeation losses, in which petrol slowly diffuses through the material.

28. The control technology typically used for evaporative emissions from petrol-fuelled vehicles includes a charcoal canister (and associated plumbing) and a purge system to burn the VOCs in a controlled manner in the engine.

29. Experience with existing evaporative-emission control programmes in the United States indicates that evaporative-emission control systems have not provided the degree of control desired, especially during severe ozone-prone days. This is partly because the volatility of in-use petrol is much higher than that of certification-test petrol. It is also due to an inadequate test procedure that resulted in inadequate control technology. The United States evaporative-emission control programme in the 1990s will emphasize reduced-volatility fuels for use in summer and an improved test procedure to encourage advanced evaporative control systems that will result in the in-use control of the four emission sources mentioned in paragraph 27 above. For countries with high volatility petrol, the single most cost-effective measure to reduce VOC emissions is to reduce volatility of in-use petrol.

30. In general, effective evaporative-emission control requires the consideration of: (a) control of petrol volatility, adjusted to climatic conditions; and (b) an appropriate test procedure.

31. A list of control options, reduction potentials and cost estimates is given in table III, with option as the best available control technology at present. Option will soon become best available technology and will represent a significant improvement over option.

32. The fuel economy benefits associated with evaporative-emission controls are estimated at less than 2 per cent. The benefits are due to the higher energy density, and low Reid-vapour-pressure (RVP) of fuel, and to the combustion rather than venting of captured vapours.

33. In principle, emissions that are released during refuelling of vehicles can be recovered by systems installed at petrol stations (Stage II) or by systems on board of vehicles. Controls at petrol stations are a well-established technology, while on-board systems have been demonstrated using several prototypes. The question of in-use safety of on-board vapour recovery systems is presently under study. It may be appropriate to develop safety performance standards in conjunction with on-board vapour recovery systems to assure their safe design. Stage II controls can be implemented more quickly since service stations in a given area can be fitted with these controls. Stage II controls benefit all petrol-fuelled vehicles while on-board systems only benefit new vehicles.

34. While evaporative emissions from motor cycles and mopeds are at present uncontrolled in the ECE region, the same general control technologies as for petrol-fuelled cars can be applied.

TABLE III

EVAPORATIVE-EMISSION CONTROL MEASURES AND REDUCTION POTENTIALS FOR PETROL-FUELLED PASSENGER CARS AND LIGHT-DUTY TRUCKS

Technology option	VOC reduction potential (%)[1/]	Cost (US$)[2/]
A. Small canister. Lenient RVP [3/] limits, 1980s US Test Procedure	<80	20
B. Small canister, stringent RVP limits,[4/] 1980s US Test Procedure	80-95	20
C. Advances evaporative controls, stringent RVP limits, [4/] 1990s US test Procedure [5/]	>95	33

1/ Relative to uncontrolled situation.
2/ Additional production-cost estimates per vehicle.
3/ Reid vapour pressure.
4/ Based on United States data, assuming an RVP limit of 62 kPa during warm season at a cost of US$ 0.0038 per litre. Taking account of the fuel economy benefit associated with low RVP petrol, the adjusted cost estimate is US$ 0.0012 per litre.
5/ United States Test Procedure in the 1990s will be designed for the more effective control of multiple diurnal emissions, running losses, operation under high ambient temperature, hot-soak conditions following extended operation, and resting losses.

V. GENERAL ASPECTS OF CONTROL TECHNOLOGIES FOR OFF-ROAD VEHICLES, MACHINES AND LOCOMOTIVES

35. This section of the technical annex considers all mobile or portable machines excluding passenger cars, light-duty vehicles, heavy-duty vehicles, motorcycles and mopeds. Emissions from ships and aircraft are discussed in sections VII and VIII below. Examples of such vehicles and machinery include agricultural and forestry tractors, construction equipment, lawnmowers, chain-saws, etc.

36. VOC emissions from off-road vehicles and machines are important and account for up to 10 per cent of national totals in the ECE region. Petrol-fuelled two-stroke engines are the largest single source category. The proportion of emissions from off-road vehicles will increase as emissions from on-road vehicles and stationary sources are reduced.

37. Estimating emission rates from some off-road sources can be time-consuming when the information required to compile the inventory is lacking.

38. Substantial progress has been achieved in the development of engine technology, exhaust gas after-treatment and fuel technology, making it possible to reduce VOC emissions from off-road vehicles and machines at reasonable cost. In addition, electrically powered alternatives exist for many applications.

39. It is important to ensure that new engine-emission standards are maintained in service. This can be done through inspection and maintenance programmes, ensuring conformity of production, full useful-life durability, warranty of emission-control components, and recall of defective vehicles and machines.

40. Enforcement, maintenance and inspection programmes for off-road vehicles and machines will be more difficult to implement than for road vehicles.

41. Fiscal incentives can encourage the introduction of desirable technology.

VI. CONTROL TECHNOLOGIES FOR VOC EMISSIONS FROM OFF-ROAD VEHICLES, MACHINES AND LOCOMOTIVES

42. State-of-the-art control technology options for off-road petrol engines are: evaporative controls, engine modifications (carburation, ignition systems, fuel injection, air injection) oxidation catalysts, open and closed loop three-way catalysts.

43. State-of-the-art control technology options for off-road diesel engines are: improved combustion chamber design, exhaust gas recirculation, electronic engine management, improved injection systems and turbocharging and intercooling.

44. Limit values for agricultural and forestry tractors and other off-road vehicle/machine engines are listed in tables IV and V. Stage I (table IV) is based on the ECE regulation 96 “Uniform provisions concerning the approval of compression - ignition (C.I.) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by engine” and a proposal for a European Union (EU) Council Directive on the approximation of the laws of the member States relating to the measures to be taken against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machines, which are identical. A second stage with lower emission limit values has been proposed as part of the EU Council Directive (table V). There are no EU proposals for diesel engines below 37 kW in stage I and below 18 kW in stage II or for petrol engines.

45. The limit values contained in tables IV and V are based on lower-emission engine technology only and refer to diesel engines only. Some countries have introduced legislation for utility engines below the 18 kW threshold for both petrol and diesel engines. The limit values for such engines in California, are shown in table VI.

46. Petrol-fuelled two-stroke engines are a special category, as they have very high VOC emissions. Attempts are under way to apply engine modifications and catalytic after-treatment to this type of

engine. Data are needed on the reduction potentials and durability of these solutions. Furthermore, different two-stroke engines that have significantly lower emissions have been and are currently being designed. In some applications 2-stroke engines are being replaced by 4-stroke counterparts.

47. Changes to the specifications of conventional fuels such as reducing petrol volatility and additions of oxygenates to petrol can reduce both evaporative and exhaust emissions of VOCs. In addition, the use of some alternative fuels in petrol and diesel engines can also reduce VOC emissions.

VII. GENERAL ASPECTS OF CONTROL TECHNOLOGY FOR VOC EMISSIONS FROM SHIPS

48. There are two major sources of VOC emissions from the marine sector, whose relative importance varies form country to country depending upon geographical location and traffic density. These are emissions from pleasure craft (2-stroke outboard engines) and emissions stemming from the loading and unloading of volatile cargoes from tanker ships.

49. Emissions from pleasure craft can contribute up to 8 per cent to national VOC emission totals. Control measures for such emissions are described in paragraph 46 above. A number of ECE countries have already introduced regulatory measures to reduce emissions from smaller boats and pleasure craft.

50. Vapour recovery systems, both on board and at terminal, should be implemented according to the technical guidance developed by the International Maritime Organization (IMO).

51. Fiscal incentives can encourage the introduction of lower-emission technology for both major emission sources.

VIII. GENERAL ASPECTS OF CONTROL TECHNOLOGY FOR VOC EMISSIONS FROM AIRCRAFT

52. This annex deals with all aircraft engines.

53. The limits on aircraft engine emissions of unburned hydrocarbons as contained in Annex 16, volume II to the Convention on International Civil Aviation (the Chicago Convention) and as may be amended from time to time, may be used for controlling the VOC emissions from turbo-jet and turbofan engines during landing and take-off (LTO) cycles within the Convention on Long-range Transboundary Air Pollution.

54. Only LTO emissions have so far been covered by the Convention on Long-range Transboundary Air Pollution with respect to emission inventories as part of national totals. Cruise emissions from domestic flights can also be considered as another part of national totals. Cruise level emissions may be more harmful. However, emission factors from the cruise phase are more uncertain than from LTO cycles.

55. Aircraft engines and aircraft with engines smaller than 26.7 kN/thrust are included in emission inventories but are not subject to international regulation at present. If they become subject to regulation, it should be borne in mind that an aircraft's lifetime is about 30 years and, therefore, new technology penetrates slowly. Retrofitting may therefore be considered when changing engines.

IX. CONTROL TECHNOLOGIES FOR VOC EMISSIONS FROM AIRCRAFT

56. State-of-the-art control technology for aircraft engine emissions encompasses fuel-air management optimization for existing engine types and two staged fuel combustion concepts for some

emerging medium to high-thrust subsonic aircraft engines types, which are beginning to enter into service.

57. Other combustion concepts such as lean/premixed/prevaporized (LPP) and rich burn/quick mix/lean burn (RQL) are being investigated for application to a second generation of supersonic aircraft engines. However, such engines are not expected to enter into service until at least 2006.

58. Fiscal incentives can encourage the introduction of lower-emission technology.

TABLE IV

Limit values (stage I) for agricultural and forestry tractors and other non-road mobile machine engines (ECE regulation 96 and proposed EU Council Directive)

Net power (P) (kW)	**Hydrocarbons (HC) (g/kWh)**
130 ≤ P < 560	1.3
75 ≤ P < 130	1.3
37 ≤ P < 75	1.3

TABLE V

Limit values (stage II) for non-road mobile machine engines (Proposed EU Council Directive)

Net power (P) (kW)	**Hydrocarbons (HC) (g/kWh)**
130 ≤ P < 560	1.0
75 ≤ P < 130	1.0
37 ≤ P < 75	1.3
18 ≤ P < 37	1.5

Note: The emissions of hydrocarbons obtained shall not exceed the amount shown in the table. These limits are engine-out limits and shall be achieved before any exhaust after-treatment device.

TABLE VI

Limit values for diesel- and petrol-fuelled engines from California include utility engines below 18 kW. Utility engines are used in garden equipment and other general utility equipment (e.g. chain-saws).

The following table contains the limit values for utility engines (handheld equipment excluded). (Limits are based on total engine displacement in cubic centimetres (cc), the limits are expressed in grams per kilowatt-hour (kWh)).

	Displacement	**HC and NO_x**
Stage I	Less than 225 cc 225 cc and greater	16.3 13.6
Stage II	All	4.4

Handheld equipment is subject to separate limit values. It is defined as equipment in which the operator is required to fully support the equipment's weight.

The following table contains the limit values for handheld engines (in grams per kWh).

Displacement		**HC**	**CO**	**NO$_x$**	**PM**
Stage I	< 20 cc	295	805	5.36	-
	20 cc to < 50 cc	241	805	5.36	-
	≥ 50 cc	161	402	5.36	-
Stage II	All	65	175	5.36	0.3

Annex IV

CLASSIFICATION OF VOLATILE ORGANIC COMPOUNDS (VOCS) BASED ON THEIR PHOTOCHEMICAL OZONE CREATION POTENTIAL (POCP)

1. This annex summarizes the information available and identifies the still existing elements to develop in order to guide the work to be carried out. It is based on information regarding hydrocarbons and ozone formation contained in two notes prepared for the Working Group on Volatile Organic Compounds (EB.AIR/WG.4/R.11 and R.13/Rev.1); on the results of further research carried out, in particular in Austria, Canada, Germany, Netherlands, Sweden, the United Kingdom, the United States of America and the EMEP Meteorological Synthesizing Centre-West (MSC-W); and on supplementary information provided by governmentally designated experts.

2. The final aim of the POCP approach is to provide guidance on regional and national control policies for volatile organic compounds (VOCs), taking into account the impact of each VOC species as well as sectoral VOC emissions in episodic ozone formation expressed in terms of the photochemical ozone creation potential (POCP), which is defined as the change in photochemical ozone production due to a change in emission of that particular VOC. POCP may be determined by photochemical model calculations or by laboratory experiments. It serves to illustrate different aspects of episodic oxidant formation; e.g. peak ozone or accumulated ozone production during an episode.

3. The POCP concept is being introduced because there is a large variation between the importance of particular VOCs in the production of ozone during episodes. A fundamental feature of the concept is that, in the presence of sunlight and NO_x, each VOC produces ozone in a similar way despite large variations in the circumstances under which ozone is produced.

4. Different photochemical model calculations indicate that substantial reduction of VOCs and NO_x emissions are necessary (order of magnitude above 50 per cent in order to achieve significant ozone reduction). Moreover the maximum concentrations of ozone near the ground are reduced in a less than proportional way when VOC emissions are reduced. This effect is shown in principle by theoretical scenario calculation. When all species are reduced by the same proportion, maximum ozone values (above 75 ppb hourly average) in Europe are reduced depending on the existing ozone level by only 10-15 per cent if the mass of non-methane man-made VOC emissions is reduced by 50 per cent. By contrast, if emissions of the most important (in terms of POCP and mass values or reactivity) non-methane man-made VOC species were reduced by 50 per cent (by mass), the calculated result is a 20-30 per cent reduction of peak episodic ozone concentration. This confirms the merits of a POCP approach to determine priorities for VOC emission control and clearly shows that VOCs may at least be divided into large categories, according to their importance in episodic ozone formation.

5. POCP values and reactivity scales have been calculated as estimates, each based on a particular scenario (e.g. emission increases and decreases, air mass trajectories) and targeted towards a particular objective (e.g. peak ozone concentration, integrated ozone, average ozone). POCP values and reactivity scales are dependent on chemical mechanisms. Clearly there are differences between the different estimates of POCPs, which in some cases can span more than a factor of four. The POCP numbers are not constant but vary in space and time. To give an example: the calculated POCP of ortho-xylene in the so-called "France-Sweden" trajectory has a value of 41 on the first day and of 97 on the fifth day of the travelling time. According to calculations of the Meteorological Synthesizing Centre-West (MSC-W) of EMEP, the POCP of ortho-xylene for O_3 over 60 ppb, varies between 54 and 112 (5 to 95 percentiles) for the grids of the EMEP area. The variation of the POCP in time and space is not only caused by the VOC composition of the air parcel due to man-made emissions but is also a result of meteorological variations. The fact is that any reactive VOC can contribute to the episodical formation of photochemical oxidants to a higher or lower extent, depending on the concentrations of NO_x and VOC

and meteorological parameters. Hydrocarbons with very low reactivity, like methane, methanol, ethane and some chlorinated hydrocarbons contribute in a negligible manner to this process. There are also differences as a result of meteorological variations between particular days and over Europe as a whole. POCP values are implicitly dependent on how emission inventories are calculated. Currently there is no consistent method or information available across Europe. Clearly, further work has to be done on the POCP approach.

6. Natural isoprene emissions from deciduous trees, together with nitrogen oxides (NO_x) mainly from man-made sources, can make a significant contribution to ozone formation in warm summer weather in areas with a large coverage of deciduous trees.

7. In table I, VOC species are grouped according to their importance in the production of episodic peak ozone concentrations. Three groups have been selected. Importance in table I is expressed on the basis of VOC emission per unit mass. Some hydrocarbons, such as n-butane, become important because of their mass emission although they may not appear so according to their OH reactivity.

8. Tables II and III show the impacts of individual VOCs expressed as indices relative to the impact of a single species (ethylene) which is given an index of 100. They indicate how such indices, i.e. POCPs, may give guidance for assessing the impact of different VOC emission reductions.

9. Table II shows averaged POCPs for each major source category based on a central POCP estimate for each VOC species in each source category. Emission inventories independently determined in the United Kingdom and Canada have been used in this compilation and presentation. For many sources, e.g. motor vehicles, combustion installations, and many industrial processes, mixtures of hydrocarbons are emitted. Measures to reduce specifically the VOC compounds identified in the POCP approach as very reactive are in most cases unavailable. In practice, most of the possible reduction measures will reduce emissions by mass irrespective of their POCPs.

10. Table III compares a number of different weighting schemes for a selected range of VOC species. In assigning priorities within a national VOC control programme, a number of indices may be used to focus on particular VOCs. The simplest but least effective approach is to focus on the relative mass emission, or relative ambient concentration.

11. Relative weighting based on OH reactivity addresses some but by no means all of the important aspects of the atmospheric reactions which generate ozone in the presence of NO_x and sunlight. The SAPRC (Statewide Air Pollution Research Centre) weightings address the situation in California. Because of differences in the model conditions appropriate to the Los Angeles basin and Europe, major differences in the fates of photochemical, labile species, such as aldehyde, result. POCPs calculated with photochemical models in the Netherlands, United States of America, United Kingdom, Sweden and by EMEP (MSC-W) address different aspects of the ozone problem in Europe.

12. Some of the less-reactive solvents cause other problems, e.g. they are extremely harmful to human health, difficult to handle, persistent, can cause negative environmental effects at other levels (e.g. in the free troposphere or the stratosphere). In many cases the best available technology for reducing solvent emission is the application of non-solvent using systems.

13. Reliable VOC emission inventories are essential to the formulation of any cost-effective VOC control policies and in particular those based on the POCP approach. National VOC emissions should therefore be specified according to sectors, at least following guidelines specified by the Executive Body, and should as far as possible be complemented by data on species and time variations of emissions.

TABLE I

Classification of VOCs into three groups according to their importance in episodic ozone formation

More Important	
Alkenes	
Aromatics	
Alkanes	> C6 alkanes except 2,3 dimethypentane
Aldehydes	All aldehydes except benzaldehyde
Biogenics	Isoprene
Less important	
Alkanes	C3-C5 alkanes and 2,3 dimethypentane
Ketones	Methyl ethyl ketone and methyl t-butyl ketone
Alcohols	Ethanol
Esters	All esters except methyl acetate
Least important	
Alkanes	Methane and ethane
Alkynes	Acetylene
Aromatics	Benzene
Aldehdes	Benzaldehyde
Ketones	Acetone
Alcohols	Methanol
Esters	Methyl acetate
Chlorinated hydrocarbons	Methyl chloride
	Methylene chloride
	Trichloroethylene and tetracholoethylene

TABLE II

Sectoral POCPs of the various emission sectors and the percentage by mass of VOCs in each ozone creation class

Sector	**Sectoral POCP Percentage mass in each ozone creation class**					
	Canada	**United Kingdom**	**More**	**Less Important**	**Least**	**Unknown**
Petrol-engined vehicle exhaust	63	61	76	16	7	1
Diesel vehicle exhaust	60	59	38	19	3	39
Petrol-engined vehicle evaporation	-	51	57	29	2	12
Other transport	63	-	-	-	-	-
Stationary combustion	-	54	34	24	24	18
Solvent usage	42	40	49	26	21	3
Surface coating	48	51	-	-	-	-
Industrial process emissions	45	32	4	41	0	55
Industrial chemicals	70	63	-	-	-	-
Petroleum refining and distribution	54	45	55	42	1	2
Natural gas leakage	-	19	24	8	66	2
Agriculture	-	40	-	-	100	-

Sector	**Sectoral POCP Percentage mass in each ozone creation class**					
	Canada	**United Kingdom**	**More**	**Less Important**	**Least**	**Unknown**
Coal mining	-	0	-	-	100	-
Domestic waste landfill	-	0	-	-	100	-
Dry cleaning	29	-	-	-	-	-
Wood combustion	55	-	-	-	-	-
Slash burn	58	-	-	-	-	-
Food industry	-	37	-	-	-	-

TABLE III

Comparison between weighting schemes (expressed relative to ethylene = 100) for 85 VOC species

				UK		SWEDEN			
VOC	**OH Scale** [a]	**Canada by mass** [b]	**SAPRC MIR** [c]	**POCP** [d]	**range** [e]	**max diff.** [f]	**0-4 days** [g]	**EMEP** [h]	**LOTOS** [i]
Methane	0.1	-	0	0.7	0-3	-	-	-	-
Ethane	3.2	91.2	2.7	8.2	2-3	17.3	12.6	5-24	6-25
Propane	9.3	100	6.2	42.1	16-124	60.4	50.3	-	-
n-Butane	15.3	212	11.7	41.4	15-115	55.4	46.7	22-85	25-87
i-Butane	14.2	103	15.7	31.5	19-59	33.1	41.1	-	-
n-Pentane	19.4	109	12.1	40.8	9-105	61.2	29.8	-	-
i-Pentane	18.8	210	16.2	29.6	12-68	36.0	31.4	-	-
n-Hexane	22.5	71	11.5	42.1	10-151	78.4	45.2	-	-
2-Methylpentane	22.2	100	17.0	52.4	19-140	71.2	52.9	-	-
3-Methylpentane	22.6	47	17.7	43.1	11-125	64.7	40.9	-	-
2,2-Dimethylbutane	10.5	-	7.5	25.1	12-49	-	-	-	-
2,3-Dimethylbutane	25.0	-	13.8	38.4	25-65	-	-	-	-
n-Heptane	25.3	41	9.4	52.9	13-165	79.1	51.8	-	-
2-Methylhexane	18.4	21	17.0	49.2	11-159	-	-	-	-
3-Methylhexane	18.4	24	16.0	49.2	11-157	-	-	-	-
n-Octane	26.6	-	7.4	49.3	12-151	69.8	46.1	-	-
2-Methylheptane	26.6	-	16.0	46.9	12-146	69.1	45.7	-	-
n-Nonane	27.4	-	6.2	46.9	10-148	63.3	35.1	-	-
2-Methyloctane	27.3	-	13.2	50.5	12-147	66.9	45.4	-	-
n-Decane	27.6	-	5.3	46.4	8-156	71.9	42.2	-	-
2-Methylnonane	27.9	-	11.7	44.8	8-153	71.9	42.3	-	-
n-Undecane	29.6	21	4.7	43.6	8-144	66.2	38.6	-	-
n-Duodecane	28.4	-	4.3	41.2	7-138	57.6	31.1	-	-
Methylcyclohexane	35.7	18	22.3	-	-	40.3	38.6	-	-
Methylene chloride	-	-	-	1	0-3	0	0	-	-
Chloroform	-	-	-	-	-	0.7	0.4	-	-
Methyl chloroform	-	-	-	0.1	0-1	0.2	0.2	-	-

				UK		**SWEDEN**			
VOC	**OH Scale** [a]	**Canada by mass** [b]	**SAPRC MIR** [c]	**POCP** [d]	**range** [e]	**max diff.** [f]	**0-4 days** [g]	**EMEP** [h]	**LOTOS** [i]
Trichloroethylene	-	-	-	6.6	1-13	8.6	11.1	-	-
Tetrachloroethylene	-	-	-	0.5	0-2	1.4	1.4	-	-
Allyl chloride	-	-	-	-	-	56.1	48.3	-	-
Methanol	10.9	-	7	12.3	9-21	16.5	21.3	-	-
Ethanol	25.5	-	15	26.8	4-89	44.6	22.5	9-58	20-71
i-Propanol	30.6	-	7	-	-	17.3	20.3	-	-
Butanol	38.9	-	30	-	-	65.5	21.4	-	-
i-Butanol	45.4	-	14	-	-	38.8	25.5	-	-
Ethylene glycol	41.4	-	21	-	-	-	-	-	-
Propylene glycol	55.2	-	18	-	-	-	-	-	-
But-2-diol	-	-	-	-	-	28.8	6.6	-	-
Dimethyl ether	22.3	-	11	-	-	28.8	34.3	-	-
Methyl-t-butylether	11.1	-	8	-	-	-	-	-	-
Ethyl-t-butylether	25.2	-	26	-	-	-	-	-	-
Acetone	1.4	-	7	17.8	10-27	17.3	12.4	-	-
Methyl ethyl ketone	5.5-	-	14	47.3	17-80	38.8	17.8	-	-
Methyl-i-butyl ketone	-	-	-	-	-	67.6	31.8	-	-
Methyl acetate	-	-	-	2.5	0-7	5.8	6.7	-	-
Ethyl acetate	-	-	-	21.8	11-56	29.5	29.4	-	-
i-Propyl acetate	-	-	-	21.5	14-36	-	-	-	-
n-Butyl acetate	-	-	-	32.3	14-91	43.9	32.0	-	-
i-Butyl acetate	-	-	-	33.2	21-59	28.8	35.3	-	-
Propylene glycol methyl ether	-	-	-	-	-	77.0	49.1	-	-
Propylene glycol methyl ether acetate	-	-	-	-	-	30.9	15.7	-	-
Ethylene	100	100	100	100	100	100	100	100	100
Propylene	217	44	125	103	75-163	73.4	59.9	69-138	55-120
1-Butene	194	32	115	95.9	57-185	79.9	49.5	-	-
2-Butene	371	-	136	99.2	82-157	78.4	43.6	-	-
1-Pentene	148	-	79	105.9	40-288	72.7	42.4	-	-
2-Pentene	327	-	79	93.0	65-160	77.0	38.1	-	-

				UK		SWEDEN			
VOC	**OH Scale** [a]	**Canada by mass** [b]	**SAPRC MIR** [c]	**POCP** [d]	**range** [e]	**max diff.** [f]	**0-4 days** [g]	**EMEP** [h]	**LOTOS** [i]
2-Methyl-1-butene	300	-	70	77.7	52-113	69.1	18.1	-	-
2-Methyl-2-butene	431	24	93	77.9	61-102	93.5	45.3	-	-
3-Methyl-1-butene	158	-	79	89.5	60-154	-	-	-	-
Isobutene	318	50	77	64.3	58-76	79.1	58.0	-	-
Isoprene	515	-	121	-	-	53.2	58.3	-	-
Acetylene	10.4	82	6.8	16.8	10-42	27.3	36.8	-	-
Benzene	5.7	71	5.3	18.9	11-45	31.7	40.2	-	-
Toluene	23.4	218	34	56.3	41-83	44.6	47.0	-	-
o-Xylene	48.3	38	87	66.6	41-97	42.4	16.7	54-112	26-67
m-Xylene	80.2	53	109	99.3	78-135	58.3	47.4	-	-
p-Xylene	49.7	53	89	88.8	63-180	61.2	47.2	-	-
Ethylbenzene	25	32	36	59.3	35-114	53.2	50.4	-	-
1,2,3-Trimethyl benzene	89	-	119	117	76-175	69.8	29.2	-	-
1,2,4-Trimethyl benzene	107	44	119	120	86-176	68.3	33.0	-	-
1,3,5-Trimethyl benzene	159	-	140	115	74-174	69.1	33.0	-	-
o-Ethyltoluene	35	-	96	66.8	31-130	59.7	40.8	-	-
m-Ethyltoluene	50	-	96	79.4	41-140	62.6	40.1	-	-
p-Ethyltoluene	33	-	96	72.5	36-135	62.6	44.3	-	-
n-Propylbenzene	17	-	28	49.2	25-110	51.1	45.4	-	-
i-Propylbenzene	18	-	30	56.5	35-105	51.1	52.3	-	-
Formaldehyde	104	-	117	42.1	22-58	42.4	26.1	-	-
Acetaldehyde	128	-	72	52.7	33-122	53.2	18.6	-	-
Proprionaldehyde	117	-	87	60.3	28-160	65.5	17.0	--	-
Butyraldehyde	124	-	-	56.8	16-160	64.0	17.1	-	-
i-Butyraldehyde	144	-	-	63.1	38-128	58.3	30.0	-	-
Valeraldehyde	112	-	-	68.6	0-268	61.2	32.1	-	-
Acrolein	-	-	-	-	-	120.1	82.3	-	-
Benzaldehyde	43	-	-10	-33.4	-82-(-12)	-	-	-	-

[a] OH+VOC rate coefficient divided by molecular weight.
[b] Ambient VOC concentrations at 18 sites in Canada expressed on mass basics.
[c] Maximum Incremental Reactivity (MIR) based on California scenarios; Statewide Air Pollution Research Centre, Los Angeles, USA.
[d] Average POCP based on three scenarios and 9 days; FRG-Ireland, France-Sweden and UK.
[e] Range of POCPs based on three scenarios and 11 days.
[f] POCPs calculated for a single source in Sweden producing maximum ozone difference.
[g] POCPs calculated for a single source in Sweden using average difference in ozone over 4 days.
[h] Range (5th-95th percentile) of POCPs calculated over EMEP grid.
[i] Range (20th-80th percentile) of POCPs calculated over LOTOS grid.

POCP = (a/b) / (c/d) x 100

where

(a)-Change in photochemical oxidant formation due to a change in a VOC emission
(b)-Integrated VOC emission up to that time
(c)-Change in photochemical oxidant formation due to a change in ethylene emissions
(d)-Integrated ethylene emission up to that time

It is a quantity derived from a photochemical ozone model by following the photochemical ozone production with and without the presence of an individual hydrocarbon. The difference in ozone concentrations between such pairs of model calculations is a measure of the contribution that VOC makes in ozone formation.

SECTION VI

1994 PROTOCOL ON FURTHER REDUCTION OF SULPHUR EMISSIONS

1994 PROTOCOL ON FURTHER REDUCTION OF SULPHUR EMISSIONS

The Parties,

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

Concerned that emissions of sulphur and other air pollutants continue to be transported across international boundaries and, in exposed parts of Europe and North America, are causing widespread damage to natural resources of vital environmental and economic importance, such as forests, soils and waters, and to materials, including historic monuments, and, under certain circumstances, have harmful effects on human health,

Resolved to take precautionary measures to anticipate, prevent or minimize emissions of air pollutants and mitigate their adverse effects,

Convinced that where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that such precautionary measures to deal with emissions of air pollutants should be cost-effective,

Mindful that measures to control emissions of sulphur and other air pollutants would also contribute to the protection of the sensitive Arctic environment,

Considering that the predominant sources of air pollution contributing to the acidification of the environment are the combustion of fossil fuels for energy production, and the main technological processes in various industrial sectors, as well as transport, which lead to emissions of sulphur, nitrogen oxides, and other pollutants,

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

Desiring to take further and more effective action to control and reduce sulphur emissions,

Cognizant that any sulphur control policy, however cost-effective it may be at the regional level, will result in a relatively heavy economic burden on countries with economies that are in transition to a market economy,

Bearing in mind that measures taken to reduce sulphur emissions should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international competition and trade,

Taking into consideration existing scientific and technical data on emissions, atmospheric processes and effects on the environment of sulphur oxides, as well as on abatement costs,

Aware that, in addition to emissions of sulphur, emissions of nitrogen oxides and of ammonia are also causing acidification of the environment,

Noting that under the United Nations Framework Convention on Climate Change, adopted in New York on 9 May 1992, there is agreement to establish national policies and take corresponding measures to combat climate change, which can be expected to lead to reductions of sulphur emissions, *Affirming* the need to ensure environmentally sound and sustainable development,

Recognizing the need to continue scientific and technical cooperation to elaborate further the approach based on critical loads and critical levels, including efforts to assess several air pollutants and various effects on the environment, materials and human health,

Underlining that scientific and technical knowledge is developing and that it will be necessary to take such developments into account when reviewing the adequacy of the obligations entered into under the present Protocol and deciding on further action,

Acknowledging the Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes by at least 30 per cent, adopted in Helsinki on 8 July 1985, and the measures already taken by many countries which have had the effect of reducing sulphur emissions,

Have agreed as follows:

Article 1: DEFINITIONS

For the purposes of the present Protocol,

1. "Convention" means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. "Executive Body" means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

4. "Commission" means the United Nations Economic Commission for Europe;

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

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

7. "SOMA" means a sulphur oxides management area designated in annex III under the conditions laid down in article 2, paragraph 3;

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

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

10. "Critical sulphur deposition" means a quantitative estimate of the exposure to oxidized sulphur compounds, taking into account the effects of base cation uptake and base cation deposition, below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge;

11. "Emission" means the discharge of substances into the atmosphere;

12. "Sulphur emissions" means all emissions of sulphur compounds expressed as kilotonnes of sulphur dioxide (kt SO_2) to the atmosphere originating from anthropogenic sources excluding from ships in international traffic outside territorial waters;

13. "Fuel" means any solid, liquid or gaseous combustible material with the exception of domestic refuse and toxic or dangerous waste;

14. "Stationary combustion source" means any technical apparatus or group of technical apparatus that is co-located on a common site and is or could be discharging waste gases through a common stack, in which fuels are oxidized in order to use the heat generated;

15. "Major new stationary combustion source" means any stationary combustion source the construction or substantial modification of which is authorized after 31 December 1995 and the thermal input of which, when operating at rated capacity, is at least 50 MW_{th}. It is a matter for the competent national authorities to decide whether a modification is substantial or not, taking into account such factors as the environmental benefits of the modification;

16. "Major existing stationary combustion source" means any existing stationary combustion source the thermal input of which, when operating at rated capacity, is at least 50 MW_{th};

17. "Gas oil" means any petroleum product within HS 2710, or any petroleum product which, by reason of its distillation limits, falls within the category of middle distillates intended for use as fuel and of which at least 85% by volume, including distillation losses, distils at 350^{o} C;

18. "Emission limit value" means the permissible concentration of sulphur compounds expressed as sulphur dioxide in the waste gases from a stationary combustion source expressed in terms of mass per volume of the waste gases expressed in mg SO_2/Nm^3, assuming an oxygen content by volume in the waste gas of 3% in the case of liquid and gaseous fuels and 6% in the case of solid fuels;

19. "Emission limitation" means the permissible total quantity of sulphur compounds expressed as sulphur dioxide discharged from a combustion source or group of combustion sources located either on a common site or within a defined geographical area, expressed in kilotonnes per year;

20. "Desulphurization rate" means the ratio of the quantity of sulphur which is separated at the combustion source site over a given period to the quantity of sulphur contained in the fuel which is introduced into the combustion source facilities and which is used over the same period;

21. "Sulphur budget" means a matrix of calculated contributions to the deposition of oxidized sulphur compounds in receiving areas, originating from the emissions from specified areas.

Article 2: ***BASIC OBLIGATIONS***

1. The Parties shall control and reduce their sulphur emissions in order to protect human health and the environment from adverse effects, in particular acidifying effects, and to ensure, as far as

possible, without entailing excessive costs, that depositions of oxidized sulphur compounds in the long term do not exceed critical loads for sulphur given, in annex I, as critical sulphur depositions, in accordance with present scientific knowledge.

2. As a first step, the Parties shall, as a minimum, reduce and maintain their annual sulphur emissions in accordance with the timing and levels specified in annex II.

3. In addition, any Party:

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

(b) Which has committed itself under paragraph 2 above to a national sulphur emission ceiling no greater than the lesser of its 1990 emissions or its obligation in the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes by at least 30%, as indicated in annex II;

(c) Whose annual sulphur emissions that contribute to acidification in areas under the jurisdiction of one or more other Parties originate only from within areas under its jurisdiction that are listed as SOMAs in annex III, and has presented documentation to this effect; and

(d) Which has specified upon signature of, or accession to, the present Protocol its intention to act in accordance with this paragraph,

shall, as a minimum, reduce and maintain its annual sulphur emissions in the area so listed in accordance with the timing and levels specified in annex II.

4. Furthermore, the Parties shall make use of the most effective measures for the reduction of sulphur emissions, appropriate in their particular circumstances, for new and existing sources, which include, inter alia:

- Measures to increase energy efficiency;
- Measures to increase the use of renewable energy;
- Measures to reduce the sulphur content of particular fuels and to encourage the use of fuel with a low sulphur content, including the combined use of high-sulphur with low-sulphur or sulphur-free fuel;
- Measures to apply best available control technologies not entailing excessive cost,

using the guidance in annex IV.

5. Each Party, except those Parties subject to the United States/Canada Air Quality Agreement of 1991, shall as a minimum:

(a) Apply emission limit values at least as stringent as those specified in annex V to all major new stationary combustion sources;

(b) No later than 1 July 2004 apply, as far as possible without entailing excessive costs, emission limit values at least as stringent as those specified in annex V to those major existing

stationary combustion sources the thermal input of which is above 500 MW_{th} taking into account the remaining lifetime of a plant, calculated from the date of entry into force of the present Protocol, or apply equivalent emission limitations or other appropriate provisions, provided that these achieve the sulphur emission ceilings specified in annex II and, subsequently, further approach the critical loads as given in annex I; and no later than 1 July 2004 apply emission limit values or emission limitations to those major existing stationary combustion sources the thermal input of which is between 50 and 500 MW_{th} using annex V as guidance;

(c) No later than two years after the date of entry into force of the present Protocol apply national standards for the sulphur content of gas oil at least as stringent as those specified in annex V. In cases where the supply of gas oil cannot otherwise be ensured, a State may extend the time period given in this subparagraph to a period of up to ten years. In this case it shall specify, in a declaration to be deposited together with the instrument of ratification, acceptance, approval or accession, its intention to extend the time period.

6. The Parties may, in addition, apply economic instruments to encourage the adoption of cost-effective approaches to the reduction of sulphur emissions.

7. The Parties to this Protocol may, at a session of the Executive Body, in accordance with rules and conditions which the Executive Body shall elaborate and adopt, decide whether two or more Parties may jointly implement the obligations set out in annex II. These rules and conditions shall ensure the fulfilment of the obligations set out in paragraph 2 above and also promote the achievement of the environmental objectives set out in paragraph 1 above.

8. The Parties shall, subject to the outcome of the first review provided for under article 8 and no later than one year after the completion of that review, commence negotiations on further obligations to reduce emissions.

Article 3: EXCHANGE OF TECHNOLOGY

1. The Parties shall, consistent with their national laws, regulations and practices, facilitate the exchange of technologies and techniques, including those that increase energy efficiency, the use of renewable energy and the processing of low-sulphur fuels, to reduce sulphur emissions, particularly through the promotion of:

(a) The commercial exchange of available technology;

(b) Direct industrial contacts and cooperation, including joint ventures;

(c) The exchange of information and experience;

(d) The provision of technical assistance.

2. In promoting the activities specified in paragraph 1 above, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

3. The Parties shall, no later than six months after the date of entry into force of the present Protocol, commence consideration of procedures to create more favourable conditions for the exchange of technology to reduce sulphur emissions.

Article 4: NATIONAL STRATEGIES, POLICIES, PROGRAMMES, MEASURES AND INFORMATION

1. Each Party shall, in order to implement its obligations under article 2:

(a) Adopt national strategies, policies and programmes, no later than six months after the present Protocol enters into force for it; and

(b) Take and apply national measures to control and reduce its sulphur emissions.

2. Each Party shall collect and maintain information on:

(a) Actual levels of sulphur emissions, and of ambient concentrations and depositions of oxidized sulphur and other acidifying compounds, taking into account, for those Parties within the geographical scope of EMEP, the work plan of EMEP; and

(b) The effects of depositions of oxidized sulphur and other acidifying compounds.

Article 5: REPORTING

1. Each Party shall report, through the Executive Secretary of the Commission, to the Executive Body, on a periodic basis as determined by the Executive Body, information on:

(a) The implementation of national strategies, policies, programmes and measures referred to in article 4, paragraph 1;

(b) The levels of national annual sulphur emissions, in accordance with guidelines adopted by the Executive Body, containing emission data for all relevant source categories; and

(c) The implementation of other obligations that it has entered into under the present Protocol,

in conformity with a decision regarding format and content to be adopted by the Parties at a session of the Executive Body. The terms of this decision shall be reviewed as necessary to identify any additional elements regarding the format and/or content of the information that are to be included in the reports.

2. Each Party within the geographical scope of EMEP shall report, through the Executive Secretary of the Commission, to EMEP, on a periodic basis to be determined by the Steering Body of EMEP and approved by the Parties at a session of the Executive Body, information on the levels of sulphur emissions with temporal and spatial resolution as specified by the Steering Body of EMEP.

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

(a) Ambient concentrations and deposition of oxidized sulphur compounds; and

(b) Calculations of sulphur budgets.

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

4. The Executive Body shall, in accordance with article 10, paragraph 2 (b), of the Convention, arrange for the preparation of information on the effects of depositions of oxidized sulphur and other acidifying compounds.

5. The Parties shall, at sessions of the Executive Body, arrange for the preparation, at regular intervals, of revised information on calculated and internationally optimized allocations of emission reductions for the States within the geographical scope of EMEP, with integrated assessment models, with a view to reducing further, for the purposes of article 2, paragraph 1, of the present Protocol, the difference between actual depositions of oxidized sulphur compounds and critical load values.

Article 6: ***RESEARCH, DEVELOPMENT AND MONITORING***

The Parties shall encourage research, development, monitoring and cooperation related to:

(a) The international harmonization of methods for the establishment of critical loads and critical levels and the elaboration of procedures for such harmonization;

(b) The improvement of monitoring techniques and systems and of the modelling of transport, concentrations and deposition of sulphur compounds;

(c) Strategies for the further reduction of sulphur emissions based on critical loads and critical levels as well as on technical developments, and the improvement of integrated assessment modelling to calculate internationally optimized allocations of emission reductions taking into account an equitable distribution of abatement costs;

(d) The understanding of the wider effects of sulphur emissions on human health, the environment, in particular acidification, and materials, including historic and cultural monuments, taking into account the relationship between sulphur oxides, nitrogen oxides, ammonia, volatile organic compounds and tropospheric ozone;

(e) Emission abatement technologies, and technologies and techniques to enhance energy efficiency, energy conservation and the use of renewable energy;

(f) The economic evaluation of benefits for the environment and human health resulting from the reduction of sulphur emissions.

Article 7: ***COMPLIANCE***

1. An Implementation Committee is hereby established to review the implementation of the present Protocol and compliance by the Parties with their obligations. It shall report to the Parties at sessions of the Executive Body and may make such recommendations to them as it considers appropriate.

2. Upon consideration of a report, and any recommendations, of the Implementation Committee, the Parties, taking into account the circumstances of a matter and in accordance with Convention practice, may decide upon and call for action to bring about full compliance with the present Protocol, including measures to assist a Party's compliance with the Protocol, and to further the objectives of the Protocol.

3. The Parties shall, at the first session of the Executive Body after the entry into force of the present Protocol, adopt a decision that sets out the structure and functions of the Implementation Committee as well as procedures for its review of compliance.

4. The application of the compliance procedure shall be without prejudice to the provisions of article 9 of the present Protocol.

Article 8: ***REVIEWS BY THE PARTIES AT SESSIONS OF THE EXECUTIVE BODY***

1. The Parties shall, at sessions of the Executive Body, pursuant to article 10, paragraph 2 (a), of the Convention, review the information supplied by the Parties and EMEP, the data on the effects of depositions of sulphur and other acidifying compounds and the reports of the Implementation Committee referred to in article 7, paragraph 1, of the present Protocol.

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

(i) Their obligations in relation to their calculated and internationally optimized allocations of emission reductions referred to in article 5, paragraph 5; and
(ii) The adequacy of the obligations and the progress made towards the achievement of the objectives of the present Protocol;

(b) Reviews shall take into account the best available scientific information on acidification, including assessments of critical loads, technological developments, changing economic conditions and the fulfilment of the obligations on emission levels;

(c) In the context of such reviews, any Party whose obligations on sulphur emission ceilings under annex II hereto do not conform to the calculated and internationally optimized allocations of emission reductions for that Party, required to reduce the difference between depositions of sulphur in 1990 and critical sulphur depositions within the geographical scope of EMEP by at least 60%, shall make every effort to undertake revised obligations;

(d) The procedures, methods and timing for such reviews shall be specified by the Parties at a session of the Executive Body. The first such review shall be completed in 1997.

Article 9: ***SETTLEMENT OF DISPUTES***

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

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

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

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

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

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

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

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

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

Article 10: ***ANNEXES***

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

Article 11: ***AMENDMENTS AND ADJUSTMENTS***

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

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

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

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

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

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

Article 12: ***SIGNATURE***

1. The present Protocol shall be open for signature at Oslo on 14 June 1994, then at United Nations Headquarters in New York until 12 December 1994 by States members of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organizations concerned are Parties to the Convention and are listed in annex II.

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

Article 13: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 12 December 1994 by the States and organizations that meet the requirements of article 12, paragraph 1.

Article 14: DEPOSITARY

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

Article 15: ENTRY INTO FORCE

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

2. For each State and organization referred to in article 12, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 16: WITHDRAWAL

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

Article 17: AUTHENTIC TEXTS

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

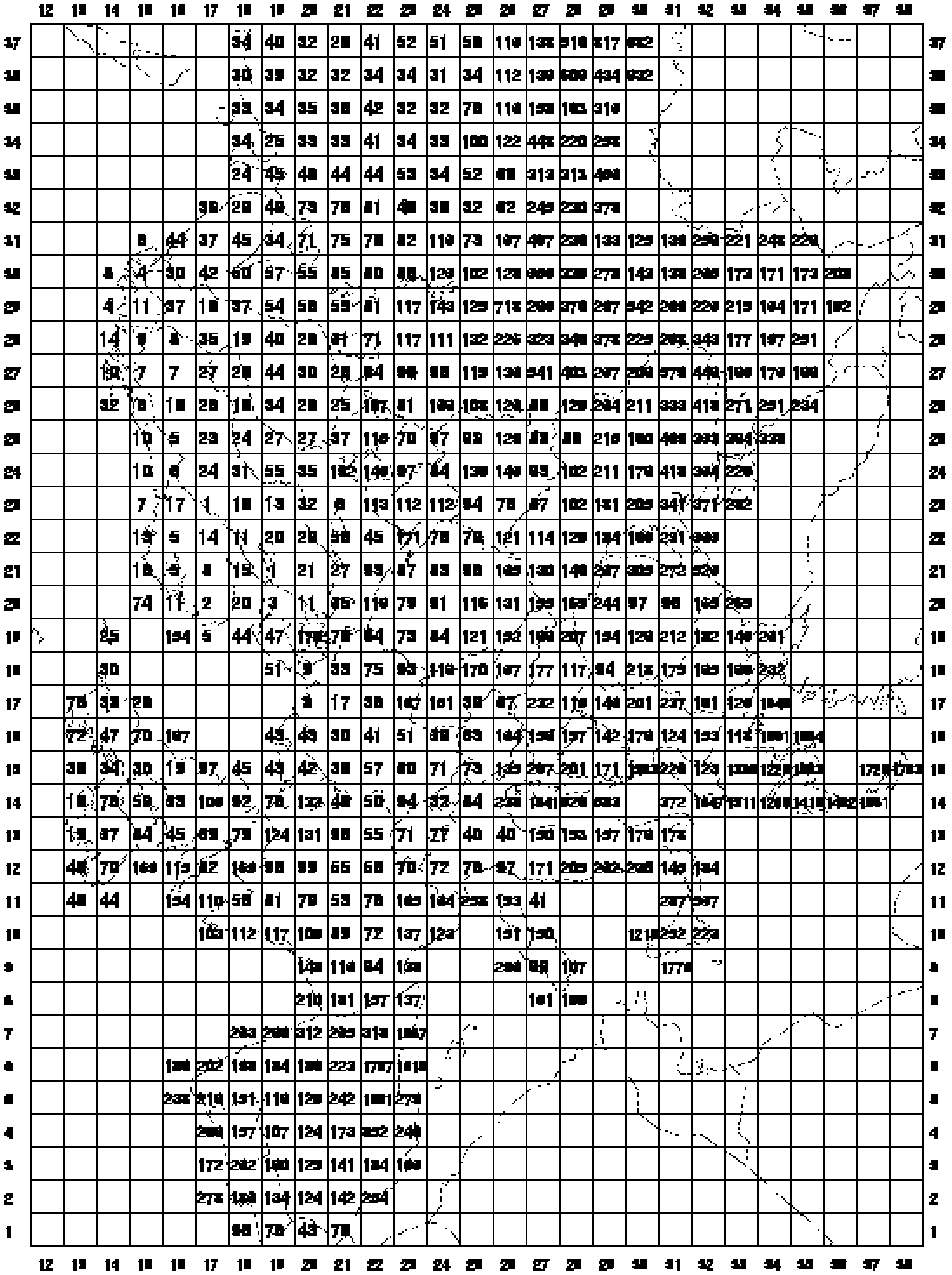
IN WITNESS WHEREOF the undersigned, being duly authorized thereto, have signed the present Protocol.

DONE at Oslo, this fourteenth day of June one thousand nine hundred and ninety-four.

Annex I

CRITICAL SULPHUR DEPOSITION

(5-percentile in centigrams of sulphur per square metre per year)



Annex II

SULPHUR EMISSIONS CEILINGS AND PERCENTAGE EMISSION REDUCTIONS

The sulphur emission ceilings listed in the table below give the obligations referred to in paragraphs 2 and 3 of article 2 of the present Protocol. The 1980 and 1990 emission levels and the percentage emission reductions listed are given for information purposes only.

	Emission levels kt SO_2 per year		**Sulphur emission ceilings [a] kt SO_2 per year**			**Percentage emission reductions (base year 1980) [b]**		
	1980	***1990***	***2000***	***2005***	***2010***	***2000***	***2005***	***2010***
Austria	397	90	78			80		
Belarus	740		456	400	370	38	46	50
Belgium	828	443	248	232	215	70	72	74
Bulgaria	2 050	2 020	1375	1 230	1 127	33	40	45
Canada								
- national	4 614	3 700	3 200			30		
- SOMA	3 245		1 750			46		
Croatia	150	160	133	125	117	11	17	22
Czech Republic	2 257	1 876	1 128	902	632	50	60	7
Denmark	451	180	90			80		
Finland	584	260	116			80		
France	3 348	1 202	868	770	737	74	77	78
Germany	7 494	5 803	1 300	990		83	87	
Greece	400	510	595	580	570	0	3	4
Hungary	1 632	1 010	898	816	653	45	50	60
Ireland	222	168	155			30		
Italy	3 800		1 330	1 042		65	73	
Liechtenstein	0.4	0.1	0.1			75		
Luxembourg	24		10			58		
Monaco [d]	0.08	0.07	0.07	0.05	0.04	13	38	50
Netherlands	466	207	106			77		
Norway	142	54	34			76		
Poland	4 100	3 210	2 583	2 173	1 397	37	47	66
Portugal	266	284	304	294		0	3	
Russian Federation [c]	7 161	4 460	4 440	4 297	4 297	38	40	40
Slovakia	843	539	337	295	240	60	65	72
Slovenia	235	195	130	94	71	45	60	70
Spain	3 319	2 316	2 143			35		
Sweden	507	130	100			80		
Switzerland	126	62	60			52		
Ukraine	3 850		2 310			40		
United Kingdom	4 898	3 780	2 449	1 470	980	50	70	80
European Community	25 513		9 598			62		

a/ If, in a given year before 2005, a Party finds that, due to a particularly cold winter, a particularly dry summer and an unforeseen short-term loss of capacity in the power supply system, domestically or in a neighbouring country, it cannot comply with its obligations under this annex, it may fulfill those obligations by averaging its national annual sulphur emissions for the year in question, the year preceding that year and the year following it, provided that the emission level in any single year is not more than 20 per cent above the sulphur emission ceiling.

The reason for exceedance in any given year and the method by which the three-year average figure will be achieved, shall be reported to the Implementation Committee.

b/ For Greece and Portugal percentage emission reductions given are based on the sulphur emission ceilings indicated for the year 2000.

c/ European part within the EMEP area.

d/ Figures for Monaco adopted at the nineteenth session of the Executive Body.

Annex III

DESIGNATION OF SULPHUR OXIDES MANAGEMENTS AREAS (SOMAS)

The following SOMA is listed for the purposes of the present Protocol:

South-east Canada SOMA

This is an area of 1 million km^2 which includes all the territory of the provinces of Prince Edward Island, Nova Scotia and New Brunswick, all the territory of the province of Quebec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Quebec-Ontario boundary intersects the James Bay coastline, and all the territory of the province of Ontario south of a straight line between the point where the Ontario-Quebec boundary intersects the James Bay coastline and Nipigon River near the north shore of Lake Superior.

Annex IV

CONTROL TECHNOLOGIES FOR SULPHUR EMISSIONS FROM STATIONARY SOURCES

I. INTRODUCTION

1. The aim of this annex is to provide guidance for identifying sulphur control options and technologies for giving effect to the obligations of the present Protocol.

2. The annex is based on information on general options for the reduction of sulphur emissions and in particular on emission control technology performance and costs contained in official documentation of the Executive Body and its subsidiary bodies.

3. Unless otherwise indicated, the reduction measures listed are considered, on the basis of operational experience of several years in most cases, to be the most well-established and economically feasible best available technologies. However, the continuously expanding experience of low-emission measures and technologies at new plants as well as of the retrofitting of existing plants will necessitate regular review of this annex.

4. Although the annex lists a number of measures and technologies spanning a wide range of costs and efficiencies, it cannot be considered as an exhaustive statement of control options. Moreover, the choice of control measures and technologies for any particular case will depend on a number of factors, including current legislation and regulatory provisions and, in particular, control technology requirements, primary energy patterns, industrial infrastructure, economic circumstances and specific in-plant conditions.

5. The annex mainly addresses the control of oxidized sulphur emissions considered as the sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3), expressed as SO_2. The share of sulphur emitted as either sulphur oxides or other sulphur compounds from non-combustion processes and other sources is small compared to sulphur emissions from combustion.

6. When measures or technologies are planned for sulphur sources emitting other components, in particular nitrogen oxides (NO_x), particulates, heavy metals and volatile organic compounds (VOCs), it is worthwhile to consider them in conjunction with pollutant-specific control options in order to maximize the overall abatement effect and minimize the impact on the environment and, especially, to avoid the transfer of air pollution problems to other media (such as waste water and solid waste).

II. MAJOR STATIONARY SOURCES FOR SULPHUR EMISSIONS

7. Fossil fuel combustion processes are the main source of anthropogenic sulphur emissions from stationary sources. In addition, some non-combustion processes may contribute considerably to the emissions. The major stationary source categories, based on EMEP/CORINAIR 90, include:

(i) Public power, cogeneration and district heating plants:
    (a) Boilers;
    (b) Stationary combustion turbines and internal combustion engines;

(ii) Commercial, institutional and residential combustion plants:
    (a) Commercial boilers;
    (b) Domestic heaters;

(iii) Industrial combustion plants and processes with combustion:
  (a) Boilers and process heaters;
  (b) Processes, e.g. metallurgical operations such as roasting and sintering, coke oven plants, processing of titanium dioxide ($Ti0_2$), etc.;
  (c) Pulp production;

(iv) Non-combustion processes, e.g. sulphuric acid production, specific organic synthesis processes, treatment of metallic surfaces;

(v) Extraction, processing and distribution of fossil fuels;

(vi) Waste treatment and disposal, e.g. thermal treatment of municipal and industrial waste.

8. Overall data (1990) for the ECE region indicate that about 88% of total sulphur emissions originate from all combustion processes (20% from industrial combustion), 5% from production processes and 7% from oil refineries. The power plant sector in many countries is the major single contributor to sulphur emissions. In some countries, the industrial sector (including refineries) is also an important SO_2 emitter. Although emissions from refineries in the ECE region are relatively small, their impact on sulphur emissions from other sources is large due to the sulphur in the oil products. Typically 60% of the sulphur intake present in the crudes remains in the products, 30% is recovered as elemental sulphur and 10% is emitted from refinery stacks.

III. GENERAL OPTIONS FOR REDUCTION OF SULPHUR EMISSIONS FROM COMBUSTION

9. General options for reduction of sulphur emissions are:

(i) Energy management measures:*

(a) Energy saving

The rational use of energy (improved energy efficiency/process operation, cogeneration and/or demand-side management) usually results in a reduction in sulphur emissions.

(b) Energy mix

In general, sulphur emissions can be reduced by increasing the proportion of non-combustion energy sources (i.e. hydro, nuclear, wind, etc.) to the energy mix. However, further environmental impacts have to be considered.

(ii) Technological options:

(a) Fuel switching

The SO_2 emissions during combustion are directly related to the sulphur content of the fuel used.

Fuel switching (e.g. from high- to low-sulphur coals and/or liquid fuels, or from coal to gas) leads to lower sulphur emissions, but there may be certain restrictions, such as the availability of low-sulphur fuels and the adaptability of existing combustion systems to different fuels. In many ECE countries,

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* Options (i) and (a) and (b) are integrated in the energy structure and policy of a Party. Implementation status, efficiency and costs per sector are not considered here.

some coal or oil combustion plants are being replaced by gas-fired combustion plants. Dual-fuel plants may facilitate fuel switching.

(b) Fuel cleaning

Cleaning of natural gas is state-of-the-art technology and widely applied for operational reasons.

Cleaning of process gas (acid refinery gas, coke oven gas, biogas, etc.) is also state-of-the-art technology.

Desulphurization of liquid fuels (light and middle fractions) is state-of-the-art technology.

Desulphurization of heavy fractions is technically feasible; nevertheless, the crude properties should be kept in mind. Desulphurization of atmospheric residue (bottom products from atmospheric crude distillation units) for the production of low-sulphur fuel oil is not, however, commonly practised; processing low-sulphur crude is usually preferable. Hydro-cracking and full conversion technology have matured and combine high sulphur retention with improved yield of light products. The number of full conversion refineries is as yet limited. Such refineries typically recover 80% to 90% of the sulphur intake and convert all residues into light products or other marketable products. For this type of refinery, energy consumption and investment costs are increased. Typical sulphur content for refinery products is given in table I below.

Current technologies to clean hard coal can remove approximately 50% of the inorganic sulphur (depending on coal properties) but none of the organic sulphur. More effective technologies are being developed which, however, involve higher specific investment and costs. Thus the efficiency of sulphur removal by coal cleaning is limited compared to flue gas desulphurization. There may be a country-specific optimization potential for the best combination of fuel cleaning and flue gas cleaning.

TABLE I

Sulphur content from refinery products
(S content (%))

	Typical present values	Anticipated future values
Gasoline	0.1	0.05
Jet kerosene	0.1	0.01
Diesel	0.05 - 0.3	<0.05
Heating oil	0.1 - 0.2	<0.1
Fuel oil	0.2 - 3.5	<1
Marine diesel	0.5 - 1.0	<0.5
Bunker oil	3.0 - 5.0	< 1 (coastal areas) < 2 (high seas)

(c) Advanced combustion technologies

These combustion technologies with improved thermal efficiency and reduced sulphur emissions include: fluidized-bed combustion (FBC): bubbling (BFBC), circulating (CFBC) and pressurized (PFBC); integrated gasification combined-cycle (IGCC); and combined-cycle gas turbines (CCGT).

Stationary combustion turbines can be integrated into combustion systems in existing conventional power plants which can increase overall efficiency by 5% to 7%, leading, for example, to a significant reduction in SO_2 emissions. However, major alterations to the existing furnace system become necessary.

Fluidized-bed combustion is a combustion technology for burning hard coal and brown coal, but it can also burn other solid fuels such as petroleum coke and low-grade fuels such as waste, peat and wood. Emissions can additionally be reduced by integrated combustion control in the system due to the addition of lime/limestone to the bed material. The total installed capacity of FBC has reached approximately 30,000 MW_{th} (250 to 350 plants), including 8,000 MW_{th} in the capacity range of greater than 50 MW_{th}. By-products from this process may cause problems with respect to use and/or disposal, and further development is required.

The IGCC process includes coal gasification and combined-cycle power generation in a gas and steam turbine. The gasified coal is burnt in the combustion chamber of the gas turbine. Sulphur emission control is achieved by the use of state-of-the-art technology for raw gas cleaning facilities upstream of the gas turbine. The technology also exists for heavy oil residues and bitumen emulsions. The installed capacity is presently about 1,000 MW_{el} (5 plants).

Combined-cycle gas-turbine power stations using natural gas as fuel with an energy efficiency of approximately 48% to 52% are currently being planned.

(d) Process and combustion modifications

Combustion modifications comparable to the measures used for NO_x emission control do not exist, as during combustion the organically and/or inorganically bound sulphur is almost completely oxidized (a certain percentage depending on the fuel properties and combustion technology is retained in the ash).

In this annex dry additive processes for conventional boilers are considered as process modifications due to the injection of an agent into the combustion unit. However, experience has shown that, when applying these processes, thermal capacity is lowered, the Ca/S ratio is high and sulphur removal low. Problems with the further utilization of the by-product have to be considered, so that this solution should usually be applied as an intermediate measure and for smaller units (table II below).

(e) Flue gas desulphurization (FGD) processes

These processes aim at removing already formed sulphur oxides, and are also referred to as secondary measures. The state-of-the-art technologies for flue gas treatment processes are all based on the removal of sulphur by wet, dry or semi-rye and catalytic chemical processes.

To achieve the most efficient programme for sulphur emission reductions beyond the energy management measures listed in (i) above a combination of technological options identified in (ii) above should be considered.

In some cases options for reducing sulphur emissions may also result in the reduction of emissions of CO_2, NO_x and other pollutants.

In public power, cogeneration and district heating plants, flue gas treatment processes used include: lime/limestone wet scrubbing (LWS); spray dry absorption (SDA); Wellman Lord process (WL); ammonia scrubbing (AS); and combined NO_x/SO_x removal processes (activated carbon process (AC) and combined catalytic NO_x/SO_x removal).

In the power generation sector, LWS and SDA cover 85% and 10%, respectively, of the installed FGD capacity.

Several new flue gas desulphurization processes, such as electron beam dry scrubbing (EBDS) and Mark 13A, have not yet passed the pilot stage.

Table II below shows the efficiency of the above-mentioned secondary measures based on the practical experience gathered from a large number of implemented plants. The implemented capacity as well as the capacity range are also mentioned. Despite comparable characteristics for several sulphur abatement technologies, local or plant-specific influences may lead to the exclusion of a given technology.

Table II also includes the usual investment cost ranges for the sulphur abatement technologies listed in sections (ii) (c), (d) and (e). However, when applying these technologies to individual cases it should be noted that investment costs of emission reduction measures will depend amongst other things on the particular technologies used, the required control systems, the plant size, the extent of the required reduction and the time-scale of planned maintenance cycles. The table thus gives only a broad range of investment costs. Investment costs for retrofit generally exceed those for new plants.

TABLE II

Emissions of sulphur oxides obtained from the application of technological options to fossil-fuelled boilers

	Uncontrolled emissions		***Additive injection***		***Wet scrubbing*** [a]		***Spray dry absorption*** [b]	
Reduction efficiency (%)			up to 60		95		up to 90	
Energy efficiency (kW$_{el}$/10^3 m^3/h)			0.1-1		6-10		3-6	
Total installed capacity (ECE Eur) (MW$_{th}$)					194,000		16,000	
Type of by-product			Mix of Ca salts and fly ashes		Gypsum (sludge/waste water)		Mix of CaSo3 * ½ H2O and fly ashes	
Specific investment (cost ECU(1990)/kW$_{el}$)			20-50		60-250		50-220	
	mg/m^3 [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***
Hard coal [d]	1,000-10,000	3.5-35	400-4,000	1.4-14	<400	<1.4	<400	<1.4
					(<200, 1% S)	<0.7	(<200, 1% S)	<0.7
Brown coal [d]	1,000-20,000	4.2-84	400-8,000	1.7-33.6	<400	<1.7	<400	<1.7
					(<200, 1% S)	<0.8	(<200, 1% S)	<0.8
Heavy oil [d]	1,000-10,000	2.8-28	400-4,000	1.1-11	<400	<1.1	<400	<1.1
					(<200, 1% S)	<0.6	(<200, 1% S)	<0.6
	Ammonia scrubbing [b]		***Wellman Lord*** [a]		***Activated carbon*** [a]		***Combined catalytic*** [a]	
Reduction efficiency (%)	up to 90		95		95		95	
Energy efficiency (kWel/103 m3/h)	3-10		10-15		4-8		2	
Total installed capacity (ECE Eur) (MWth)	200		2,000		700		1,300	
Type of by-product	Ammonia fertilizer		Elemental S Sulphuric acid (99 vol.%)		Elemental S Sulphuric acid (99 vol.%)		Sulphuric acid (70 wt.%)	
Specific investment (cost ECU(1990)/kW$_{el}$)	230-270 [e]		200-300 [e]		280-320 [e] [f]		320-350 [e] [f]	
	mg/m^3 [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***	***mg/m^3*** [c]	***g/kWh$_{el}$***
Hard coal [d]	<400	<1.4	<400	<1.4	<400	<1.4	<400	<1.4
	(<200, 1% S)	<0.7	(<200, 1% S)	<0.7	(<200, 1% S)	< 0.7	(<200, 1% S)	< 0.7
Brown coal [d]	<400	<1.7	<400	<1.7	<400	<1.7	<400	< 1.7
	(<200, 1% S)	<0.8	(<200, 1% S)	<0.8	(<200, 1% S)	<0.8	(<200, 1% S)	< 0.8
Heavy oil [d]	<400	<1.1	<400	<1.1	<400	<1.1	<400	< 1.1
	(<200, 1% S)	<0.6	(<200, 1% S)	<0.6	(<200, 1% S)	<0.6	(<200, 1% S)	< 0.6

a/ For high sulphur content in the fuel the removal efficiency has to be adapted. However, the scope for doing so may be process-specific. Availability of these processes is usually 95%.
b/ Limited applicability for high-sulphur fuels.
c/ Emission in mg/m^3 (STP), dry, 6% oxygen for solid fuels, 3% oxygen for liquid fuels.
d/ Conversion factor depends on fuel properties, specific fuel gas volume and thermal efficiency of boiler (conversion factors (m^3/kWh$_{el}$, thermal efficiency: 36%) used: hard coal: 3.50; brown coal: 4.20; heavy oil: 2.80).
e/ Specific investment cost relates to a small sample of installations.
f/ Specific investment cost includes gentrification process.

The table was established mainly for large combustion installations in the public sector. However, the control options are also valid for other sectors with similar exhaust gases.

IV. CONTROL TECHNIQUES FOR OTHER SECTORS

10. The control techniques listed in section 9 (ii) (a) to (e) are valid not only in the power plant sector but also in various other sectors of industry. Several years of operational experience have been acquired, in most cases in the power plant sector.

11. The application of sulphur abatement technologies in the industrial sector merely depends on the process's specific limitations in the relevant sectors. Important contributors to sulphur emissions and corresponding reduction measures are presented in table III below.

TABLE III

Source	Reduction measures
Roasting of non-ferrous sulphides	Wet sulphuric acid catalytic process (WSA)
Viscose production	Double-contact process
Sulphuric acid production	Double-contact process, improved yield
Kraft pulp production	Variety of process-integrated measures

12. In the sectors listed in table 3, process-integrated measures, including raw material changes (if necessary combined with sector-specific flue gas treatment), can be used to achieve the most effective reduction of sulphur emissions.

13. Reported examples are the following:

(a) In new kraft pulp mills, sulphur emission of less than 1 kg of sulphur per tonne of pulp AD (air dried) can be achieved; [**]

(b) In sulphite pulp mills, 1 to 1.5 kg of sulphur per tonne of pulp AD can be achieved;

(c) In the case of roasting of sulphides, removal efficiencies of 80 to 99% for 10,000 to 200,000 m^3/h units have been reported (depending on the process);

(d) For one iron ore sintering plant, an FGD unit of 320,000 m^3/h capacity achieves a clean gas value below 100 mg SO_x/Nm^3 at 6% O_2;

(e) Coke ovens are achieving less than 400 mg SO_x/Nm^3 at 6% O_2;

(f) Sulphuric acid plants achieve a conversion rate larger than 99%;

(g) Advanced Claus plant achieves sulphur recovery of more than 99%.

[**] Control of sulphur-to-sodium ratio is required, i.e. removal of sulphur in the form of neutral salts and use of sulphur-free sodium make-up.

V. BY-PRODUCTS AND SIDE-EFFECTS

14. As efforts to reduce sulphur emissions from stationary sources are increased in the countries of the ECE region, the quantities of by-products will also increase.

15. Options which would lead to usable by-products should be selected. Furthermore, options that lead to increased thermal efficiency and minimize the waste disposal issue whenever possible should be selected. Although most by-products are usable or recyclable products such as gypsum, ammonia salts, sulphuric acid or sulphur, factors such as market conditions and quality standards need to be taken into account. Further utilization of FBC and SDA by-products have to be improved and investigated, as disposal sites and disposal criteria limit disposal in several countries.

16. The following side-effects will not prevent the implementation of any technology or method but should be considered when several sulphur abatement options are possible:

(a) Energy requirements of the gas treatment processes;

(b) Corrosion attack due to the formation of sulphuric acid by the reaction of sulphur oxides with water vapour;

(c) Increased use of water and waste water treatment;

(d) Reagent requirements;

(e) Solid waste disposal.

VI. MONITORING AND REPORTING

17. The measures taken to carry out national strategies and policies for the abatement of air pollution include: legislation and regulatory provisions, economic incentives and disincentives; as well as technological requirements (best available technology).

18. In general, standards are set, per emission source, according to plant size, operating mode, combustion technology, fuel type and whether it is a new or existing plant. An alternative approach also used is to set a target for the reduction of total sulphur emissions from a group of sources and to allow a choice of where to take action to reach this target (the bubble concept).

19. Efforts to limit the sulphur emissions to the levels set out in the national framework legislation have to be controlled by a permanent monitoring and reporting system and reported to the supervising authorities.

20. Several monitoring systems, using both continuous and discontinuous measurement methods, are available. However, quality requirements vary. Measurements are to be carried out by qualified institutes using measuring and monitoring systems. To this end, a certification system can provide the best assurance.

21. In the framework of modern automated monitoring systems and process control equipment, reporting does not create a problem. The collection of data for further use is a state-of-the-art technique; however, data to be reported to competent authorities differ from case to case. To obtain better comparability, data sets and prescribing regulations should be harmonized. Harmonization is also

desirable for quality assurance of measuring and monitoring systems. This should be taken into account when comparing data.

22. To avoid discrepancies and inconsistencies, key issues and parameters, including the following, must be well defined:

(a) Definition of standards expressed as ppmv, mg/Nm^3, g/GJ, kg/h or kg/tonne of product. Most of these units need to be calculated and need specification in terms of gas temperature, humidity, pressure, oxygen content or heat input value;

(b) Definition of the period over which standards are to be averaged, expressed as hours, months or a year;

(c) Definition of failure times and corresponding emergency regulations regarding bypass of monitoring systems or shut-down of the installation;

(d) Definition of methods for back-filling of data missed or lost as a result of equipment failure;

(e) Definition of the parameter set to be measured. Depending on the type of industrial process, the necessary information may differ. This also involves the location of the measurement point within the system.

23. Quality control of measurements has to be ensured.

Annex V

EMISSION AND SULPHUR CONTENT LIMIT VALUES

A. EMISSION LIMIT VALUES FOR MAJOR STATIONARY COMBUSTION SOURCES [a/]			
	(i) (MW$_{th}$)	**(ii) Emission limit value** (mg SO_2/Nm^3 [b/])	**(iii) Desulphurization rate** (percent)
1. Solid Fuels (based on 6% oxygen in flue gas)	50-100	2 000	
	100-500	2 000-400 (linear decrease)	40 (for 100-167 MW$_{th}$) 40-90 (linear increase for 167-500 MW$_{th}$)
	>500	400	90
2. Liquid fuels (based on 3% oxygen in flue gas)	50-300	1 700	
	300-500	1 700-400 (linear decrease)	90
	>500	400	90
3. Gaseous Fuels (based on 3% oxygen in flue gas)			
-Gaseous fuels in general		35	
-Liquefied gas		5	
-Low calorific gases from gasification of refinery residues, coke oven gas, blast-furnace gas		800	

B. GAS OIL	Sulphur content (per cent)
Diesel for on-road vehicles	0.05
Other types	0.2

a/ As guidance, for a plant with a multi-fuel firing unit involving the simultaneous use of two or more types of fuels, the competent authorities shall set emission limit values taking into account the emission limit values from column (ii) relevant for each individual fuel, the rate of thermal input delivered by each fuel and, for refineries, the relevant specific characteristics of the plant. For refineries, such a combined limit value shall under no circumstances exceed 1,700 mg SO_2/Nm^3.

In particular, the limit values shall not apply to the following plants:

- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials, e.g. reheating furnaces, furnaces for heat treatment;
- Post-combustion plants, i.e. any technical apparatus designed to purify the waste gases by combustion which is not operated as an independent combustion plant;
- Facilities for the regeneration of catalytic cracking catalysts;
- Facilities for the conversion of hydrogen sulphide into sulphur;
- Reactors used in the chemical industry;
- Coke battery furnaces;
- Cowpers;

- Waste incinerators;
- Plants powered by diesel, petrol and gas engines or by gas turbines, irrespective of the fuel used.

In a case where a Party, due to the high sulphur content of indigenous solid or liquid fuels, cannot meet the emission limit values set forth in column (ii), it may apply the desulphurization rates set forth in column (iii) or a maximum limit value of 800 mg SO_2/Nm^3 (although preferably not more than 650 mg SO_2/Nm^3). The Party shall report any such application to the Implementation Committee in the calendar year in which it is made.

Where two or more separate new plants are installed in such a way that, taking technical and economic factors into account, their waste gases could, in the judgement of the competent authorities, be discharged through a common stack, the combination formed by such plants is to be regarded as a single unit.

b/ mg SO_2/Nm^3 is defined at a temperature of 273^o K and a pressure of 101.3 kPa, after correction for the water vapour content.

SECTION VII

1998 PROTOCOL ON HEAVY METALS

1998 PROTOCOL ON HEAVY METALS

The Parties,

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

Concerned that emissions of certain heavy metals are transported across national boundaries and may cause damage to ecosystems of environmental and economic importance and may have harmful effects on human health,

Considering that combustion and industrial processes are the predominant anthropogenic sources of emissions of heavy metals into the atmosphere,

Acknowledging that heavy metals are natural constituents of the Earth's crust and that many heavy metals in certain forms and appropriate concentrations are essential to life,

Taking into consideration existing scientific and technical data on the emissions, geochemical processes, atmospheric transport and effects on human health and the environment of heavy metals, as well as on abatement techniques and costs,

Aware that techniques and management practices are available to reduce air pollution caused by the emissions of heavy metals,

Recognizing that countries in the region of the United Nations Economic Commission for Europe (UN/ECE) have different economic conditions, and that in certain countries the economies are in transition,

Resolved to take measures to anticipate, prevent or minimize emissions of certain heavy metals and their related compounds, taking into account the application of the precautionary approach, as set forth in principle 15 of the Rio Declaration on Environment and Development,

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

Mindful that measures to control emissions of heavy metals would also contribute to the protection of the environment and human health in areas outside the UN/ECE region, including the Arctic and international waters,

Noting that abating the emissions of specific heavy metals may provide additional benefits for the abatement of emissions of other pollutants,

Aware that further and more effective action to control and reduce emissions of certain heavy metals may be needed and that, for example, effects-based studies may provide a basis for further action,

Noting the important contribution of the private and non-governmental sectors to knowledge of the effects associated with heavy metals, available alternatives and abatement techniques, and their role in assisting in the reduction of emissions of heavy metals,

Bearing in mind the activities related to the control of heavy metals at the national level and in international forums, Have agreed as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Protocol,

1. “Convention” means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. “Executive Body” means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

4. “Commission” means the United Nations Economic Commission for Europe;

5. “Parties” means, unless the context otherwise requires, the Parties to the present Protocol;

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

7. “Heavy metals” means those metals or, in some cases, metalloids which are stable and have a density greater than 4.5 g/cm^3 and their compounds;

8. “Emission” means a release from a point or diffuse source into the atmosphere;

9. “Stationary source” means any fixed building, structure, facility, installation, or equipment that emits or may emit a heavy metal listed in annex I directly or indirectly into the atmosphere;

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

11. “Major stationary source category” means any stationary source category that is listed in annex II and that contributes at least one per cent to a Party’s total emissions from stationary sources of a heavy metal listed in annex I for the reference year specified in accordance with annex I.

Article 2: ***OBJECTIVE***

The objective of the present Protocol is to control emissions of heavy metals caused by anthropogenic activities that are subject to long-range transboundary atmospheric transport and are likely to have significant adverse effects on human health or the environment, in accordance with the provisions of the following articles.

Article 3: ***BASIC OBLIGATIONS***

1. Each Party shall reduce its total annual emissions into the atmosphere of each of the heavy metals listed in annex I from the level of the emission in the reference year set in accordance with that annex by taking effective measures, appropriate to its particular circumstances.

2. Each Party shall, no later than the timescales specified in annex IV, apply:

(a) The best available techniques, taking into consideration annex III, to each new stationary source within a major stationary source category for which annex III identifies best available techniques;

(b) The limit values specified in annex V to each new stationary source within a major stationary source category. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;

(c) The best available techniques, taking into consideration annex III, to each existing stationary source within a major stationary source category for which annex III identifies best available techniques. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions;

(d) The limit values specified in annex V to each existing stationary source within a major stationary source category, insofar as this is technically and economically feasible. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions.

3. Each Party shall apply product control measures in accordance with the conditions and timescales specified in annex VI.

4. Each Party should consider applying additional product management measures, taking into consideration annex VII.

5. Each Party shall develop and maintain emission inventories for the heavy metals listed in annex I, for those Parties within the geographical scope of EMEP, using as a minimum the methodologies specified by the Steering Body of EMEP, and, for those Parties outside the geographical scope of EMEP, using as guidance the methodologies developed through the work plan of the Executive Body.

6. A Party that, after applying paragraphs 2 and 3 above, cannot achieve the requirements of paragraph 1 above for a heavy metal listed in annex I, shall be exempted from its obligations in paragraph 1 above for that heavy metal.

7. Any Party whose total land area is greater than 6,000,000 km^2 shall be exempted from its obligations in paragraphs 2 (b), (c), and (d) above, if it can demonstrate that, no later than eight years after the date of entry into force of the present Protocol, it will have reduced its total annual emissions of each of the heavy metals listed in annex I from the source categories specified in annex II by at least 50 per cent from the level of emissions from these categories in the reference year specified in accordance with annex I. A Party that intends to act in accordance with this paragraph shall so specify upon signature of, or accession to, the present Protocol.

Article 4: *EXCHANGE OF INFORMATION AND TECHNOLOGY*

1. The Parties shall, in a manner consistent with their laws, regulations and practices, facilitate the exchange of technologies and techniques designed to reduce emissions of heavy metals, including but not limited to exchanges that encourage the development of product management measures and the application of best available techniques, in particular by promoting:

(a) The commercial exchange of available technology;

(b) Direct industrial contacts and cooperation, including joint ventures;

(c) The exchange of information and experience; and

(d) The provision of technical assistance.

2. In promoting the activities specified in paragraph 1 above, the Parties shall create favourable conditions by facilitating contacts and cooperation among appropriate organizations and individuals in the private and public sectors that are capable of providing technology, design and engineering services, equipment or finance.

Article 5: *STRATEGIES, POLICIES, PROGRAMMES AND MEASURES*

1. Each Party shall develop, without undue delay, strategies, policies and programmes to discharge its obligations under the present Protocol.

2. A Party may, in addition:

(a) Apply economic instruments to encourage the adoption of cost-effective approaches to the reduction of heavy metal emissions;

(b) Develop government/industry covenants and voluntary agreements;

(c) Encourage the more efficient use of resources and raw materials;

(d) Encourage the use of less polluting energy sources;

(e) Take measures to develop and introduce less polluting transport systems;

(f) Take measures to phase out certain heavy metal emitting processes where substitute processes are available on an industrial scale;

(g) Take measures to develop and employ cleaner processes for the prevention and control of pollution.

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

Article 6: *RESEARCH, DEVELOPMENT AND MONITORING*

The Parties shall encourage research, development, monitoring and cooperation, primarily focusing on the heavy metals listed in annex I, related, but not limited, to:

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

(b) Pollutant pathways and inventories in representative ecosystems;

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

(d) Best available techniques and practices and emission control techniques currently employed by the Parties or under development;

(e) Collection, recycling and, if necessary, disposal of products or wastes containing one or more heavy metals;

(f) Methodologies permitting consideration of socio-economic factors in the evaluation of alternative control strategies;

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

(h) Alternatives to the use of heavy metals in products listed in annexes VI and VII;

(i) Gathering information on levels of heavy metals in certain products, on the potential for emissions of those metals to occur during the manufacture, processing, distribution in commerce, use, and disposal of the product, and on techniques to reduce such emissions.

Article 7: ***REPORTING***

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

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

(b) Each Party within the geographical scope of EMEP shall report, through the Executive Secretary of the Commission, to EMEP, on a periodic basis to be determined by the Steering Body of EMEP and approved by the Parties at a session of the Executive Body, information on the levels of emissions of the heavy metals listed in annex I, using as a minimum the methodologies and the temporal and spatial resolution specified by the Steering Body of EMEP. Parties in areas outside the geographical scope of EMEP shall make available similar information to the Executive Body if requested to do so. In addition, each Party shall, as appropriate, collect and report relevant information relating to its emissions of other heavy metals, taking into account the guidance on the methodologies and the temporal and spatial resolution of the Steering Body of EMEP and the Executive Body.

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

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

Article 8: CALCULATIONS

EMEP shall, using appropriate models and measurements and in good time before each annual session of the Executive Body, provide to the Executive Body calculations of transboundary fluxes and depositions of heavy metals within the geographical scope of EMEP. In areas outside the geographical scope of EMEP, models appropriate to the particular circumstances of Parties to the Convention shall be used.

Article 9: COMPLIANCE

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

Article 10: REVIEWS BY THE PARTIES AT SESSIONS OF THE EXECUTIVE BODY

1. The Parties shall, at sessions of the Executive Body, pursuant to article 10, paragraph 2 (a), of the Convention, review the information supplied by the Parties, EMEP and other subsidiary bodies and the reports of the Implementation Committee referred to in article 9 of the present Protocol.

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

3. The Parties shall, at sessions of the Executive Body, review the sufficiency and effectiveness of the obligations set out in the present Protocol.

(a) Such reviews will take into account the best available scientific information on the effects of the deposition of heavy metals, assessments of technological developments, and changing economic conditions;

(b) Such reviews will, in the light of the research, development, monitoring and cooperation undertaken under the present Protocol:

(i) Evaluate progress towards meeting the objective of the present Protocol;
(ii) Evaluate whether additional emission reductions beyond the levels required by this Protocol are warranted to reduce further the adverse effects on human health or the environment; and
(iii) Take into account the extent to which a satisfactory basis exists for the application of an effects-based approach;

(c) The procedures, methods and timing for such reviews shall be specified by the Parties at a session of the Executive Body.

4. The Parties shall, based on the conclusion of the reviews referred to in paragraph 3 above and as soon as practicable after completion of the review, develop a work plan on further steps to reduce emissions into the atmosphere of the heavy metals listed in annex I.

Article 11: ***SETTLEMENT OF DISPUTES***

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

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

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

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

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

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

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

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

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

Article 12: ***ANNEXES***

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

Article 13: ***AMENDMENTS TO THE PROTOCOL***

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

2. Proposed amendments shall be submitted in writing to the Executive Secretary of the Commission, who shall communicate them to all Parties. The Parties meeting within the Executive

Body shall discuss the proposed amendments at its next session, provided that the proposals have been circulated by the Executive Secretary to the Parties at least ninety days in advance.

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

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

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

6. In the case of a proposal to amend annex I, VI or VII by adding a heavy metal, a product control measure or a product or product group to the present Protocol:

(a) The proposer shall provide the Executive Body with the information specified in Executive Body decision 1998/1, including any amendments thereto; and

(b) The Parties shall evaluate the proposal in accordance with the procedures set forth in Executive Body decision 1998/1, including any amendments thereto.

7. Any decision to amend Executive Body decision 1998/1 shall be taken by consensus of the Parties meeting within the Executive Body and shall take effect sixty days after the date of adoption.

Article 14: ***SIGNATURE***

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

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

Article 15: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 21 December 1998 by the States and organizations that meet the requirements of article 14, paragraph 1.

Article 16: ***DEPOSITARY***

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

Article 17: ***ENTRY INTO FORCE***

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

2. For each State and organization referred to in article 14, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 18: ***WITHDRAWAL***

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

Article 19: ***AUTHENTIC TEXTS***

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

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

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

Annex I

HEAVY METALS REFERRED TO IN ARTICLE 3, PARAGRAPH 1, AND THE REFERENCE YEAR FOR THE OBLIGATION

Heavy metal	**Reference year**
Cadmium (Cd)	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.
Lead (Pb)	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.
Mercury (Hg)	1990; or an alternative year from 1985 to 1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession.

Annex II

STATIONARY SOURCE CATEGORIES

I. INTRODUCTION

1. Installations or parts of installations for research, development and the testing of new products and processes are not covered by this annex.

2. The threshold values given below generally refer to production capacities or output. Where one operator carries out several activities falling under the same subheading at the same installation or the same site, the capacities of such activities are added together.

II. LIST OF CATEGORIES

Category	Description of the category
1	Combustion installations with a net rated thermal input exceeding 50 MW.
2	Metal ore (including sulphide ore) or concentrate roasting or sintering installations with a capacity exceeding 150 tonnes of sinter per day for ferrous ore or concentrate, and 30 tonnes of sinter per day for the roasting of copper, lead or zinc, or any gold and mercury ore treatment.
3	Installations for the production of pig-iron or steel (primary or secondary fusion, including electric arc furnaces) including continuous casting, with a capacity exceeding 2.5 tonnes per hour.
4	Ferrous metal foundries with a production capacity exceeding 20 tonnes per day.
5	Installations for the production of copper, lead and zinc from ore, concentrates or secondary raw materials by metallurgical processes with a capacity exceeding 30 tonnes of metal per day for primary installations and 15 tonnes of metal per day for secondary installations, or for any primary production of mercury.
6	Installations for the smelting (refining, foundry casting, etc.), including the alloying, of copper, lead and zinc, including recovered products, with a melting capacity exceeding 4 tonnes per day for lead or 20 tonnes per day for copper and zinc.
7	Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day.
8	Installations for the manufacture of glass using lead in the process with a melting capacity exceeding 20 tonnes per day.
9	Installations for chlor-alkali production by electrolysis using the mercury cell process.
10	Installations for the incineration of hazardous or medical waste with a capacity exceeding 1 tonne per hour, or for the co-incineration of hazardous or medical waste specified in accordance with national legislation.
11	Installations for the incineration of municipal waste with a capacity exceeding 3 tonnes per hour, or for the co-incineration of municipal waste specified in accordance with national legislation.

Annex III

BEST AVAILABLE TECHNIQUES FOR CONTROLLING EMISSIONS OF HEAVY METALS AND THEIR COMPOUNDS FROM THE SOURCE CATEGORIES LISTED IN ANNEX II

I. INTRODUCTION

1. This annex aims to provide Parties with guidance on identifying best available techniques for stationary sources to enable them to meet the obligations 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. The information regarding emission control performance and costs is based on official documentation of the Executive Body and its subsidiary bodies, in particular documents received and

reviewed by the Task Force on Heavy Metal Emissions and the Ad Hoc Preparatory Working Group on Heavy Metals. Furthermore, other international information on best available techniques for emission control has been taken into consideration (e.g. the European Community's technical notes on BAT, the PARCOM recommendations for BAT, and information provided directly by experts).

4. Experience with new products and new plants incorporating low-emission techniques, as well as with the retrofitting of existing plants, is growing continuously; this annex may, therefore, need amending and updating.

5. The annex lists a number of measures spanning a range of costs and efficiencies. The choice of measures for any particular case will depend on, and may be limited by, a number of factors, such as economic circumstances, technological infrastructure, any existing emission control device, safety, energy consumption and whether the source is a new or existing one.

6. This annex takes into account the emissions of cadmium, lead and mercury and their compounds, in solid (particle-bound) and/or gaseous form. Speciation of these compounds is, in general, not considered here. Nevertheless, the efficiency of emission control devices with regard to the physical properties of the heavy metal, especially in the case of mercury, has been taken into account.

7. Emission values expressed as mg/m^3 refer to standard conditions (volume at 273.15 K, 101.3 kPa, dry gas) not corrected for oxygen content unless otherwise specified, and are calculated in accordance with draft CEN (Comité européen de normalisation) and, in some cases, national sampling and monitoring techniques.

II. GENERAL OPTIONS FOR REDUCING EMISSIONS OF HEAVY METALS AND THEIR COMPOUNDS

8. There are several possibilities for controlling or preventing heavy metal emissions. Emission reduction measures focus on add-on technologies and process modifications (including maintenance and operating control). The following measures, which may be implemented depending on the wider technical and/or economic conditions, are available:

(a) Application of low-emission process technologies, in particular in new installations;

(b) Off-gas cleaning (secondary reduction measures) with filters, scrubbers, absorbers, etc.;

(c) Change or preparation of raw materials, fuels and/or other feed materials (e.g. use of raw materials with low heavy metal content);

(d) Best management practices such as good housekeeping, preventive maintenance programmes, or primary measures such as the enclosure of dust-creating units;

(e) Appropriate environmental management techniques for the use and disposal of certain products containing Cd, Pb, and/or Hg.

9. It is necessary to monitor abatement procedures to ensure that appropriate control measures and practices are properly implemented and achieve an effective emission reduction. Monitoring abatement procedures will include:

(a) Developing an inventory of those reduction measures identified above that have already been implemented;

(b) Comparing actual reductions in Cd, Pb and Hg emissions with the objectives of the Protocol;

(c) Characterizing quantified emissions of Cd, Pb and Hg from relevant sources with appropriate techniques;

(d) Regulatory authorities periodically auditing abatement measures to ensure their continued efficient operation.

10. Emission reduction measures should be cost-efficient. Cost-efficient strategy considerations should be based on total costs per year per unit abated (including capital and operating costs). Emission reduction costs should also be considered with respect to the overall process.

III. CONTROL TECHNIQUES

11. The major categories of available control techniques for Cd, Pb and Hg emission abatement are primary measures such as raw material and/or fuel substitution and low-emission process technologies, and secondary measures such as fugitive emission control and off-gas cleaning. Sector-specific techniques are specified in chapter IV.

12. The data on efficiency are derived from operating experience and are considered to reflect the capabilities of current installations. The overall efficiency of flue gas and fugitive emission reductions depends to a great extent on the evacuation performance of the gas and dust collectors (e.g. suction hoods). Capture/collection efficiencies of over 99% have been demonstrated. In particular cases experience has shown that control measures are able to reduce overall emissions by 90% or more.

13. In the case of particle-bound emissions of Cd, Pb and Hg, the metals can be captured by dust-cleaning devices. Typical dust concentrations after gas cleaning with selected techniques are given in table I. Most of these measures have generally been applied across sectors. The minimum expected performance of selected techniques for capturing gaseous mercury is outlined in table II. The application of these measures depends on the specific processes and is most relevant if concentrations of mercury in the flue gas are high.

TABLE I

Performance of dust-cleaning devices expressed as hourly average dust concentrations

	Dust concentrations after cleaning (mg/m^3)
Fabric filters	< 10
Fabric filters, membrane type	< 1
Dry electrostatic precipitators	< 50
Wet electrostatic precipitators	< 50
High-efficiency scrubbers	< 50

Note: Medium- and low-pressure scrubbers and cyclones generally show lower dust removal efficiencies.

TABLE II

Minimum expected performance of mercury separators expressed as hourly average mercury concentrations

	Mercury content after cleaning (mg/m^3)
Selenium filter	< 0.01
Selenium scrubber	< 0.2
Carbon filter	< 0.01
Carbon injection + dust separator	< 0.05
Odda Norzink chloride process	< 0.1
Lead sulphide process	< 0.05
Bolkem (Thiosulphate) process	< 0.1

14. Care should be taken to ensure that these control techniques do not create other environmental problems. The choice of a specific process because of its low emission into the air should be avoided if it worsens the total environmental impact of the heavy metals' discharge, e.g. due to more water pollution from liquid effluents. The fate of captured dust resulting from improved gas cleaning must also be taken into consideration. A negative environmental impact from the handling of such wastes will reduce the gain from lower process dust and fume emissions into the air.

15. Emission reduction measures can focus on process techniques as well as on off-gas cleaning. The two are not independent of each other; the choice of a specific process might exclude some gas-cleaning methods.

16. The choice of a control technique will depend on such parameters as the pollutant concentration and/or speciation in the raw gas, the gas volume flow, the gas temperature, and others. Therefore, the fields of application may overlap; in that case, the most appropriate technique must be selected according to case-specific conditions.

17. Adequate measures to reduce stack gas emissions in various sectors are described below. Fugitive emissions have to be taken into account. Dust emission control associated with the discharging, handling, and stockpiling of raw materials or by-products, although not relevant to long-range transport, may be important for the local environment. The emissions can be reduced by moving these activities to completely enclosed buildings, which may be equipped with ventilation and dedusting facilities, spray systems or other suitable controls. When stockpiling in unroofed areas, the material surface should be otherwise protected against wind entrainment. Stockpiling areas and roads should be kept clean.

18. The investment/cost figures listed in the tables have been collected from various sources and are highly case-specific. They are expressed in 1990 US$ (US$ 1 (1990) = ECU 0.8 (1990)). They depend on such factors as plant capacity, removal efficiency and raw gas concentration, type of technology, and the choice of new installations as opposed to retrofitting.

IV. SECTORS

19. This chapter contains a table per relevant sector with the main emission sources, control measures based on the best available techniques, their specific reduction efficiency and the related costs, where available. Unless stated otherwise, the reduction efficiencies in the tables refer to direct stack gas emissions.

Combustion of fossil fuels in utility and industrial boilers
(annex II, category 1)

20. The combustion of coal in utility and industrial boilers is a major source of anthropogenic mercury emissions. The heavy metal content is normally several orders of magnitude higher in coal than in oil or natural gas.

21. Improved energy conversion efficiency and energy conservation measures will result in a decline in the emissions of heavy metals because of reduced fuel requirements. Combusting natural gas or alternative fuels with a low heavy metal content instead of coal would also result in a significant reduction in heavy metal emissions such as mercury. Integrated gasification combined-cycle (IGCC) power plant technology is a new plant technology with a low-emission potential.

22. With the exception of mercury, heavy metals are emitted in solid form in association with fly-ash particles. Different coal combustion technologies show different magnitudes of fly-ash generation: grate-firing boilers 20-40%; fluidized-bed combustion 15%; dry bottom boilers (pulverized coal combustion) 70-100% of total ash. The heavy metal content in the small particle size fraction of the fly-ash has been found to be higher.

23. Beneficiation, e.g. “washing” or “bio-treatment”, of coal reduces the heavy metal content associated with the inorganic matter in the coal. However, the degree of heavy metal removal with this technology varies widely.

24. A total dust removal of more than 99.5% can be obtained with electrostatic precipitators (ESP) or fabric filters (FF), achieving dust concentrations of about 20 mg/m^3 in many cases. With the exception of mercury, heavy metal emissions can be reduced by at least 90-99%, the lower figure for the more easily volatilized elements. Low filter temperature helps to reduce the gaseous mercury off-gas content.

25. The application of techniques to reduce emissions of nitrogen oxides, sulphur dioxide and particulates from the flue gas can also remove heavy metals. Possible cross media impact should be avoided by appropriate waste water treatment.

26. Using the techniques mentioned above, mercury removal efficiencies vary extensively from plant to plant, as seen in table III. Research is ongoing to develop mercury removal techniques, but until such techniques are available on an industrial scale, no best available technique is identified for the specific purpose of removing mercury.

TABLE III

Control measures, reduction efficiencies and costs for fossil-fuel combustion emissions

Emission source	Control measure(s)	Reduction efficiency (%)	Abatement costs
Combustion of fuel oil	Switch from fuel oil to gas	Cd, Pb: 100; Hg: 70 - 80	Highly case-specific
Combustion of coal	Switch from coal to fuels with lower heavy metals emissions	Dust: 70 - 100	Highly case-specific
	ESP (cold-side)	Cd, Pb: > 90; Hg: 10 - 40	Specific investment US$ 5-10/m^3 waste gas per hour (> 200,000 m^3/h)

Emission source	Control measure(s)	Reduction efficiency (%)	Abatement costs
Combustion of coal	Wet flue-gas desulphurization (FGD) [a/]	Cd, Pb: > 90; Hg: 10 - 90 [b/]	..
	Fabric filters (FF)	Cd: > 95; Pb: > 99; Hg: 10 - 60	Specific investment US$ 8-15/m^3 waste gas per hour (> 200,000 m^3/h)

a/ Hg removal efficiencies increase with the proportion of ionic mercury. High-dust selective catalytic reduction (SCR) installations facilitate Hg(II) formation.

b/ This is primarily for SO_2 reduction. Reduction in heavy metal emissions is a side benefit. (Specific investment US$ 60-250/kW_{el}.)

Primary iron and steel industry
(annex II, category 2)

27. This section deals with emissions from sinter plants, pellet plants, blast furnaces, and steelworks with a basic oxygen furnace (BOF). Emissions of Cd, Pb and Hg occur in association with particulates. The content of the heavy metals of concern in the emitted dust depends on the composition of the raw materials and the types of alloying metals added in steel-making. The most relevant emission reduction measures are outlined in table IV. Fabric filters should be used whenever possible; if conditions make this impossible, electrostatic precipitators and/or high-efficiency scrubbers may be used.

28. When using BAT in the primary iron and steel industry, the total specific emission of dust directly related to the process can be reduced to the following levels:

Sinter plants	40 - 120 g/Mg
Pellet plants	40 g/Mg
Blast furnace	35 - 50 g/Mg
BOF	35 - 70 g/Mg.

29. Purification of gases using fabric filters will reduce the dust content to less than 20 mg/m^3, whereas electrostatic precipitators and scrubbers will reduce the dust content to 50 mg/m^3 (as an hourly average). However, there are many applications of fabric filters in the primary iron and steel industry that can achieve much lower values.

TABLE IV

Emission sources, control measures, dust reduction efficiencies and costs for the primary iron and steel industry

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
Sinter plants	Emission optimized sintering	ca. 50	..
	Scrubbers and ESP	> 90	..
	Fabric filters	> 99	..
Pellet plants	ESP + lime reactor + fabric filters	> 99	..
	Scrubbers	> 95	..
Blast furnaces	FF / ESP	> 99	ESP: 0.24-1/Mg pig-iron
Blast furnace gas cleaning	Wet scrubbers	> 99	..
	Wet ESP	> 99	..

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
BOF	Primary dedusting: wet separator/ESP/FF	> 99	Dry ESP: 2.25/Mg steel
	Secondary dedusting: dry ESP/FF	> 97	FF: 0.26/Mg steel
Fugitive emissions	Closed conveyor belts, enclosure, wetting stored feedstock, cleaning of roads	80 - 99	..

30. Direct reduction and direct smelting are under development and may reduce the need for sinter plants and blast furnaces in the future. The application of these technologies depends on the ore characteristics and requires the resulting product to be processed in an electric arc furnace, which should be equipped with appropriate controls.

Secondary iron and steel industry
(annex II, category 3)

31. It is very important to capture all the emissions efficiently. That is possible by installing doghouses or movable hoods or by total building evacuation. The captured emissions must be cleaned. For all dust-emitting processes in the secondary iron and steel industry, dedusting in fabric filters, which reduces the dust content to less than 20 mg/m^3, shall be considered as BAT. When BAT is used also for minimizing fugitive emissions, the specific dust emission (including fugitive emission directly related to the process) will not exceed the range of 0.1 to 0.35 kg/Mg steel. There are many examples of clean gas dust content below 10 mg/m^3 when fabric filters are used. The specific dust emission in such cases is normally below 0.1 kg/Mg.

32. For the melting of scrap, two different types of furnace are in use: open-hearth furnaces and electric arc furnaces (EAF) where open-hearth furnaces are about to be phased out.

33. The content of the heavy metals of concern in the emitted dust depends on the composition of the iron and steel scrap and the types of alloying metals added in steel-making. Measurements at EAF have shown that 95% of emitted mercury and 25% of cadmium emissions occur as vapour. The most relevant dust emission reduction measures are outlined in table V.

TABLE V

Emission sources, control measures, dust reduction efficiencies and costs for the secondary iron and steel industry

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
EAF	ESP FF	> 99 > 99.5	.. FF: 24/Mg steel

Iron foundries
(annex II, category 4)

34. It is very important to capture all the emissions efficiently. That is possible by installing doghouses or movable hoods or by total building evacuation. The captured emissions must be cleaned. In iron foundries, cupola furnaces, electric arc furnaces and induction furnaces are operated. Direct particulate and gaseous heavy metal emissions are especially associated with melting and sometimes, to a small extent, with pouring. Fugitive emissions arise from raw material handling, melting, pouring and fettling. The most relevant emission reduction measures are outlined in table VI

with their achievable reduction efficiencies and costs, where available. These measures can reduce dust concentrations to 20 mg/m^3, or less.

35. The iron foundry industry comprises a very wide range of process sites. For existing smaller installations, the measures listed may not be BAT if they are not economically viable.

TABLE VI

Emission sources, control measures, dust reduction efficiencies and costs for iron foundries

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
EAF	ESP	> 99	..
	FF	> 99.5	FF: 24/Mg iron
Induction furnace	FF/dry absorption + FF	> 99	..
Cold blast cupola	Below-the-door take-off: FF	> 98	..
	Above-the-door take-off:		
	FF + pre-dedusting	> 97	8-12/Mg iron
	FF + chemisorption	> 99	45/Mg iron
Hot blast cupola	FF + pre-dedusting	> 99	23/Mg iron
	Disintegrator/ venturi scrubber	> 97	..

Primary and secondary non-ferrous metal industry
(annex II, categories 5 and 6)

36. This section deals with emissions and emission control of Cd, Pb and Hg in the primary and secondary production of non-ferrous metals like lead, copper, zinc, tin and nickel. Due to the large number of different raw materials used and the various processes applied, nearly all kinds of heavy metals and heavy metal compounds might be emitted from this sector. Given the heavy metals of concern in this annex, the production of copper, lead and zinc are particularly relevant.

37. Mercury ores and concentrates are initially processed by crushing, and sometimes screening. Ore beneficiation techniques are not used extensively, although flotation has been used at some facilities processing low-grade ore. The crushed ore is then heated in either retorts, at small operations, or furnaces, at large operations, to the temperatures at which mercuric sulphide sublimates. The resulting mercury vapour is condensed in a cooling system and collected as mercury metal. Soot from the condensers and settling tanks should be removed, treated with lime and returned to the retort or furnace.

38. For efficient recovery of mercury the following techniques can be used:

- Measures to reduce dust generation during mining and stockpiling, including minimizing the size of stockpiles;
- Indirect heating of the furnace;
- Keeping the ore as dry as possible;
- Bringing the gas temperature entering the condenser to only 10 to 20°C above the dew point;
- Keeping the outlet temperature as low as possible; and
- Passing reaction gases through a post-condensation scrubber and/or a selenium filter.

Dust formation can be kept down by indirect heating, separate processing of fine grain classes of ore, and control of ore water content. Dust should be removed from the hot reaction gas before it enters the mercury condensation unit with cyclones and/or electrostatic precipitators.

39. For gold production by amalgamation, similar strategies as for mercury can be applied. Gold is also produced using techniques other than amalgamation, and these are considered to be the preferred option for new plants.

40. Non-ferrous metals are mainly produced from sulphitic ores. For technical and product quality reasons, the off-gas must go through a thorough dedusting (< 3 mg/m^3) and could also require additional mercury removal before being fed to an SO_3 contact plant, thereby also minimizing heavy metal emissions.

41. Fabric filters should be used when appropriate. A dust content of less than 10 mg/m^3 can be obtained. The dust of all pyrometallurgical production should be recycled in-plant or off-site, while protecting occupational health.

42. For primary lead production, first experiences indicate that there are interesting new direct smelting reduction technologies without sintering of the concentrates. These processes are examples of a new generation of direct autogenous lead smelting technologies which pollute less and consume less energy.

43. Secondary lead is mainly produced from used car and truck batteries, which are dismantled before being charged to the smelting furnace. This BAT should include one melting operation in a short rotary furnace or shaft furnace. Oxy-fuel burners can reduce waste gas volume and flue dust production by 60%. Cleaning the flue-gas with fabric filters makes it possible to achieve dust concentration levels of 5 mg/m^3.

44. Primary zinc production is carried out by means of roast-leach electrowin technology. Pressure leaching may be an alternative to roasting and may be considered as a BAT for new plants depending on the concentrate characteristics. Emissions from pyrometallurgical zinc production in Imperial Smelting (IS) furnaces can be minimized by using a double bell furnace top and cleaning with high-efficiency scrubbers, efficient evacuation and cleaning of gases from slag and lead casting, and thorough cleaning (< 10 mg/m^3) of the CO-rich furnace off-gases.

45. To recover zinc from oxidized residues these are processed in an IS furnace. Very low-grade residues and flue dust (e.g. from the steel industry) are first treated in rotary furnaces (Waelz-furnaces) in which a high-content zinc oxide is manufactured. Metallic materials are recycled through melting in either induction furnaces or furnaces with direct or indirect heating by natural gas or liquid fuels or in vertical New Jersey retorts, in which a large variety of oxidic and metallic secondary material can be recycled. Zinc can also be recovered from lead furnace slags by a slag fuming process.

TABLE VII (a)

Emission sources, control measures, dust reduction efficiencies and costs for the primary non-ferrous metal industry

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
Fugitive emissions	Suction hoods, enclosure, etc. off-gas cleaning by FF	> 99	..

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs US$)
Roasting/sintering	Updraught sintering: ESP + scrubbers (prior to double contact sulphuric acid plant) + FF for tail gases	..	7 - 10/Mg H_2SO_4
Conventional smelting (blast furnace reduction)	Shaft furnace: closed top/ efficient evacuation of tap holes + FF, covered launders, double bell furnace top	..	..
Imperial smelting	High-efficiency scrubbing Venturi scrubbers Double bell furnace top	> 95	.. .. 4/Mg metal produced
Pressure leaching	Application depends on leaching characteristics of concentrates	> 99	Site-specific
Direct smelting reduction processes	Flash smelting, e.g. Kivcet, Outokumpu and Mitsubishi processes	..	..
	Bath smelting, e.g. top blown rotary converter, Ausmelt, Isasmelt, QSL and Noranda processes	Ausmelt: Pb 77, Cd 97; QSL: Pb 92, Cd 93	QSL: operating costs 60/Mg Pb

TABLE VII (b)

Emission sources, control measures, dust reduction efficiencies and costs for the secondary non-ferrous metal industry

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs, US$)
Lead production	Short rotary furnace: suction hoods for tap holes + FF; tube condenser, oxy-fuel burner	99.9	45/Mg Pb
Zinc production	Imperial smelting	> 95	14/Mg Zn

46. In general, processes should be combined with an effective dust collecting device for both primary gases and fugitive emissions. The most relevant emission reduction measures are outlined in tables VII (a) and (b). Dust concentrations below 5 mg/m^3 have been achieved in some cases using fabric filters.

Cement industry
(annex II, category 7)

47. Cement kilns may use secondary fuels such as waste oil or waste tyres. Where waste is used, emission requirements for waste incineration processes may apply, and where hazardous waste is used, depending on the amount used in the plant, emission requirements for hazardous waste incineration processes may apply. However, this section refers to fossil fuel fired kilns.

48. Particulates are emitted at all stages of the cement production process, consisting of material handling, raw material preparation (crushers, dryers), clinker production and cement preparation. Heavy metals are brought into the cement kiln with the raw materials, fossil and waste fuels.

49. For clinker production the following kiln types are available: long wet rotary kiln, long dry rotary kiln, rotary kiln with cyclone preheater, rotary kiln with grate preheater, shaft furnace. In terms

of energy demand and emission control opportunities, rotary kilns with cyclone preheaters are preferable.

50. For heat recovery purposes, rotary kiln off-gases are conducted through the preheating system and the mill dryers (where installed) before being dedusted. The collected dust is returned to the feed material.

51. Less than 0.5% of lead and cadmium entering the kiln is released in exhaust gases. The high alkali content and the scrubbing action in the kiln favour metal retention in the clinker or kiln dust.

52. The emissions of heavy metals into the air can be reduced by, for instance, taking off a bleed stream and stockpiling the collected dust instead of returning it to the raw feed. However, in each case these considerations should be weighed against the consequences of releasing the heavy metals into the waste stockpile. Another possibility is the hot-meal bypass, where calcined hot-meal is in part discharged right in front of the kiln entrance and fed to the cement preparation plant. Alternatively, the dust can be added to the clinker. Another important measure is a very well controlled steady operation of the kiln in order to avoid emergency shut-offs of the electrostatic precipitators. These may be caused by excessive CO concentrations. It is important to avoid high peaks of heavy metal emissions in the event of such an emergency shut-off.

53. The most relevant emission reduction measures are outlined in table VIII. To reduce direct dust emissions from crushers, mills, and dryers, fabric filters are mainly used, whereas kiln and clinker cooler waste gases are controlled by electrostatic precipitators. With ESP, dust can be reduced to concentrations below 50 mg/m^3. When FF are used, the clean gas dust content can be reduced to 10 mg/m^3.

TABLE VIII

Emission sources, control measures, reduction efficiencies and costs for the cement industry

Emission source	Control measure(s)	Reduction efficiency (%)	Abatement costs
Direct emissions from crushers, mills, dryers	FF	Cd, Pb: > 95	..
Direct emissions from rotary kilns, clinker coolers	ESP	Cd, Pb: > 95	..
Direct emissions from rotary kilns	Carbon adsorption	Hg: > 95	..

Glass industry
(annex II, category 8)

54. In the glass industry, lead emissions are particularly relevant given the various types of glass in which lead is introduced as raw material (e.g. crystal glass, cathode ray tubes). In the case of soda-lime container glass, lead emissions depend on the quality of the recycled glass used in the process. The lead content in dusts from crystal glass melting is usually about 20-60%.

55. Dust emissions stem mainly from batch mixing, furnaces, diffuse leakages from furnace openings, and finishing and blasting of glass products. They depend notably on the type of fuel used, the furnace type and the type of glass produced. Oxy-fuel burners can reduce waste gas volume and flue dust production by 60%. The lead emissions from electrical heating are considerably lower than from oil/gas-firing.

56. The batch is melted in continuous tanks, day tanks or crucibles. During the melting cycle using discontinuous furnaces, the dust emission varies greatly. The dust emissions from crystal glass tanks (<5 kg/Mg melted glass) are higher than from other tanks (<1 kg/Mg melted soda and potash glass).

57. Some measures to reduce direct metal-containing dust emissions are: pelleting the glass batch, changing the heating system from oil/gas-firing to electrical heating, charging a larger share of glass returns in the batch, and applying a better selection of raw materials (size distribution) and recycled glass (avoiding lead-containing fractions). Exhaust gases can be cleaned in fabric filters, reducing the emissions below 10 mg/m^3. With electrostatic precipitators 30 mg/m^3 is achieved. The corresponding emission reduction efficiencies are given in table IX.

58. The development of crystal glass without lead compounds is in progress.

TABLE IX

Emission sources, control measures, dust reduction efficiencies and costs for the glass industry

Emission source	Control measure(s)	Dust reduction efficiency (%)	Abatement costs (total costs)
Direct emissions	FF	> 98	..
	ESP	> 90	..

Chlor-alkali industry
(annex II, category 9)

59. In the chlor-alkali industry, Cl_2, alkali hydroxides and hydrogen are produced through electrolysis of a salt solution. Commonly used in existing plants are the mercury process and the diaphragm process, both of which need the introduction of good practices to avoid environmental problems. The membrane process results in no direct mercury emissions. Moreover, it shows a lower electrolytic energy and higher heat demand for alkali hydroxide concentration (the global energy balance resulting in a slight advantage for membrane cell technology in the range of 10 to 15%) and a more compact cell operation. It is, therefore, considered as the preferred option for new plants. Decision 90/3 of 14 June 1990 of the Commission for the Prevention of Marine Pollution from Land-based Sources (PARCOM) recommends that existing mercury cell chlor-alkali plants should be phased out as soon as practicable with the objective of phasing them out completely by 2010.

60. The specific investment for replacing mercury cells by the membrane process is reported to be in the region of US$ 700-1000/Mg Cl_2 capacity. Although additional costs may result from, inter alia, higher utility costs and brine purification cost, the operating cost will in most cases decrease. This is due to savings mainly from lower energy consumption, and lower waste-water treatment and waste-disposal costs.

61. The sources of mercury emissions into the environment in the mercury process are: cell room ventilation; process exhausts; products, particularly hydrogen; and waste water. With regard to emissions into air, Hg diffusely emitted from the cells to the cell room are particularly relevant. Preventive measures and control are of great importance and should be prioritized according to the relative importance of each source at a particular installation. In any case specific control measures are required when mercury is recovered from sludges resulting from the process.

62. The following measures can be taken to reduce emissions from existing mercury process plants:

- Process control and technical measures to optimize cell operation, maintenance and more efficient working methods;
- Coverings, sealings and controlled bleeding-off by suction;
- Cleaning of cell rooms and measures that make it easier to keep them clean; and
- Cleaning of limited gas streams (certain contaminated air streams and hydrogen gas).

63. These measures can cut mercury emissions to values well below 2.0 g/Mg of Cl_2 production capacity, expressed as an annual average. There are examples of plants that achieve emissions well below 1.0 g/Mg of Cl_2 production capacity. As a result of PARCOM decision 90/3, existing mercury-based chlor-alkali plants were required to meet the level of 2 g of Hg/Mg of Cl_2 by 31 December 1996 for emissions covered by the Convention for the Prevention of Marine Pollution from Land-based Sources. Since emissions depend to a large extent on good operating practices, the average should depend on and include maintenance periods of one year or less.

Municipal, medical and hazardous waste incineration
(annex II, categories 10 and 11)

64. Emissions of cadmium, lead and mercury result from the incineration of municipal, medical and hazardous waste. Mercury, a substantial part of cadmium and minor parts of lead are volatilized in the process. Particular actions should be taken both before and after incineration to reduce these emissions.

65. The best available technology for dedusting is considered to be fabric filters in combination with dry or wet methods for controlling volatiles. Electrostatic precipitators in combination with wet systems can also be designed to reach low dust emissions, but they offer fewer opportunities than fabric filters especially with pre-coating for adsorption of volatile pollutants.

66. When BAT is used for cleaning the flue gases, the concentration of dust will be reduced to a range of 10 to 20 mg/m^3; in practice lower concentrations are reached, and in some cases concentrations of less than 1 mg/m^3 have been reported. The concentration of mercury can be reduced to a range of 0.05 to 0.10 mg/m^3 (normalized to 11% O_2).

67. The most relevant secondary emission reduction measures are outlined in table X. It is difficult to provide generally valid data because the relative costs in US$/tonne depend on a particularly wide range of site-specific variables, such as waste composition.

68. Heavy metals are found in all fractions of the municipal waste stream (e.g. products, paper, organic materials). Therefore, by reducing the quantity of municipal waste that is incinerated, heavy metal emissions can be reduced. This can be accomplished through various waste management strategies, including recycling programmes and the composting of organic materials. In addition, some UN/ECE countries allow municipal waste to be landfilled. In a properly managed landfill, emissions of cadmium and lead are eliminated and mercury emissions may be lower than with incineration. Research on emissions of mercury from landfills is taking place in several UN/ECE countries.

TABLE X

Emission sources, control measures, reduction efficiencies and costs for municipal, medical and hazardous waste incineration

Emission source	Control measure(s)	Reduction efficiency (%)	Abatement costs (total costs US$)
Stack gases	High-efficiency scrubbers	Pb, Cd: > 98; Hg: ca. 50	..
	ESP (3 fields)	Pb, Cd: 80 - 90	10-20/Mg waste
	Wet ESP (1 field)	Pb, Cd: 95 - 99	..
	Fabric filters	Pb, Cd: 95 - 99	15-30/Mg waste
	Carbon injection + FF	Hg: > 85	operating costs: ca. 2-3/Mg waste
	Carbon bed filtration	Hg: > 99	operating costs: ca. 50/Mg waste

Annex IV

TIMESCALES FOR THE APPLICATION OF LIMIT VALUES AND BEST AVAILABLE TECHNIQUES TO NEW EXISTING STATIONARY SOURCES

The timescales for the application of limit values and best available techniques are:

(a) For new stationary sources: two years after the date of entry into force of the present Protocol;

(b) For existing stationary sources: eight years after the date of entry into force of the present Protocol. If necessary, this period may be extended for specific existing stationary sources in accordance with the amortization period provided for by national legislation.

Annex V

LIMIT VALUES FOR CONTROLLING EMISSION FROM MAJOR STATIONARY SOURCES

I. INTRODUCTION

1. Two types of limit value are important for heavy metal emission control:

- Values for specific heavy metals or groups of heavy metals; and
- Values for emissions of particulate matter in general.

2. In principle, limit values for particulate matter cannot replace specific limit values for cadmium, lead and mercury, because the quantity of metals associated with particulate emissions differs from one process to another. However, compliance with these limits contributes significantly to reducing heavy metal emissions in general. Moreover, monitoring particulate emissions is generally less expensive than monitoring individual species and continuous monitoring of individual heavy metals is in general not feasible. Therefore, particulate limit values are of great practical importance and are also laid down in this annex in most cases to complement or replace specific limit values for cadmium or lead or mercury.

3. Limit values, expressed as mg/m^3, refer to standard conditions (volume at 273.15 K, 101.3 kPa, dry gas) and are calculated as an average value of one-hour measurements, covering several hours of operation, as a rule 24 hours. Periods of start-up and shutdown should be excluded. The averaging time may be extended when required to achieve sufficiently precise monitoring results. With regard to the oxygen content of the waste gas, the values given for selected major stationary sources shall apply. Any dilution for the purpose of lowering concentrations of pollutants in waste gases is forbidden. Limit values for heavy metals include the solid, gaseous and vapour form of the metal and its compounds, expressed as the metal. Whenever limit values for total emissions are given, expressed as g/unit of production or capacity respectively, they refer to the sum of stack and fugitive emissions, calculated as an annual value.

4. In cases in which an exceeding of given limit values cannot be excluded, either emissions or a performance parameter that indicates whether a control device is being properly operated and maintained shall be monitored. Monitoring of either emissions or performance indicators should take place continuously if the emitted mass flow of particulates is above 10 kg/h. If emissions are monitored, the concentrations of air pollutants in gas-carrying ducts have to be measured in a representative fashion. If particulate matter is monitored discontinuously, the concentrations should be measured at regular intervals, taking at least three independent readings per check. Sampling and analysis of all pollutants as well as reference measurement methods to calibrate automated measurement systems shall be carried out according to the standards laid down by the Comité européen de normalisation (CEN) or the International Organization for Standardization (ISO). While awaiting the development of the CEN or ISO standards, national standards shall apply. National standards can also be used if they provide equivalent results to CEN or ISO standards.

5. In the case of continuous monitoring, compliance with the limit values is achieved if none of the calculated average 24-hour emission concentrations exceeds the limit value or if the 24-hour average of the monitored parameter does not exceed the correlated value of that parameter that was established during a performance test when the control device was being properly operated and maintained. In the case of discontinuous emission monitoring, compliance is achieved if the average reading per check does not exceed the value of the limit. Compliance with each of the limit values expressed as total emissions per unit of production or total annual emissions is achieved if the monitored value is not exceeded, as described above.

II. SPECIFIC LIMIT VALUES FOR SELECTED MAJOR STATIONARY SOURCES

Combustion of fossil fuels (annex II, category 1):

6. Limit values refer to 6% O_2 in flue gas for solid fuels and to 3% O_2 for liquid fuels.

7. Limit value for particulate emissions for solid and liquid fuels: 50 mg/m^3.

Sinter plants (annex II, category 2):

8. Limit value for particulate emissions: 50 mg/m^3.

Pellet plants (annex II, category 2):

9. Limit value for particulate emissions:

   (a) Grinding, drying: 25 mg/m^3; and

   (b) Pelletizing: 25 mg/m^3; or

10. Limit value for total particulate emissions: 40 g/Mg of pellets produced.

Blast furnaces (annex II, category 3):

11. Limit value for particulate emissions: 50 mg/m^3.

Electric arc furnaces (annex II, category 3):

12. Limit value for particulate emissions: 20 mg/m^3.

Production of copper and zinc, including Imperial Smelting furnaces (annex II, categories 5 and 6)

13. Limit value for particulate emissions: 20 mg/m^3.

Production of lead (annex II, categories 5 and 6):

14. Limit value for particulate emissions: 10 mg/m^3.

Cement industry (annex II, category 7):

15. Limit value for particulate emissions: 50 mg/m^3.

Glass industry (annex II, category 8):

16. Limit values refer to different O_2 concentrations in flue gas depending on furnace type: tank furnaces: 8%; pot furnaces and day tanks: 13%.

17. Limit value for lead emissions: 5 mg/m^3.

Chlor-alkali industry (annex II, category 9):

18. Limit values refer to the total quantity of mercury released by a plant into the air, regardless of the emission source and expressed as an annual mean value.

19. Limit values for existing chlor-alkali plants shall be evaluated by the Parties meeting within the Executive Body no later than two years after the date of entry into force of the present Protocol.

20. Limit value for new chlor-alkali plants: 0.01 g Hg/Mg Cl_2 production capacity.

Municipal, medical and hazardous waste incineration (annex II, categories 10 and 11):

21. Limit values refer to 11% O_2 concentration in flue gas.

22. Limit value for particulate emissions:

(a) 10 mg/m^3 for hazardous and medical waste incineration;

(b) 25 mg/m^3 for municipal waste incineration.

23. Limit value for mercury emissions:

(a) 0.05 mg/m^3 for hazardous waste incineration;

(b) 0.08 mg/m^3 for municipal waste incineration;

(c) Limit values for mercury-containing emissions from medical waste incineration shall be evaluated by the Parties meeting within the Executive Body no later than two years after the date of entry into force of the present Protocol.

Annex VI

PRODUCT CONTROL MEASURES

1. Except as otherwise provided in this annex, no later than six months after the date of entry into force of the present Protocol, the lead content of marketed petrol intended for on-road vehicles shall not exceed 0.013 g/l. Parties marketing unleaded petrol with a lead content lower than 0.013 g/l shall endeavour to maintain or lower that level.

2. Each Party shall endeavour to ensure that the change to fuels with a lead content as specified in paragraph 1 above results in an overall reduction in the harmful effects on human health and the environment.

3. Where a State determines that limiting the lead content of marketed petrol in accordance with paragraph 1 above would result in severe socio-economic or technical problems for it or would not lead to overall environmental or health benefits because of, inter alia, its climate situation, it may extend the time period given in that paragraph to a period of up to 10 years, during which it may market leaded petrol with a lead content not exceeding 0.15 g/l. In such a case, the State shall specify, in a declaration to be deposited together with its instrument of ratification, acceptance, approval or accession, that it intends to extend the time period and present to the Executive Body in writing information on the reasons for this.

4. A Party is permitted to market small quantities, up to 0.5 per cent of its total petrol sales, of leaded petrol with a lead content not exceeding 0.15 g/l to be used by old on-road vehicles.

5. Each Party shall, no later than five years, or ten years for countries with economies in transition that state their intention to adopt a ten-year period in a declaration to be deposited with their instrument of ratification, acceptance, approval or accession, after the date of entry into force of this Protocol, achieve concentration levels which do not exceed:

(a) 0.05 per cent of mercury by weight in alkaline manganese batteries for prolonged use in extreme conditions (e.g. temperature below 0EC or above 50EC, exposed to shocks); and

(b) 0.025 per cent of mercury by weight in all other alkaline manganese batteries.

The above limits may be exceeded for a new application of a battery technology, or use of a battery in a new product, if reasonable safeguards are taken to ensure that the resulting battery or product without an easily removable battery will be disposed of in an environmentally sound manner. Alkaline manganese button cells and batteries composed of button cells shall also be exempted from this obligation.

Annex VII

PRODUCT MANAGEMENT MEAURES

1. This annex aims to provide guidance to Parties on product management measures.

2. The Parties may consider appropriate product management measures such as those listed below, where warranted as a result of the potential risk of adverse effects on human health or the environment from emissions of one or more of the heavy metals listed in annex I, taking into account all relevant risks and benefits of such measures, with a view to ensuring that any changes to products result in an overall reduction of harmful effects on human health and the environment:

(a) The substitution of products containing one or more intentionally added heavy metals listed in annex I, if a suitable alternative exists;

(b) The minimization or substitution in products of one or more intentionally added heavy metals listed in annex I;

(c) The provision of product information including labelling to ensure that users are informed of the content of one or more intentionally added heavy metals listed in annex I and of the need for safe use and waste handling;

(d) The use of economic incentives or voluntary agreements to reduce or eliminate the content in products of the heavy metals listed in annex I; and

(e) The development and implementation of programmes for the collection, recycling or disposal of products containing one of the heavy metals in annex I in an environmentally sound manner.

3. Each product or product group listed below contains one or more of the heavy metals listed in annex I and is the subject of regulatory or voluntary action by at least one Party to the Convention based for a significant part on the contribution of that product to emissions of one or more of the heavy metals in annex I. However, sufficient information is not yet available to confirm that they are a significant source for all Parties, thereby warranting inclusion in annex VI. Each Party is encouraged to consider available information and, where satisfied of the need to take precautionary measures, to apply product management measures such as those listed in paragraph 2 above to one or more of the products listed below:

(a) Mercury-containing electrical components, i.e. devices that contain one or several contacts/sensors for the transfer of electrical current such as relays, thermostats, level switches, pressure switches and other switches (actions taken include a ban on most mercury-containing electrical components; voluntary programmes to replace some mercury switches with electronic or special switches; voluntary recycling programmes for switches; and voluntary recycling programmes for thermostats);

(b) Mercury-containing measuring devices such as thermometers, manometers, barometers, pressure gauges, pressure switches and pressure transmitters (actions taken include a ban on mercury-containing thermometers and ban on measuring instruments);

(c) Mercury-containing fluorescent lamps (actions taken include reductions in mercury content per lamp through both voluntary and regulatory programmes and voluntary recycling programmes);

(d) Mercury-containing dental amalgam (actions taken include voluntary measures and a ban with exemptions on the use of dental amalgams and voluntary programmes to promote capture of dental amalgam before release to water treatment plants from dental surgeries);

(e) Mercury-containing pesticides including seed dressing (actions taken include bans on all mercury pesticides including seed treatments and a ban on mercury use as a disinfectant);

(f) Mercury-containing paint (actions taken include bans on all such paints, bans on such paints for interior use and use on children's toys; and bans on use in antifouling paints); and

(g) Mercury-containing batteries other than those covered in annex VI (actions taken include reductions in mercury content through both voluntary and regulatory programmes and environmental charges and voluntary recycling programmes).

SECTION VIII

1998 PROTOCOL ON PERSISTENT ORGANIC POLLUTANTS

1998 PROTOCOL ON PERSISTENT ORGANIC POLLUTANTS

The Parties,

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

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

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

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

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

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

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

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

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

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

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

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

Conscious of the need for a cost-effective regional approach to combating air pollution, *Noting* the important contribution of the private and non-governmental sectors to knowledge of the effects associated with persistent organic pollutants, available alternatives and abatement techniques, and their role in assisting in the reduction of emissions of persistent organic pollutants,

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

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

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

Have agreed as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Protocol,

1. “Convention” means the Convention on Long-range Transboundary Air Pollution, adopted in Geneva on 13 November 1979;

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

3. “Executive Body” means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

4. “Commission” means the United Nations Economic Commission for Europe;

5. “Parties” means, unless the context otherwise requires, the Parties to the present Protocol;

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

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

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

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

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

11. “Major stationary source category” means any stationary source category listed in annex VIII;

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

Article 2: ***OBJECTIVE***

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

Article 3: ***BASIC OBLIGATIONS***

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

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

(b) (i) To ensure that, when the substances listed in annex I are destroyed or disposed of, such destruction or disposal is undertaken in an environmentally sound manner, taking into account relevant subregional, regional and global regimes governing the management of hazardous wastes and their disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;
  (ii) To endeavour to ensure that the disposal of substances listed in annex I is carried out domestically, taking into account pertinent environmental considerations;
  (iii) To ensure that the transboundary movement of the substances listed in annex I is conducted in an environmentally sound manner, taking into consideration applicable subregional, regional, and global regimes governing the transboundary movement of hazardous wastes, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;

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

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

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

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

5. Each Party shall:

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

(b) No later than the timescales specified in annex VI, apply:

(i) The best available techniques, taking into consideration annex V, to each new stationary source within a major stationary source category for which annex V identifies best available techniques;
(ii) Limit values at least as stringent as those specified in annex IV to each new stationary source within a category mentioned in that annex, taking into consideration annex V. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission levels;
(iii) The best available techniques, taking into consideration annex V, to each existing stationary source within a major stationary source category for which annex V identifies best available techniques, insofar as this is technically and economically feasible. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions;
(iv) Limit values at least as stringent as those specified in annex IV to each existing stationary source within a category mentioned in that annex, insofar as this is technically and economically feasible, taking into consideration annex V. A Party may, as an alternative, apply different emission reduction strategies that achieve equivalent overall emission reductions;
(v) Effective measures to control emissions from mobile sources, taking into consideration annex VII.

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

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

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

Article 4: ***EXEMPTIONS***

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

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

(a) For research other than that referred to in paragraph 1 above, if:

(i) No significant quantity of the substance is expected to reach the environment during the proposed use and subsequent disposal;
(ii) The objectives and parameters of such research are subject to assessment and authorization by the Party; and
(iii) In the event of a significant release of a substance into the environment, the exemption will terminate immediately, measures will be taken to mitigate the release as appropriate, and an assessment of the containment measures will be conducted before research may resume;

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

(i) No suitable alternative measures are available to the Party to address the situation;
(ii) The measures taken are proportional to the magnitude and severity of the emergency;
(iii) Appropriate precautions are taken to protect human health and the environment and to ensure that the substance is not used outside the geographical area subject to the emergency;
(iv) The exemption is granted for a period of time that does not exceed the duration of the emergency; and
(v) Upon termination of the emergency, any remaining stocks of the substance are subject to the provisions of article 3, paragraph 1 (b);

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

(i) The exemption is granted for a maximum of five years;
(ii) The exemption has not previously been granted by it under this article;
(iii) No suitable alternatives exist for the proposed use;
(iv) The Party has estimated the emissions of the substance resulting from the exemption and their contribution to the total emissions of the substance from the Parties;
(v) Adequate precautions are taken to ensure that the emissions to the environment are minimized; and
(vi) Upon termination of the exemption, any remaining stocks of the substance are subject to the provisions of article 3, paragraph 1 (b).

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

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

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

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

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

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

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

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

Article 5: EXCHANGE OF INFORMATION AND TECHNOLOGY

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

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

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

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

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

Article 6: PUBLIC AWARENESS

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

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

(b) Information on risk reduction;

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

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

Article 7: *STRATEGIES, POLICIES, PROGRAMMES, MEASURES AND INFORMATION*

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

2. Each Party shall:

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

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

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

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

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

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

Article 8: *RESEARCH, DEVELOPMENT AND MONITORING*

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

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

(b) Pollutant pathways and inventories in representative ecosystems;

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

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

(e) Methodologies permitting consideration of socio-economic factors in the evaluation of alternative control strategies;

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

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

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

Priority should be given to research on substances considered to be the most likely to be submitted under the procedures specified in article 14, paragraph 6.

Article 9: ***REPORTING***

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

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

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

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

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

Article 10: REVIEWS BY THE PARTIES AT SESSIONS OF THE EXECUTIVE BODY

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

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

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

Article 11: COMPLIANCE

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

Article 12: SETTLEMENT OF DISPUTES

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

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

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

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

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

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

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

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

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

Article 13: *ANNEXES*

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

Article 14: *AMENDMENTS*

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

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

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

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

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

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

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

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

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

Article 15: ***SIGNATURE***

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

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

Article 16: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 21 December 1998 by the States and organizations that meet the requirements of article 15, paragraph 1.

Article 17: ***DEPOSITARY***

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

Article 18: ***ENTRY INTO FORCE***

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

2. For each State and organization referred to in article 15, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the ninetieth

day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 19: ***WITHDRAWAL***

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

Article 20: ***AUTHENTIC TEXTS***

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

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

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

Annex I

SUBSTANCES SCHEDULED FOR ELIMINATION

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

Substance	**Implementation requirements**	
	Elimination of	**Conditions**
Aldrin CAS: 309-00-2	Production	None
	Use	None
Chlordane CAS: 57-74-9	Production	None
	Use	None
Chlordecone CAS: 143-50-0	Production	None
	Use	None
DDT CAS: 50-29-3	Production	1. 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. 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.
	Use	None, except as identified in annex II.
Dieldrin CAS: 60-57-1	Production	None
	Use	None
Endrin CAS: 72-20-8	Production	None
	Use	None
Heptachlor CAS: 76-44-8	Production	None
	Use	None, except for use by certified personnel for the control of fire ants in closed industrial electrical junction boxes. Such use shall be re-evaluated under this Protocol no later than two years after the date of entry into force.
Hexabromobiphenyl CAS: 36355-01-8	Production	None
	Use	None
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.

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

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

Annex II

SUBSTANCES SCHEDULED FOR RESTRICTIONS ON USE

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

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

Substance	**Implementation requirements**	
	Restricted to uses	**Conditions**
PCB [a/]	PCBs in use as of the date of entry into force or produced up to 31 December 2005 in accordance with the provisions of annex I.	Parties shall make determined efforts designed to lead to: (a) The elimination of the use of identifiable PCBs in equipment (i.e. transformers, capacitors or other receptacles containing residual liquid stocks) containing PCBs in volumes greater than 5 dm^3 and having a concentration of 0.05% PCBs or greater, as soon as possible, but no later than 31 December 2010, or 31 December 2015 for countries with economies in transition; (b) The destruction or decontamination in an environmentally sound manner of all liquid PCBs referred to in subparagraph (a) and other liquid PCBs containing more than 0.005% PCBs not in equipment, as soon as possible, but no later than 31 December 2015, or 31 December 2020 for countries with economies in transition; and (c) The decontamination or disposal of equipment referred in subparagraph (a) in an environmentally sound manner.

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

Annex III

SUBSTANCES REFERRED TO IN ARTICLE 3, PARAGRAPHS 5 (a), AND THE REFERENCE YEAR FOR THE OBLIGATION

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

a/ Polycyclic aromatic hydrocarbons (PAHs): For the purposes of emission inventories, the following four indicator compounds shall be used: 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.

Annex IV

LIMIT VALUES FOR PCDD/F FROM MAJOR STATIONARY SOURCES

I. INTRODUCTION

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

2. Limit values are expressed as ng/m^3 or mg/m^3 under standard conditions (273.15 K, 101.3 kPa, and dry gas).

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

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

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

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

II. LIMIT VALUES FOR MAJOR STATIONARY SOURCES

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

Municipal solid waste (burning more than 3 tonnes per hour)	0.1 ng TE/m^3
Medical solid waste (burning more than 1 tonne per hour)	0.5 ng TE/m^3
Hazardous waste (burning more than 1 tonne per hour)	0.2 ng TE/m^3

Annex V

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

I. INTRODUCTION

1. The purpose of this annex is to provide the Parties to the Convention with guidance in identifying best available techniques to allow them to meet the obligations in article 3, paragraph 5, of the Protocol.

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

- “Techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- “Available” techniques means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the territory of the Party in question, as long as they are reasonably accessible to the operator;
- “Best” means most effective in achieving a high general level of protection of the environment as a whole.

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

- The use of low-waste technology;
- The use of less hazardous substances;
- The furthering of recovery and recycling of substances generated and used in the process and of waste;
- Comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
- Technological advances and changes in scientific knowledge and understanding;
- The nature, effects and volume of the emissions concerned;
- The commissioning dates for new or existing installations;
- The time needed to introduce the best available technique;
- The consumption and nature of raw materials (including water) used in the process and its energy efficiency;
- The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- The need to prevent accidents and to minimize their consequences for the environment.

The concept of best available techniques is not aimed at the prescription of any specific technique or technology, but at taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions.

3. Information regarding the effectiveness and costs of control measures is based on documents received and reviewed by the Task Force and the Preparatory Working Group on POPs. Unless otherwise indicated, the techniques listed are considered to be well established on the basis of operational experience.

4. Experience with new plants incorporating low-emission techniques, as well as with retrofitting of existing plants, is continuously growing. The regular elaboration and amendment of the annex will therefore be necessary. Best available techniques (BAT) identified for new plants can usually be applied to existing plants provided there is an adequate transition period and they are adapted.

5. The annex lists a number of control measures which span a range of costs and efficiencies. The choice of measures for any particular case will depend on a number of factors, including economic circumstances, technological infrastructure and capacity, and any existing air pollution control measures.

6. The most important POPs emitted from stationary sources are:

(a) Polychlorinated dibenzo-p-dioxins/furans (PCDD/F);

(b) Hexachlorobenzene (HCB);

(c) Polycyclic aromatic hydrocarbons (PAHs).

Relevant definitions are provided in annex III to the present Protocol.

II. MAJOR STATIONARY SOURCES OF POP EMISSIONS

7. PCDD/F are emitted from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. Major stationary sources of PCDD/F may be as follows:

(a) Waste incineration, including co-incineration;

(b) Thermal metallurgical processes, e.g. production of aluminium and other non-ferrous metals, iron and steel;

(c) Combustion plants providing energy;

(d) Residential combustion; and

(e) Specific chemical production processes releasing intermediates and by-products.

8. Major stationary sources of PAH emissions may be as follows:

(a) Domestic wood and coal heating;

(b) Open fires such as refuse burning, forest fires and after-crop burning;

(c) Coke and anode production;

(d) Aluminium production (via Soederberg process); and

(e) Wood preservation installations, except for a Party for which this category does not make a significant contribution to its total emissions of PAH (as defined in annex III).

9. Emissions of HCB result from the same type of thermal and chemical processes as those emitting PCDD/F, and HCB is formed by a similar mechanism. Major sources of HCB emissions may be as follows:

(a) Waste incineration plants, including co-incineration;

(b) Thermal sources of metallurgical industries; and

(c) Use of chlorinated fuels in furnace installations.

III. GENERAL APPROACHES TO CONTROLLING EMISSIONS OF POPS

10. There are several approaches to the control or prevention of POP emissions from stationary sources. These include the replacement of relevant feed materials, process modifications (including maintenance and operational control) and retrofitting existing plants. The following list provides a general indication of available measures, which may be implemented either separately or in combination:

(a) Replacement of feed materials which are POPs or where there is a direct link between the materials and POP emissions from the source;

(b) Best environmental practices such as good housekeeping, preventive maintenance programmes, or process changes such as closed systems (for instance in cokeries or use of inert electrodes for electrolysis);

(c) Modification of process design to ensure complete combustion, thus preventing the formation of persistent organic pollutants, through the control of parameters such as incineration temperature or residence time;

(d) Methods for flue-gas cleaning such as thermal or catalytic incineration or oxidation, dust precipitation, adsorption;

(e) Treatment of residuals, wastes and sewage sludge by, for example, thermal treatment or rendering them inert.

11. The emission levels given for different measures in tables 1, 2, 4, 5, 6, 8, and 9 are generally case-specific. The figures or ranges give the emission levels as a percentage of the emission limit values using conventional techniques.

12. Cost-efficient considerations may be based on total costs per year per unit of abatement (including capital and operational costs). POP emission reduction costs should also be considered within the framework of the overall process economics, e.g. the impact of control measures and costs of production. Given the many influencing factors, investment and operating cost figures are highly case-specific.

IV. CONTROL TECHNIQUES FOR THE REDUCTION OF PCDD/F EMISSIONS

A. Waste incineration

13. Waste incineration includes municipal waste, hazardous waste, medical waste and sewage sludge incineration.

14. The main control measures for PCDD/F emissions from waste incineration facilities are:

(a) Primary measures regarding incinerated wastes;

(b) Primary measures regarding process techniques;

(c) Measures to control physical parameters of the combustion process and waste gases (e.g. temperature stages, cooling rate, O_2 content, etc.);

(d) Cleaning of the flue gas; and

(e) Treatment of residuals from the cleaning process.

15. The *primary measures regarding the incinerated wastes*, involving the management of feed material by reducing halogenated substances and replacing them by non-halogenated alternatives, are not appropriate for municipal or hazardous waste incineration. It is more effective to modify the incineration process and install secondary measures for flue-gas cleaning. The management of feed material is a useful primary measure for waste reduction and has the possible added benefit of recycling. This may result in indirect PCDD/F reduction by decreasing the waste amounts to be incinerated.

16. The *modification of process techniques* to optimize combustion conditions is an important and effective measure for the reduction of PCDD/F emissions (usually 850°C or higher, assessment of oxygen supply depending on the heating value and consistency of the wastes, sufficient residence time -- 850°C for ca. 2 sec -- and turbulence of the gas, avoidance of cold gas regions in the incinerator, etc.). Fluidized bed incinerators keep a lower temperature than 850°C with adequate emission results. For existing incinerators this would normally involve redesigning and/or replacing a plant -- an option which may not be economically viable in all countries. The carbon content in ashes should be minimized.

17. *Flue gas measures*. The following measures are possibilities for lowering reasonably effectively the PCDD/F content in the flue gas. The *de novo* synthesis takes place at about 250 to 450°C. These measures are a prerequisite for further reductions to achieve the desired levels at the end of the pipe:

(a) Quenching the flue gases (very effective and relatively inexpensive);

(b) Adding inhibitors such as triethanolamine or triethylamine (can reduce oxides of nitrogen as well), but side-reactions have to be considered for safety reasons;

(c) Using dust collection systems for temperatures between 800 and 1000°C, e.g. ceramic filters and cyclones;

(d) Using low-temperature electric discharge systems; and

(e) Avoiding fly ash deposition in the flue gas exhaust system.

18. Methods for *cleaning the flue gas* are:

(a) Conventional dust precipitators for the reduction of particle-bound PCDD/F;

(b) Selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR);

(c) Adsorption with activated charcoal or coke in fixed or fluidized systems;

(d) Different types of adsorption methods and optimized scrubbing systems with mixtures of activated charcoal, open hearth coal, lime and limestone solutions in fixed bed, moving bed and fluidized bed reactors. The collection efficiency for gaseous PCDD/F can be improved with the use of a suitable pre-coat layer of activated coke on the surface of a bag filter;

(e) H_2O_2-oxidation; and

(f) Catalytic combustion methods using different types of catalysts (i.e. Pt/Al_2O_3 or copper-chromite catalysts with different promoters to stabilize the surface area and to reduce ageing of the catalysts).

19. The methods mentioned above are capable of reaching emission levels of 0.1 ng TE/m^3 PCDD/F in the flue gas. However, in systems using activated charcoal or coke adsorbers/filters care must be taken to ensure that fugitive carbon dust does not increase PCDD/F emissions downstream. Also, it should be noted that adsorbers and dedusting installations prior to catalysts (SCR technique) yield PCDD/F-laden residues, which need to be reprocessed or require proper disposal.

20. A comparison between the different measures to reduce PCDD/F in flue gas is very complex. The resulting matrix includes a wide range of industrial plants with different capacities and configuration. Cost parameters include the reduction measures for minimizing other pollutants as well, such as heavy metals (particle-bound or not particle-bound). A direct relation for the reduction in PCDD/F emissions alone cannot, therefore, be isolated in most cases. A summary of the available data for the various control measures is given in table I.

21. Medical waste incinerators may be a major source of PCDD/F in many countries. Specific medical wastes such as human anatomical parts, infected waste, needles, blood, plasma and cytostatica are treated as a special form of hazardous waste, while other medical wastes are frequently incinerated on-site in a batch operation. Incinerators operating with batch systems can meet the same requirements for PCDD/F reduction as other waste incinerators.

22. Parties may wish to consider adopting policies to encourage the incineration of municipal and medical waste in large regional facilities rather than in smaller ones. This approach may make the application of BAT more cost-effective.

23. *The treatment of residuals from the flue-gas cleaning process*. Unlike incinerator ashes, these residuals contain relatively high concentrations of heavy metals, organic pollutants (including PCDD/F), chlorides and sulphides. Their method of disposal, therefore, has to be well controlled. Wet scrubber systems in particular produce large quantities of acidic, contaminated liquid waste. Some special treatment methods exist. They include:

(a) The catalytic treatment of fabric filter dusts under conditions of low temperatures and lack of oxygen;

(b) The scrubbing of fabric filter dusts by the 3-R process (extraction of heavy metals by acids and combustion for destruction of organic matter);

(c) The vitrification of fabric filter dusts;

(d) Further methods of immobilization; and

(e) The application of plasma technology.

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; only parts could be collected; other chlorine-containing material, for instance kitchen salt, paper, etc., cannot be avoided. For hazardous chemical waste this is not desirable. Useful primary measure and feasible in special cases (for instance, waste oils, electrical components, etc.) with the possible added benefit of recycling of the materials
Modification of process technology: - Optimized combustion conditions; - Avoidance of temperatures below 850°C and cold regions in flue gas; - Sufficient oxygen content; control of oxygen input depending on the heating value and consistency of feed material; and - Sufficient residence time and turbulence.			Retrofitting of the whole process needed.

Management options	Emission level (%)[a/]	Estimated costs	Management risks
Flue gas measures: Avoiding particle deposition by:			
- Soot cleaners, mechanical rappers, sonic or steam soot blowers.			Steam soot blowing can increase PCDD/F formation rates.
Dust removal, generally in waste incinerators:	< 10	Medium	Removal of PCDD/F adsorbed onto particles. Removal methods of particles in hot flue gas streams used only in pilot plants.
- Fabric filters;	1 - 0.1	Higher	Use at temperatures < 150°C.
- Ceramic filters;	Low efficiency		Use at temperatures 800-1000°C.
- Cyclones; and	Low efficiency	Medium	
- Electrostatic precipitation.	Medium efficiency		Use at a temperature of 450°C; promotion of the de novo synthesis of PCDD/F possible, higher NO_x emissions, reduction of heat recovery.
Catalytic oxidation.			Use at temperatures of 800-1000°C. Separate gas phase abatement necessary.
Gas quenching.			
High-performance adsorption unit with added activated charcoal particles (electrodynamic venturi).			
Selective catalytic reduction (SCR).		High investment and low operating costs	NO_x reduction if NH_3 is added; high space demand, spent catalysts and residues of activated carbon (AC) or lignite coke (ALC) may be disposed of, catalysts can be reprocessed by manufacturers in most cases, AC and ALC can be combusted under strictly controlled conditions.
Different types of wet and dry adsorption methods with mixtures of activated charcoal, open-hearth coke, lime and limestone solutions in fixed bed, moving bed and fluidized bed reactors:			

Management options	Emission level (%)[a/]	Estimated costs	Management risks
- Fixed bed reactor, adsorption with activated charcoal or open-hearth coke; and	< 2 (0.1 ng TE/m^3)	High investment, medium operating costs	Removal of residuals, high demand of space.
-Entrained flow or circulating fluidized bed reactor with added activated coke/lime or limestone solutions and subsequent fabric filter.	< 10 (0.1 ng TE/m^3)	Low investment, medium operating costs	Removal of residuals.
Addition of H_2O_2.	< 2 - 5 (0.1 ng TE/m^3)	Low in-vestment, low operating costs	

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, 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 II.

25. Metal production and treatment plants with PCDD/F emissions can meet a maximum emission concentration of 0.1 ng TE/m^3 (if waste gas volume flow > 5000 m^3/h) using control measures.

TABLE II

Emission reduction of PCDD/F in the metallurgical industry

Management options	Emission level (%) [a/]	Estimated costs	Management risks
Sinter plants			
Primary measures: - Optimization/encapsulation of sinter conveying belts;		Low	Not 100% achievable
- Waste gas recirculation e.g. emission optimized sintering (EOS) reducing waste gas flow by ca. 35% (reduced costs of further secondary measures by the reduced waste gas flow), cap. 1 million Nm^3/h;	40	Low	

Management options	Emission level (%) [a/]	Estimated costs	Management risks
Secondary measures:			
- Electrostatic precipitation + molecular sieve;	Medium efficiency	Medium	
- Addition of limestone/activated carbon mixtures;	High efficiency (0.1 ng TE/m^3)	Medium	
- High-performance scrubbers - existing installation: AIRFINE (Voest Alpine Stahl Linz) since 1993 for 600 000 Nm^3/h; second installation planned in the Netherlands (Hoogoven) for 1998.	High efficiency emission reduction to 0.2-0.4 ng TE/m^3	Medium	0.1 ng TE/m^3 could be reached with higher energy demand; no existing installation.
Non-ferrous production (e.g. copper)			
Primary measures:			
- Pre-sorting of scrap, avoidance of feed material like plastics and PVC-contaminated scrap, stripping of coatings and use of chlorine-free insulating materials;		Low	
Secondary measures:			
- Quenching the hot waste gases;	High efficiency	Low	
- Use of oxygen or of oxygen-enriched air in firing, oxygen injection in the shaft kiln (providing complete combustion and minimization of waste gas volume);	5 – 7 (1.5-2 TE/m^3)	High	
- Fixed bed reactor or fluidized jet stream reactor by adsorption with activated charcoal or open-hearth coal dust;	(0.1 ng TE/m^3)	High	
- Catalytic oxidation; and	(0.1 ng TE/m^3)	High	
- Reduction of residence time in the critical region of temperature in the waste gas system.			
Iron and steel production			
Primary measures:			
- Cleaning of the scrap from oil prior to charging of production vessels;		Low	Cleaning solvents have to be used.
- Elimination of organic tramp materials such as oils, emulsions, greases, paint and plastics from feedstock cleaning;		Low	
- Lowering of the specific high waste gas volumes;		Medium	
- Separate collection and treatment of emissions from loading and discharging;.		Low	

Management options	Emission level (%) [a/]	Estimated costs	Management risks
Secondary measures:			
- Separate collection and treatment of emissions from loading and discharging; and		Low	
- Fabric filter in combination with coke injection.	< 1	Medium	
Secondary aluminium production			
Primary measures:			
- Avoidance of halogenated material (hexachloroethane);		Low	
- Avoidance of chlorine-containing lubricants (for instance chlorinated paraffins); and		Low	
- Clean-up and sorting of dirty scrap charges, e.g. by swarf decoating and drying, swim-sink separation techniques and whirling stream deposition;			
Secondary measures:			
- Single- and multi-stage fabric filter with added activation of limestone/ activated carbon in front of the filter;	< 1 (0.1 ng TE/m^3)	Medium/ high	
- Minimization and separate removal and purification of differently contaminated waste gas flows;		Medium/ high	
- Avoidance of particulate deposition from the waste gas and promotion of rapid passing of the critical temperature range; and		Medium/ high	
- Improved pretreatment of aluminium scrap shredders by using swim-sink separation techniques and grading through whirling stream deposition.		Medium/ high	

a/ Remaining emission compared to unreduced mode.

SINTER PLANTS

26. Measurements at sinter plants in the iron and steel industry have generally shown PCDD/F emissions in the range of 0.4 to 4 ng TE/m^3. A single measurement at one plant without any control measures showed an emission concentration of 43 ng TE/m^3.

27. Halogenated compounds may result in the formation of PCDD/F if they enter sinter plants in the feed materials (coke breeze, salt content in the ore) and in added recycled material (e.g. millscale, blast furnace top gas dust, filter dusts and sludges from waste water treatment). However, similarly to waste incineration, there is no clear link between the chlorine content of the feed materials and emissions of PCDD/F. An appropriate measure may be the avoidance of contaminated residual material and de-oiling or degreasing of millscale prior to its introduction into the sinter plant.

28. The most effective PCDD/F emission reduction can be achieved using a combination of different secondary measures, as follows:

(a) Recirculating waste gas significantly reduces PCDD/F emissions. Furthermore, the waste gas flow is reduced significantly, thereby reducing the cost of installing any additional end-of-pipe control systems;

(b) Installing fabric filters (in combination with electrostatic precipitators in some cases) or electrostatic precipitators with the injection of activated carbon/open-hearth coal/limestone mixtures into the waste gas;

(c) Scrubbing methods have been developed which include pre-quenching of the waste gas, leaching by high-performance scrubbing and separation by drip deposition. Emissions of 0.2 to 0.4 ng TE/m^3 can be achieved. By adding suitable adsorption agents like lignite coal cokes/coal slack, an emission concentration of 0.1 ng TE/m^3 can be reached.

PRIMARY AND SECONDARY PRODUCTION OF COPPER

29. Existing plants for the primary and secondary production of copper can achieve a PCDD/F emission level of a few picograms to 2 ng TE/m^3 after flue-gas cleaning. A single copper shaft furnace emitted up to 29 ng TE/m^3 PCDD/F before optimization of the aggregates. Generally, there is a wide range of PCDD/F emission values from these plants because of the large differences in raw materials used in differing aggregates and processes.

30. Generally, the following measures are suitable for reducing PCDD/F emissions:

(a) Pre-sorting scrap;

(b) Pretreating scrap, for example stripping of plastic or PVC coatings, pretreating cable scrap using only cold/mechanical methods;

(c) Quenching hot waste gases (providing utilization of heat), to reduce residence time in the critical region of temperature in the waste gas system;

(d) Using oxygen or oxygen-enriched air in firing, or oxygen injection in the shaft kiln (providing complete combustion and minimization of waste gas volume);

(e) Adsorption in a fixed bed reactor or fluidized jet stream reactor with activated charcoal or open-hearth coal dust; and

(f) Catalytic oxidation.

PRODUCTION OF STEEL

31. PCDD/F emissions from converter steelworks for steel production and from hot blast cupola furnaces, electric furnaces and electric arc furnaces for the melting of cast iron are significantly lower than 0.1 ng TE/m^3. Cold-air furnaces and rotary tube furnaces (melting of cast iron) have higher PCDD/F emissions.

32. Electric arc furnaces used in secondary steel production can achieve an emission concentration value of 0.1 ng TE/m^3 if the following measures are used:

(a) Separate collection of emissions from loading and discharging; and

(b) Use of a fabric filter or an electrostatic precipitator in combination with coke injection.

33. The feedstock to electric arc furnaces often contains oils, emulsions or greases. General primary measures for PCDD/F reduction can be sorting, de-oiling and de-coating of scraps, which may contain plastics, rubber, paints, pigments and vulcanizing additives.

SMELTING PLANTS IN THE SECONDARY ALUMINIUM INDUSTRY

34. PCDD/F emissions from smelting plants in the secondary aluminium industry are in the range of approximately 0.1 to 14 ng TE/m^3. These levels depend on the type of smelting aggregates, materials used and waste gas purification techniques employed.

35. In summary, single- and multi-stage fabric filters with the addition of limestone/activated carbon/open-hearth coal in front of the filter meet the emission concentration of 0.1 ng TE/m^3, with reduction efficiencies of 99 per cent.

36. The following measures can also be considered:

(a) Minimizing and separately removing and purifying differently contaminated waste gas flows;

(b) Avoiding waste gas particle deposition;

(c) Rapidly passing the critical temperature range;

(d) Improving the pre-sorting of scrap aluminium from shredders by using swim-sink separation techniques and grading through whirling stream deposition; and

(e) Improving the pre-cleaning of scrap aluminium by swarf decoating and swarf drying.

37. Options (d) and (e) are important because it is unlikely that modern fluxless smelting techniques (which avoid halide salt fluxes) will be able to handle the low-grade scrap that can be used in rotary kilns.

38. Discussions are continuing under the Convention for the Protection of the Marine Environment of the North-east Atlantic regarding the revision of an earlier recommendation to phase out the use of hexachloroethane in the aluminium industry.

39. The melt can be treated using state-of-the-art technology, for example with nitrogen/chlorine mixtures in the ratio of between 9:1 and 8:2, gas injection equipment for fine dispersion and nitrogen pre- and post-flushing and vacuum degreasing. For nitrogen/chlorine mixtures, a PCDD/F emission concentration of about 0.03 ng TE/m^3 was measured (as compared to values of > 1 ng TE/m^3 for treatment with chlorine only). Chlorine is required for the removal of magnesium and other undesired components.

C. *Combustion of fossil fuels in utility and industrial boilers*

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

41. It should be noted that PCDD/F emissions could increase significantly if waste material (sewage sludge, waste oil, rubber wastes, etc.) is added to the fuel. The combustion of wastes for energy supply should be undertaken only in installations using waste gas purification systems with highly efficient PCDD/F reduction (described in section A above).

42. The application of techniques to reduce emissions of nitrogen oxides, sulphur dioxide and particulates from the flue gas can also remove PCDD/F emissions. When using these techniques, PCDD/F removal efficiencies will vary from plant to plant. Research is ongoing to develop PCDD/F removal techniques, but until such techniques are available on an industrial scale, no best available technique is identified for the specific purpose of PCDD/F removal.

D. Residential combustion

43. The contribution of residential combustion appliances to total emissions of PCDD/F is less significant when approved fuels are properly used. In addition, large regional differences in emissions can occur due to the type and quality of fuel, geographical appliance density and usage.

44. Domestic fireplaces have a worse burn-out rate for hydrocarbons in fuels and waste gases than large combustion installations. This is especially true if they use solid fuels such as wood and coal, with PCDD/F emission concentrations in the range of 0.1 to 0.7 ng TE/m^3.

45. Burning packing material added to solid fuels increases PCDD/F emissions. Even though it is prohibited in some countries, the burning of rubbish and packing material may occur in private households. Due to increasing disposal charges, it must be recognized that household waste materials are being burned in domestic firing installations. The use of wood with the addition of waste packing material can lead to an increase in PCDD/F emissions from 0.06 ng TE/m^3 (exclusively wood) to 8 ng TE/m^3 (relative to 11 per cent O_2 by volume). These results have been confirmed by investigations in several countries in which up to 114 ng TE/m^3 (with respect to 13% oxygen by volume) was measured in waste gases from residential combustion appliances burning waste materials.

46. The emissions from residential combustion appliances can be reduced by restricting the input materials to good-quality fuel and avoiding the burning of waste, halogenated plastics and other materials. Public information programmes for the purchasers/operators of residential combustion appliances can be effective in achieving this goal.

E. Firing installations for wood (<50 MW capacity)

47. Measurement results for wood-firing installations indicate that PCDD/F emissions above 0.1 ng TE/m^3 occur in waste gases especially during unfavourable burn-out conditions and/or when the substances burned have a higher content of chlorinated compounds than normal untreated wood. An indication of poor firing is the total carbon concentration in the waste gas. Correlations have been found between CO emissions, burn-out quality and PCDD/F emissions. Table III 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/m^3)	Emission factor (ng TE/kg)	Emission factor (ng/GJ)
Natural wood (beech tree)	0.02 - 0.10	0.23 - 1.3	12-70
Natural wood chips from forests	0.07 - 0.21	0.79 - 2.6	43-140
Chipboard	0.02 - 0.08	0.29 - 0.9	16-50
Urban waste wood	2.7 - 14.4	26 - 173	1400-9400
Residential waste	114	3230	
Charcoal	0.03		

48. The combustion of urban waste wood (demolition wood) in moving grates leads to relatively high PCDD/F emissions, compared to non-waste wood sources. A primary measure for emission reduction is to avoid the use of treated waste wood in wood-firing installations. Combustion of treated wood should be undertaken only in installations with the appropriate flue-gas cleaning to minimize PCDD/F emissions.

V. CONTROL TECHNIQUES FOR THE REDUCTION OF PAH EMISSIONS

A. Coke production

49. During coke production, PAHs are released into the ambient air mainly:

(a) When the oven is charged through the charging holes;

(b) By leakages from the oven door, the ascension pipes and the charging hole lids; and

(c) During coke pushing and coke cooling.

50. Benzo(a)pyrene (BaP) concentration varies substantially between the individual sources in a coke battery. The highest BaP concentrations are found on the top of the battery and in the immediate vicinity of the doors.

51. PAH from coke production can be reduced by technically improving existing integrated iron and steel plants. This might entail the closure and replacement of old coke batteries and the general reduction in coke production, for instance by injecting high-value coal in steel production.

52. A PAH reduction strategy for coke batteries should include the following technical measures:

(a) Charging the coke ovens:

- Particulate matter emission reduction when charging the coal from the bunker into the charging cars;
- Closed systems for coal transfer when coal pre-heating is used;
- Extraction of filling gases and subsequent treatment, either by passing the gases into the adjacent oven or by passing via a collecting main to an

incinerator and a subsequent dedusting device. In some cases the extracted filling gases may be burned on the charging cars, but the environmental performance and safety of these charging-car-based systems is less satisfactory. Sufficient suction should be generated by steam or water injection in the ascension pipes;

(b) Emissions at charging hole lids during coking operation should be avoided by:

- Using charging hole lids with highly efficient sealing;
- Luting the charging hole lids with clay (or equally effective material) after each charging operation;
- Cleaning the charging hole lids and frames before closing the charging hole;
- Keeping oven ceilings free from coal residuals;

(c) Ascension pipe lids should be equipped with water seals to avoid gas and tar emissions, and the proper operation of the seals should be maintained by regular cleaning;

(d) Coke oven machinery for operating the coke oven doors should be equipped with systems for cleaning the seals' surfaces on the oven door frames and oven doors;

(e) Coke oven doors:

- Highly effective seals should be used (e.g. spring-loaded membrane doors);
- Seals on the oven doors and door frames should be cleaned thoroughly at every handling operation;
- Doors should be designed in a manner that allows the installation of particulate matter extraction systems with connection to a dedusting device (via a collecting main) during pushing operations;

(f) The coke transfer machine should be equipped with an integrated hood, stationary duct and stationary gas cleaning system (preferably a fabric filter);

(g) Low-emission procedures should be applied for coke cooling, 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 per cent. Coal pre-heating boosts productivity by 30 per cent. This can be raised to 40 per cent 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 IV 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 adjacent oven as far as possible;	5	(Amortization of investment costs, taking into account energy recovery, heated water, gas for synthesis and saved cooling water, may be 5 years.)	

Management options	Emission level (%)[a/]	Estimated costs	Management risks
- Emissions at charging hole lids should be avoided as far as possible, e.g. by special hole lid construction and highly effective sealing methods. Coke oven doors with highly effective sealings should be used. Cleaning of charging hole lids and frames before closing the charging hole;	< 5		
- Waste gases from pushing operations should be collected and fed to a dedusting device;	< 5		
- Quenching during coke cooling by wet methods only if properly applied without waste water.			
Low emission procedures for coke cooling, e.g. dry coke cooling.	No emissions into water	Higher investment costs than for wet cooling (but lower costs by preheating of coke and use of waste heat.)	
Increasing the use of high-volume ovens to lower the number of openings and the surface of sealing areas.	Considerable	Investment about 10% higher than conventional plants	In most cases total retrofitting or the installation of a new cokery is needed.

a/ Remaining emission compared to unreduced mode.

B. <u>Anode production</u>

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 V summarizes PAH emission control measures for anode production.

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 per cent. 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.

TABLE V

PAH emission control for anode production

Management options	Emission level (%)[a/]	Estimated costs	Management risks
Modernization of old plants by reducing diffuse emissions with the following measures: - Reduction of leakages; - Installation of flexible sealants at the oven doors; - Evacuation of filling gases and subsequent treatment, either by passing the gases into the adjacent oven or by passing the gases via a collecting main to an incinerator and a subsequent dedusting device on the ground; - Operating and coke oven cooling systems; and - Evacuation and purification of particulate emissions from coke.	3-10	High	
Established technologies for anode production in the Netherlands:	45-50		Implemented in the Netherlands in 1990. Scrubbing with limestone or petroleum cokes is effective for reducing PAH; with aluminium not known.

Management options	**Emission level (%)**[a/]	**Estimated costs**	**Management risks**
- New kiln with dry scrubber (with limestone/petroleum cokes or with aluminium); - 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 auto-thermal mode.	Operating in autothermal mode only if the concentration of PAH in the waste gas is high.

[a/] Remaining emission compared to unreduced mode.

66. Table VI 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

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

a/ Remaining emission compared to unreduced mode.

D. Residential combustion

67. PAH emissions from residential combustion can be detected from stoves or open fireplaces especially when wood or coal is used. Households could be a significant source of PAH emissions. This is the result of the use of fireplaces and small firing installations burning solid fuels in households. In some countries the usual fuel for stoves is coal. Coal-burning stoves emit less PAH than wood-burning ones, because of their higher combustion temperatures and more consistent fuel quality.

68. Furthermore, combustion systems with optimized operation characteristics (e.g. burning rate) effectively control PAH emissions from residential combustion. Optimized combustion conditions include optimized combustion chamber design and optimized supply of air. There are several techniques which optimize combustion conditions and reduce emissions. There is a significant difference in emissions between different techniques. A modern wood-fired boiler with a water accumulation tank, representing BAT, reduces the emission by more than 90 per cent compared to an outdated boiler without a water accumulation tank. A modern boiler has three different zones: a fireplace for the gasification of wood, a gas combustion zone with ceramics or other material which allow temperatures of some 1000°C, and a convection zone. The convection part where the water absorbs the heat should be sufficiently long and effective so that the gas temperature can be reduced from 1000°C to 250°C or less. There are also several techniques to supplement old and outdated boilers, for example with water accumulation tanks, ceramic inserts and pellet burners.

69. Optimized burning rates are accompanied by low emissions of carbon monoxide (CO), total hydrocarbons (THC) and PAHs. Setting limits (type approval regulations) on the emission of CO and THCs also affects the emission of PAHs. Low emission of CO and THCs results in low emission of PAHs. Since measuring PAH is far more expensive than measuring CO, it is more cost-effective to set a limit value for CO and THCs. Work is continuing on a proposal for a CEN standard for coal- and wood-fired boilers up to 300 kW (see table VII).

TABLE VII

Draft CEN standards in 1997

Class		3	2	1	3	2	1	3	2	1
	Effect (kW)	CO			THC			Particulates		
Manual	< 50	5000	8000	25000	150	300	2000	150/125	180/150	200/180
	50-150	2500	5000	12500	100	200	1500	150/125	180/150	200/180
	>150-300	1200	2000	12500	100	200	1500	150/125	180/150	200/180
Automatic	< 50	3000	5000	15000	100	200	1750	150/125	180/150	200/180
	50-150	2500	4500	12500	80	150	1250	150/125	180/150	200/180
	> 150-300	1200	2000	12500	80	150	1250	150/125	180/150	200/180

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

70. Emissions from residential wood combustion stoves can be reduced:

(a) For existing stoves, by public information and awareness programmes regarding proper stove operation, the use of untreated wood only, fuel preparation procedures and the correct seasoning of wood for moisture content; and

(b) For new stoves, by the application of product standards as described in the draft CEN standard (and equivalent product standards in the United States and Canada).

71. More general measures for PAH emission reduction are those related to the development of centralized systems for households and energy conservation such as improved thermal insulation to reduce energy consumption.

72. Information is summarized in table VIII.

TABLE VIII

PAH emission control for residential combustion

Management options	Emission level (%)[a/]	Estimated costs	Management risks
Use of dried coal and wood (dried wood is wood stored for at least 18-24 months).	High effectiveness		
Use of dried coal.	High effectiveness		
Design of heating systems for solid fuels to provide optimized complete burning conditions: - Gasification zone; - Combustion with ceramics; - Effective convection zone.	55	Medium	Negotiations have to be held with stove manufacturers to introduce an approval scheme for stoves.
Water accumulation tank.			

Management options	Emission level (%)[a/]	Estimated costs	Management risks
Technical instructions for efficient operation. **Public information programme concerning the use of wood-burning stoves.**	30 - 40	Low	Might be achieved also by vigorous public education, combined with practical instructions and stove type regulation.

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 IX, 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 IX

Possible alternatives to wood preservation involving PAH-based products

Management options	Management risks
Use of alternative materials for application in construction: - Sustainably produced hardwood (riverbanks, fences, gates); - Plastics (horticulture posts); - Replacement of artificial constructions by natural ones (such as riverbanks, fences, etc.); - Use of untreated wood. There are several alternative wood-preserving techniques in development which do not include impregnation with PAH-based products.	Other environmental problems have to be evaluated such as: - Availability of suitably produced wood; - Emissions caused by the production and disposal of plastics, especially PVC.

Annex VI

TIMESCALES FOR THE APPLICATION OF LIMIT VALUES AND BEST AVAILABLE TECHNIQUES TO NEW AND EXISTING STATIONARY SOURCES

The timescales for the application of limit values and best available techniques are:

(a) For new stationary sources: two years after the date of entry into force of the present Protocol;

(b) For existing stationary sources: eight years after the date of entry into force of the present Protocol. If necessary, this period may be extended for specific existing stationary sources in accordance with the amortization period provided for by national legislation.

Annex VII

RECOMMENDED CONTROL MEASURES FOR REDUCING EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MOBILE SOURCES

1. Relevant definitions are provided in annex III to the present Protocol.

I. ACHIEVABLE EMISSION LEVELS FOR NEW VEHICLES AND FUEL PARAMETERS

A. *Achievable emission levels for new vehicles*

2. Diesel-fuelled passenger cars

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

3. Heavy-duty vehicles

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

4. Off-road engines

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

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

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*/ "Uniform provisions concerning the approval of compression ignition (C.I.) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by the engine." The regulation came into force on 15 December 1995 and its amendment came into force on 5 March 1997.

Step 2

Net power (P) (kW)	**Mass of hydrocarbons**	**Mass of particulates**
$0 \leq P < 18$		
$18 \leq P < 37$	1.5 g/kWh	0.8 g/kWh
$37 \leq P < 75$	1.3 g/kWh	0.4 g/kWh
$75 \leq P < 130$	1.0 g/kWh	0.3 g/kWh
$130 \leq P < 560$	1.0 g/kWh	0.2 g/kWh

B. Fuel parameters

5. Diesel fuel

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

N.S.: Not specified.

*/ 1 January of year specified.

**/ Indicative value.

II. RESTRICTION OF HALOGENATED SCAVENGERS, ADDITIVES IN FUELS AND LUBRICANTS

6. In some countries, 1,2-dibromomethane in combination with 1,2-dichloromethane is used as a scavenger in leaded petrol. Moreover, PCDD/F are formed during the combustion process in the engine. The application of three-way catalytic converters for cars will require the use of unleaded fuel. The addition of scavengers and other halogenated compounds to petrol and other fuels and to lubricants should be avoided as far as possible.

7. Table I summarizes measures for PCDD/F emission control from the exhaust from road transport motor vehicles.

Table I

PCDD/F emission control for the exhaust from road transport motor vehicles

Management options	Management risks
Avoiding adding halogenated compounds to fuels - 1,2-dichloromethane - 1,2-dichloromethane and corresponding bromo compounds as scavengers in leaded fuels for spark ignition engines (Bromo compounds may lead to the formation of brominated dioxins or furans.) Avoiding halogenated additives in fuels and lubricants.	Halogenated scavengers will be phased out as the market for leaded petrol shrinks because of the increasing use of closed-loop three-way catalytic converters with spark ignition engines.

III. CONTROL MEASURES FOR EMISSIONS OF POPS FROM MOBILE SOURCES

A. POP emissions from motor vehicles

8. POP emissions from motor vehicles occur as particle-bound PAHs emitted from diesel-fuelled vehicles. To a minor extent PAHs are also emitted by petrol-fuelled vehicles.

9. Lubrication oil and fuels may contain halogenated compounds as a result of additives or the production process. These compounds may be transformed during combustion into PCDD/F and subsequently emitted with the exhaust gases.

B. Inspection and maintenance

10. For diesel-fuelled mobile sources, the effectiveness of the control of emissions of PAHs may be ensured through programmes to test the mobile sources periodically for particulate emissions, opacity during free acceleration, or equivalent methods.

11. For petrol-fuelled mobile sources, the effectiveness of the control of emissions of PAHs (in addition to other exhaust components) may be ensured through programmes to test periodically the fuel metering and the efficiency of the catalytic converter.

C. Techniques to control PAH emissions from diesel- and petrol fuelled motor vehicles

1. General aspects of control technologies

12. It is important to ensure that vehicles are designed to meet emission standards while in service. This can be done by ensuring conformity of production, lifetime durability, warranty of emission-control components, and recall of defective vehicles. For vehicles in use, continued emission control performance can be ensured by an effective inspection and maintenance programme.

2. Technical measures for emission control

13. The following measures to control PAH emissions are important:

(a) Fuel-quality specifications and engine modifications to control emissions before they are formed (primary measures); and

(b) Addition of exhaust treatment systems, e.g. oxidizing catalysts or particle traps (secondary measures).

(a) Diesel engines

14. Diesel-fuel modification can yield two benefits: a lower sulphur content reduces emissions of particles and increases the conversion efficiency of oxidizing catalysts, and the reduction in di- and tri-aromatic compounds reduces the formation and emission of PAHs.

15. A primary measure to reduce emissions is to modify the engine to achieve more complete combustion. Many different modifications are in use. In general, vehicle exhaust composition is influenced by changes in combustion chamber design and by higher fuel injection pressures. At present, most diesel engines rely on mechanical engine control systems. Newer engines increasingly use computerized electronic control systems with greater potential flexibility in controlling emissions. Another technology to control emissions is the combined technology of turbocharging and intercooling. This system is successful in reducing NO_x as well as increasing fuel economy and power output. For heavy- and light-duty engines the use of intake manifold tuning is also a possibility.

16. Controlling the lubricating oil is important to reduce particulate matter (PM), as 10 to 50 per cent of particulate matter is formed from engine oil. Oil consumption can be reduced by improved engine manufacturing specifications and improved engine seals.

17. Secondary measures to control emissions are additions of exhaust treatment systems. In general, for diesel engines the use of an oxidizing catalyst in combination with a particulate filter has been shown to be effective in reducing PAH emissions. A particle trap oxidizer is being evaluated. It is located in the exhaust system to trap PM and can provide some regeneration of the filter by burning the collected PM, through electrical heating of the system or some other means of regeneration. For proper regeneration of passive system traps during normal operation, a burner-assisted regeneration system or the use of additives is required.

(b) *Petrol engines*

18. PAH-reduction measures for petrol-fuelled engines are primarily based on the use of a closed-loop three-way catalytic converter, which reduces PAHs as part of the HC emission reductions.

19. Improved cold start behaviour reduces organic emissions in general and PAHs in particular (for instance start-up catalysts, improved fuel evaporation/atomization, heated catalysts).

20. Table II summarizes measures for PAH emission control from the exhaust from road transport motor vehicles.

Table II

PAH emission control for the exhaust from road transport motor vehicles

Management options	Emission level (%)	Management risks
Spark ignition engines:		
- Closed-loop three-way catalytic converter,	10-20	Availability of unleaded petrol.
- Catalysts for reducing cold start emissions.	5-15	Commercially available in some countries.
Fuel for spark ignition engines: - Reduction of aromatics, - Reduction of sulphur.		Availability of refinery capacity.
Diesel engines: - Oxidizing catalyst, - Trap oxidizer/particulate filter.	20-70	
Diesel fuel modification: - Reduction of sulphur to reduce particulate emissions.		Availability of refinery capacity.
Improvement of diesel engine specifications: - Electronic control system, injection rate adjustment and high-pressure fuel injection, - Turbocharging and intercooling, - Exhaust gas recirculation.		Existing technologies.

Annex VIII

MAJOR STATIONARY SOURCES

I. INTRODUCTION

Installations or parts of installations for research, development and the testing of new products are not covered by this list. A more complete description of the categories may be found in annex V.

II. LIST OF CATEGORIES

Category	Description of the category
1	Incineration, including co-incineration, of municipal, hazardous or medical waste, or of sewage sludge.
2	Sinter plants.
3	Primary and secondary production of copper.
4	Production of steel.
5	Smelting plants in the secondary aluminium industry.
6	Combustion of fossil fuels in utility and industrial boilers with a thermal capacity above 50 MW_{th}.
7	Residential combustion.
8	Firing installations for wood with a thermal capacity below 50 MW_{th}.
9	Coke production.
10	Anode production.
11	Aluminium production using the Soederberg process.
12	Wood preservation installations, except for a Party for which this category does not make a significant contribution to its total emissions of PAH (as defined in annex III).

SECTION IX

1999 PROTOCOL TO ABATE ACIDIFICATION EUTROPHICATION AND GROUND-LEVEL OZONE

1999 PROTOCOL TO ABATE ACIDIFICATION, EUTROPHICATION AND GROUND-LEVEL OZONE

The Parties,

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

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

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

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

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

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

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

Resolved to apply a multi-effect, multi-pollutant approach to preventing or minimizing the exceedances of critical loads and levels,

Taking into account the emissions from certain existing activities and installations responsible for present air pollution levels and the development of future activities and installations,

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

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

Reaffirming that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction, *Conscious* of the need for a cost-effective regional approach to combating air pollution that takes account of the variations in effects and abatement costs between countries,

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

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

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

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

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

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

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

Bearing in mind also the need to avoid, in so far as possible, taking measures for the achievement of the objectives of this Protocol that aggravate other health and environment-related problems,

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

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

Aware also of the commitments that Parties have assumed under the United Nations Framework Convention on Climate Change, *Have agreed* as follows:

Article 1: ***DEFINITIONS***

For the purposes of the present Protocol,

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

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

3. “Executive Body” means the Executive Body for the Convention constituted under article 10, paragraph 1, of the Convention;

4. “Commission” means the United Nations Economic Commission for Europe;

5. “Parties” means, unless the context otherwise requires, the Parties to the present Protocol;

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

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

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

9. “Reduced nitrogen compounds” means ammonia and its reaction products;

10. “Sulphur” means all sulphur compounds, expressed as sulphur dioxide (SO_2);

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

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

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

14. “Pollutant emissions management area", or “PEMA”, means an area designated in annex III under the conditions laid down in article 3, paragraph 9;

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

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

Article 2: ***OBJECTIVE***

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

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

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

(c) For ozone:

- (i) For Parties within the geographical scope of EMEP, the critical levels of ozone, as given in annex I;
- (ii) For Canada, the Canada-wide Standard for ozone; and
- (iii) For the United States of America, the National Ambient Air Quality Standard for ozone.

Article 3: ***BASIC OBLIGATIONS***

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

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

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

achieve national or regional goals for acidification abatement and to meet national air quality standards.

4. Limit values for new and existing boilers and process heaters with a rated thermal input exceeding 50 MW_{th} and new heavy-duty vehicles shall be evaluated by the Parties at a session of the Executive Body with a view to amending annexes IV, V and VIII no later than two years after the date of entry into force of the present Protocol.

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

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

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

8. Each Party shall, subject to paragraph 10:

(a) Apply, as a minimum, the ammonia control measures specified in annex IX; and

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

9. Paragraph 10 shall apply to any Party:

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

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

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

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

10. A Party to which this paragraph applies shall:

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

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

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

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

Article 4: ***EXCHANGE OF INFORMATION AND TECHNOLOGY***

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

(a) The development and updating of databases on best available techniques, including those that increase energy efficiency, low-emission burners and good environmental practice in agriculture;

(b) The exchange of information and experience in the development of less polluting transport systems;

(c) Direct industrial contacts and cooperation, including joint ventures; and

(d) The provision of technical assistance.

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

Article 5: ***PUBLIC AWARENESS***

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

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

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

(c) Levels of tropospheric ozone; and

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

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

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

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

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

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

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

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

Article 6: *STRATEGIES, POLICIES, PROGRAMMES, MEASURES AND INFORMATION*

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

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

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

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

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

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

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

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

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

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

2. Each Party shall collect and maintain information on:

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

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

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

Article 7: ***REPORTING***

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

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

(i) Where a Party applies different emission reduction strategies under article 3, paragraphs 2 and 3, it shall document the strategies applied and its compliance with the requirements of those paragraphs;
(ii) Where a Party judges certain limit values, as specified in accordance with article 3, paragraph 3, not to be technically and economically feasible, taking into consideration the costs and advantages, it shall report and justify this;

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

(i) Levels of emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds using, as a minimum, the methodologies and the temporal and spatial resolution specified by the Steering Body of EMEP;
(ii) Levels of emissions of each substance in the reference year (1990) using the same methodologies and temporal and spatial resolution;
(iii) Data on projected emissions and current reduction plans; and
(iv) Where it deems it appropriate, any exceptional circumstances justifying emissions that are temporarily higher than the ceilings established for it for one or more pollutants; and

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

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

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

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

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

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

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

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

Article 8: RESEARCH, DEVELOPMENT AND MONITORING

The Parties shall encourage research, development, monitoring and cooperation related to:

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

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

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

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

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

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

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

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

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

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

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

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

Article 9: ***COMPLIANCE***

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

Article 10: *REVIEWS BY THE PARTIES AT SESSIONS OF THE EXECUTIVE BODY*

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

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

(i) Their obligations in relation to their calculated and internationally optimized allocations of emission reductions referred to in article 7, paragraph 5, above; and
(ii) The adequacy of the obligations and the progress made towards the achievement of the objective of the present Protocol;

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

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

Article 11: *SETTLEMENT OF DISPUTES*

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

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

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

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

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

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

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

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

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

Article 12: *ANNEXES*

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

Article 13: *AMENDMENTS AND ADJUSTMENTS*

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

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

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

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

5. Any Party that is unable to approve an amendment to an annex, other than to an annex referred to in paragraph 3, shall so notify the Depositary in writing within ninety days from the date of the communication of its adoption. The Depositary shall without delay notify all Parties of any

such notification received. A Party may at any time substitute an acceptance for its previous notification and, upon deposit of an instrument of acceptance with the Depositary, the amendment to such an annex shall become effective for that Party.

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

Article 14: ***SIGNATURE***

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

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

Article 15: ***RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION***

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

2. The present Protocol shall be open for accession as from 31 May 2000 by the States and organizations that meet the requirements of article 14, paragraph 1.

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

Article 16: ***DEPOSITARY***

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

Article 17: ***ENTRY INTO FORCE***

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

2. For each State and organization that meets the requirements of article 14, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into

force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

Article 18: WITHDRAWAL

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

Article 19: AUTHENTIC TEXTS

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

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

DONE at Gothenburg (Sweden), this thirtieth day of November one thousand nine hundred and ninety-nine.

Annex I

CRITICAL LOADS AND LEVELS

I. CRITICAL LOADS OF ACIDITY

A. For Parties within the geographical scope of EMEP

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

B. For Parties in North America

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

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

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

II. CRITICAL LOADS OF NUTRIENT NITROGEN

For Parties within the geographical scope of EMEP

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

III. CRITICAL LEVELS OF OZONE

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

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

7. The long-term critical level of ozone for crops of an AOT40 of 3000 ppb.hours for May-July (used as a typical growing season) and for daylight hours was used to define areas at risk where the critical level is exceeded. A specific reduction of exceedances was targeted in the integrated assessment modelling undertaken for the present Protocol to provide guidance for setting the emission ceilings in annex II. The long-term critical level of ozone for crops is considered also to protect other plants such as trees and natural vegetation. Further scientific work is under way to develop a more differentiated interpretation of exceedances of critical levels of ozone for vegetation.

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

B. *For Parties in North America*

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

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

Annex II

EMISSION CEILINGS

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

TABLE I

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

Party	Emission levels 1980	Emission levels 1990	Emission ceilings for 2010	Percentage emission reductions for 2010 (base year 1990)
Armenia	141	73	73	0%
Austria	400	91	39	-57%
Belarus	740	637	480	-25%
Belgium	828	372	106	-72%
Bulgaria	2050	2008	856	-57%
Canada national [a/]	4643	3236		
PEMA (SOMA)	3135	1873		
Croatia	150	180	70	-61%
Czech Republic	2257	1876	283	-85%
Denmark	450	182	55	-70%
Finland	584	260	116	-55%
France	3208	1269	400	-68%
Germany	7514	5313	550	-90%
Greece	400	509	546	7%
Hungary	1633	1010	550	-46%
Ireland	222	178	42	-76%
Italy	3757	1651	500	-70%
Latvia	-	119	107	-10%
Liechtenstein	0.39	0.15	0.11	-27%
Lithuania	311	222	145	-35%
Luxembourg	24	15	4	-73%
Netherlands	490	202	50	-75%
Norway	137	53	22	-58%
Poland	4100	3210	1397	-56%
Portugal	266	362	170	-53%
Republic of Moldova	308	265	135	-49%
Romania	1055	1311	918	-30%
Russian Federation [b/]	7161	4460		
PEMA	1062	1133	635	-44%
Slovakia	780	543	110	-80%
Slovenia	235	194	27	-86%
Spain [b/]	2959	2182	774	-65%
Sweden	491	119	67	-44%
Switzerland	116	43	26	-40%

Party	Emission levels		Emission ceilings for	Percentage emission reductions for 2010 (base year 1990)
	1980	1990	2010	
Ukraine	3849	2782	1457	-48%
United Kingdom	4863	3731	625	-83%
United States of America [c/]				
European Community	26456	16436	4059	-75%

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

b/ Figures apply to the European part within the EMEP area.

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

TABLE II

Emission ceilings for nitrogen oxides (thousands of tonnes of NO_2 per year)

Party	Emission levels 1990	Emission ceilings for 2010	Percentage emission reductions for 2010 (base year 1990)
Armenia	46	46	0%
Austria	194	107	-45%
Belarus	285	255	-11%
Belgium	339	181	-47%
Bulgaria	361	266	-26%
Canada [a/]	2104		
Croatia	87	87	0%
Czech Republic	742	286	-61%
Denmark	282	127	-55%
Finland	300	170	-43%
France	1882	860	-54%
Germany	2693	1081	-60%
Greece	343	344	0%
Hungary	238	198	-17%
Ireland	115	65	-43%
Italy	1938	1000	-48%
Latvia	93	84	-10%

Party	**Emission levels 1990**	**Emission ceilings for 2010**	**Percentage emission reductions for 2010 (base year 1990)**
Liechtenstein	0.63	0.37	-41%
Lithuania	158	110	-30%
Luxembourg	23	11	-52%
Netherlands	580	266	-54%
Norway	218	156	-28%
Poland	1280	879	-31%
Portugal	348	260	-25%
Republic of Moldova	100	90	-10%
Romania	546	437	-20%
Russian Federation [b/]	3600		
PEMA	360	265	-26%
Slovakia	225	130	-42%
Slovenia	62	45	-27%
Spain [b/]	1113	847	-24%
Sweden	338	148	-56%
Switzerland	166	79	-52%
Ukraine	1888	1222	-35%
United Kingdom	2673	1181	-56%
United States of America [c/]			
European Community	13161	6671	-49%

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

b/ Figures apply to the European part within the EMEP area.

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

TABLE III

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

Party	Emission levels 1990	Emission ceilings for 2010	Percentage emission reductions for 2010 (base year 1990)
Armenia	25	25	0%
Austria	81	66	-19%
Belarus	219	158	-28%
Belgium	107	74	-31%
Bulgaria	144	108	-25%
Croatia	37	30	-19%
Czech Republic	156	101	-35%
Denmark	122	69	-43%
Finland	35	31	-11%
France	814	780	-4%
Germany	764	550	-28%
Greece	80	73	-9%
Hungary	124	90	-27%
Ireland	126	116	-8%
Italy	466	419	-10%
Latvia	44	44	0%
Liechtenstein	0.15	0.15	0%
Lithuania	84	84	0%
Luxembourg	7	7	0%
Netherlands	226	128	-43%
Norway	23	23	0%
Poland	508	468	-8%
Portugal	98	108	10%
Republic of Moldova	49	42	-14%
Romania	300	210	-30%
Russian Federation [a/]	1191		
PEMA	61	49	-20%
Slovakia	62	39	-37%
Slovenia	24	20	-17%
Spain [a/]	351	353	1%
Sweden	61	57	-7%
Switzerland	72	63	-13%
Ukraine	729	592	-19%
United Kingdom	333	297	-11%
European Community	3671	3129	-15%

a/ Figures apply to the European part within the EMEP area.

TABLE IV

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

Party	**Emission levels 1990**	**Emission ceilings for 2010**	**Percentage emission reductions for 2010 (base year 1990)**
Armenia	81	81	0%
Austria	351	159	-55%
Belarus	533	309	-42%
Belgium	324	144	-56%
Bulgaria	217	185	-15%
Canada [a/]	2880		
Croatia	105	90	-14%
Czech Republic	435	220	-49%
Denmark	178	85	-52%
Finland	209	130	-38%
France	2957	1100	-63%
Germany	3195	995	-69%
Greece	373	261	-30%
Hungary	205	137	-33%
Ireland	197	55	-72%
Italy	2213	1159	-48%
Latvia	152	136	-11%
Liechtenstein	1.56	0.86	-45%
Lithuania	103	92	-11%
Luxembourg	20	9	-55%
Netherlands	502	191	-62%
Norway	310	195	-37%
Poland	831	800	-4%
Portugal	640	202	-68%
Republic of Moldova	157	100	-36%
Romania	616	523	-15%
Russian Federation [b/]	3566		
PEMA	203	165	-19%
Slovakia	149	140	-6%
Slovenia	42	40	-5%
Spain [b/]	1094	669	-39%
Sweden	526	241	-54%
Switzerland	292	144	-51%
Ukraine	1369	797	-42%
United Kingdom	2555	1200	-53%
United States of America [c/]			
European Community	15353	6600	-57%

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

b/ Figures apply to the European part within the EMEP area.

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

Annex III

DESIGNATED POLLUTANTS EMISSIONS MANAGEMENT AREA (PEMA)

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

Russian Federation PEMA

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

Annex IV

LIMIT VALUES FOR EMISSIONS OF SULPHUR FROM STATIONARY SPURCES

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

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

2. For the purpose of section A, except table II and paragraphs 11 and 12, limit value means the quantity of a gaseous substance contained in the waste gases from an installation that is not to be exceeded. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as mg/m^3), assuming standard conditions for temperature and pressure for dry gas (volume at 273.15 K, 101.3 kPa). With regard to the oxygen content of the exhaust gas, the values given in the tables below for each source category shall apply. Dilution for the purpose of lowering concentrations of pollutants in waste gases is not permitted. Start-up, shutdown and maintenance of equipment are excluded.

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

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

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

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

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

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

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

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

TABLE I

Limit values for SOx emissions released from boilers [a/]

	Thermal input (MWth)	**Limit value (mg SO_2/Nm^3) [b/]**	**Alternative for domestic solid fuels removal efficiency**
Solid and liquid fuels, new installations	50 - 100	850	90% [d/]
	100 - 300	850 - 200 [c/] (linear decrease)	92% [d/]
	> 300	200 [c/]	95% [d/]
Solid fuels, existing installations	50 - 100	2000	
	100 - 500	2000 - 400 (linear decrease)	
	> 500	400	
	50 - 150		40%
	150 - 500		40 - 90% (linear increase)
	> 500		90%
Liquid fuels, existing installations	50 - 300	1700	
	300 - 500	1700 - 400 (linear decrease)	
	> 500	400	
Gaseous fuels in general, new and existing installations		35	
Liquefied gas, new and existing installations		5	
Low-calorific-value gases (e.g. gasification of refinery residues or combustion of coke oven gas)		new 400 existing 800	
Blast-furnace gas		new 200 existing 800	
New combustion plant in refineries (average of all new combustion installations)	> 50 (total refinery capacity)	600	
Existing combustion plant in refineries (average of all existing combustion installations)		1000	

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

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

c/ 400 with heavy fuel oil S <0.25%.

d/ If an installation reaches 300 mg/Nm^3 SO_2, it may be exempted from applying the removal efficiency.

10. Gas oil:

TABLE II

Limit values for the sulphur content of gas oil [a/]

	Sulphur content (per cent by weight)
Gas oil	< 0.2 after 1 July 2000 < 0.1 after 1 January 2008

a/ "Gas oil" means any petroleum product within HS 2710, or any petroleum product which, by reason of its distillation limits, falls within the category of middle distillates intended for use as fuel and of which at least 85 per cent by volume, including distillation losses, distils at 350^0C. Fuels used in on-road and non-road vehicles and agricultural tractors are excluded from this definition. Gas oil intended for marine use is included in the definition if it meets the description above or it has a viscosity or density falling within the ranges of viscosity or density defined for marine distillates in table I of ISO 8217 (1996).

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

(a) Sulphur recovery 99.5% for new plant;

(b) Sulphur recovery 97% for existing plant.

12. Titanium dioxide production: in new and existing installations, discharges arising from digestion and calcination steps in the manufacture of titanium dioxide shall be reduced to a value of not more than 10 kg of SO_2 equivalent per Mg of titanium dioxide produced.

B. Canada

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

C. United States of America

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

(a) Electric Utility Steam Generating Units - 40 Code of Federal Regulations (C.F.R.) Part 60, Subpart D, and Subpart Da;
(b) Industrial-Commercial-Institutional Steam Generating Units - 40 C.F.R. Part 60, Subpart Db, and Subpart Dc;
(c) Sulphuric Acid Plants - 40 C.F.R. Part 60, Subpart H;
(d) Petroleum Refineries - 40 C.F.R. Part 60, Subpart J;
(e) Primary Copper Smelters - 40 C.F.R. Part 60, Subpart P;
(f) Primary Zinc Smelters - 40 C.F.R. Part 60, Subpart Q;
(g) Primary Lead Smelters - 40 C.F.R. Part 60, Subpart R;
(h) Stationary Gas Turbines - 40 C.F.R. Part 60, Subpart GG;
(i) Onshore Natural Gas Processing - 40 C.F.R. Part 60, Subpart LLL;
(j) Municipal Waste Combustors - 40 C.F.R. Part 60, Subpart Ea, and Subpart Eb; and
(k) Hospital/Medical/Infectious Waste Incinerators - 40 C.F.R. Part 60, Subpart Ec.

Annex V

LIMIT VALUES FOR EMISSIONS OF NITROGEN OXIDES FROM STATIONARY SOURCES

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

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

2. For the purpose of section A, limit value means the quantity of a gaseous substance contained in the waste gases from an installation that is not to be exceeded. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as mg/m^3), assuming standard conditions for temperature and pressure for dry gas (volume at 273.15 K, 101.3 kPa). With regard to the oxygen content of exhaust gas, the values given in the tables below for each source category shall apply. Dilution for the purpose of lowering concentrations of pollutants in waste gases is not permitted. Limit values generally address NO together with NO_2, commonly named NO_x, expressed as NO_2. Start-up, shutdown and maintenance of equipment are excluded.

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

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

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

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

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

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

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

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

TABLE I

Limit values for NO_x emissions released from boilers[a/]

	Limit value (mg/Nm^3) [b/]
Solid fuels, new installations:	
- Boilers 50 - 100 MW_{th}	400
- Boilers 100 - 300 MW_{th}	300
- Boilers >300 MW_{th}	200
Solid fuels, existing installations:	
- Solid in general	650
- Solid with less than 10% volatile compounds	1300
Liquid fuels, new installations:	
- Boilers 50 - 100 MW_{th}	400
- Boilers 100 - 300 MW_{th}	300
- Boilers >300 MW_{th}	200
Liquid fuels, existing installations	450
Gaseous fuels, new installations:	
Fuel: natural gas	
- Boilers 50 - 300 MW_{th}	150
- Boilers > 300 MW_{th}	100
Fuel: all other gases	200
Gaseous fuels, existing installations	350

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

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

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

TABLE II

Limit values for NO_x emissions released from onshore combustion turbines

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

a/ Natural gas is naturally occurring methane with not more than 20% (by volume) of inerts and other constituents.

b/ 75 mg/Nm^3 if:

- Combustion turbine used in a combined heat and power system; or
- Combustion turbine driving compressor for public gas grid supply.

For combustion turbines not falling into either of the above categories, but having an efficiency greater than 35%, determined at ISO base load conditions, the limit value shall be 50*n/35 where n is the combustion turbine efficiency expressed as a percentage (and determined at ISO base load conditions).

c/ This limit value applies only to combustion turbines firing light and medium distillates.

d/ The limit values do not apply to combustion turbines running less than 150 hours a year.

11. Cement production:

TABLE III

Limit values for NO_x emissions released from cement production [a/]

	Limit value (mg/Nm^3)
New installations (10% O_2) - Dry kilns - Other kilns	 500 800
Existing installations (10% O_2)	1200

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

12. Stationary engines:

TABLE IV

Limit values for NO_x emissions released from new stationary engines

Capacity, technique, fuel specification	Limit value [a/] (mg/Nm^3)
Spark ignition (= Otto) engines, 4-stroke, > 1 MW_{th} - Lean-burn engines - All other engines	 250 500
Compression ignition (= Diesel) engines, > 5 MW_{th} - Fuel: natural gas (jet ignition engines) - Fuel: heavy fuel oil - Fuel: diesel oil or gas oil	 500 600 500

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

13. Production and processing of metals:

TABLE V

Limit values for NO_x emissions released from primary iron and steel[a/] production

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

a/ Production and processing of metals: metal ore roasting or sintering installations, installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting with a capacity exceeding 2.5 Mg/hour, installations for the processing of ferrous metals (hot rolling mills > 20 Mg/hour of crude steel).

14. Nitric acid production:

TABLE VI

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

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

B. *Canada*

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

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

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

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

C. *United States of America*

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

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

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

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

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

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

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

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

Annex VI

LIMIT VALUES IMIT VALUES FOR EMISSIONS OF VOLATILE ORGANIC COMPOUNDS FROM STATIONARY SOURCES

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

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

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

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

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

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

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

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

(i) New vehicles defined (see below) as vehicles of category M1 and of category N1 insofar as they are coated at the same installation as M1 vehicles;
(ii) Truck cabins, defined as the housing for the driver, and all integrated housing for the technical equipment of category N2 and N3 vehicles;
(iii) Vans and trucks defined as category N1, N2 and N3 vehicles, but excluding truck cabins;
(iv) Buses defined as category M2 and M3 vehicles; and
(v) Other metallic and plastic surfaces including those of aeroplanes, ships, trains, etc., wooden surfaces, textile, fabric, film and paper surfaces.

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

- M1 vehicles are those used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat;
- M2 vehicles are those used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 Mg;
- M3 vehicles are those used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 Mg;
- N1 vehicles are those used for the carriage of goods and having a maximum mass not exceeding 3.5 Mg;
- N2 vehicles are those used for the carriage of goods and having a maximum mass exceeding 3.5 Mg but not exceeding 12 Mg;
- N3 vehicles are those used for the carriage of goods and having a maximum mass exceeding 12 Mg.

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

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

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

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

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

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

(iii) Publication rotogravure: rotogravure used for printing paper for magazines, brochures, catalogues or similar products, using toluene-based inks;

(iv) Rotogravure: a printing process using a cylindrical image carrier in which the printing area is below the non-printing area, using liquid inks that dry through evaporation. The recesses are filled with ink and the surplus is cleaned off the non-printing area before the surface to be printed contacts the cylinder and lifts the ink from the recesses;

(v) Rotary screen printing: a web-fed printing process in which the ink is passed onto the surface to be printed by forcing it through a porous image carrier, in which the printing area is open and the non-printing area is sealed off, using liquid inks that dry only through evaporation. Web-fed means that the material to be printed is fed to the machine from a reel as distinct from separate sheets;

(vi) Laminating associated to a printing process: the adhering of two or more flexible materials to produce laminates; and

(vii) Varnishing: a process by which a varnish or an adhesive coating is applied to a flexible material for the purpose of later sealing the packaging material;

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

(j) “Conversion of natural or synthetic rubber” means any process of mixing, crushing, blending, calendering, extruding and vulcanization of natural or synthetic rubber and additionally processes for the processing of natural or synthetic rubber to derive an end product;

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

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

(m) “Vehicle refinishing” means any industrial or commercial coating activity and associated degreasing activities performing:

(i) The coating of road vehicles, or part of them, carried out as part of vehicle repair, conservation or decoration outside manufacturing installations, or

(ii) The original coating of road vehicles, or part of them, with refinishing-type materials, where this is carried out away from the original manufacturing line, or

(iii) The coating of trailers (including semi-trailers);

(n) “Impregnation of wooden surfaces” means any process impregnating timber with preservative;

(o) “Standard conditions” means a temperature of 273.15 K and a pressure of 101.3 kPa;

(p) “NMVOCs” comprise all organic compounds except methane which at 273.15 K show a vapour pressure of at least 0.01 kPa or which show a comparable volatility under the given application conditions;

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

(r) “Fugitive emission of NMVOCs” means any emission, not in waste gases, of NMVOC into air, soil and water as well as, unless otherwise stated, solvents contained in any

product and includes uncaptured emissions of NMVOCs released to the outside environment via windows, doors, vents and similar openings. Fugitive limit values are calculated on the basis of a solvent management plan (see appendix I to the present annex);

(s) "Total emission of NMVOCs" means the sum of fugitive emission of NMVOCs and emission of NMVOCs in waste gases;

(t) "Input" means the quantity of organic solvents and their quantity in preparations used when carrying out a process, including the solvents recycled inside and outside the installation, and which are counted every time they are used to carry out the activity;

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

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

(w) "Substances harmful to human health" are subdivided into two categories:

(i) Halogenated VOCs that have possible risk of irreversible effects; or
(ii) Hazardous substances that are carcinogens, mutagens or toxic to reproduction or that may cause cancer, may cause heritable genetic damage, may cause cancer by inhalation, may impair fertility or may cause harm to the unborn child.

4. The following requirements shall be satisfied:

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

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

(c) If measurements of emissions of NMVOCs are required, they should be carried out continuously if emissions of NMVOCs exceed 10 kg of total organic carbon (TOC)/h in the exhaust duct downstream from an emission reduction instalation and the hours of operation exceed

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

200 hours a year. For all other installations, discontinuous measurement is required as a minimum. For the approval of compliance, own approaches may be used provided that they result in equal stringency;

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

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

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

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

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

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

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

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

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

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

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

8. Storage and distribution of petrol:

TABLE I

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

Capacity, technique, further specification	Threshold values	Limit value
Vapour recovery unit serving storage and distribution facilities at refinery tank farms or terminals	5000 m^3 petrol throughput annually	10 g VOC/Nm^3 including methane

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

9. Adhesive coating:

TABLE II

Limit values for NMVOC emissions released from adhesive coating

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

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

10. Wood and plastic lamination:

TABLE III

Limit values for NMVOC emissions released from wood and plastic lamination

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

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

TABLE IV

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

Capacity, technique, further specification	**Threshold value for solvent consumption (Mg/year)[a/]**	**Limit value [b/] for total emissions of NMVOCs**
New installations, car coating (M1, M2)	> 15 (and > 5,000 coated items a year)	45 g NMVOC/m^2 or 1.3 kg/item and 33 g NMVOC/m^2
Existing installations, car coating (M1, M2)	> 15 (and > 5,000 coated items a year)	60 g NMVOC /m^2 or 1.9 kg/item and 41 g NMVOC/m^2
New and existing installations, car coating (M1, M2)	> 15 (≤ 5,000 coated monocoques or > 3,500 coated chassis a year)	90 g NMVOC/m^2 or 1.5 kg/item and 70 g NMVOC/m^2
New installations, coating of new truck cabins (N1, N2, N3)	> 15 (≤ 5,000 coated items a year)	65 g NMVOC/m^2
New installations, coating of new truck cabins (N1, N2, N3)	> 15 (> 5,000 coated items a year)	55 g NMVOC/m^2
Existing installations, coating of new truck cabins (N1, N2, N3)	> 15 (≤ 5,000 coated items a year)	85 g NMVOC/m^2
Existing installations, coating of new truck cabins (N1, N2, N3)	> 15 (> 5,000 coated items a year)	75 g NMVOC/m^2
New installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (≤ 2,500 coated items a year)	90 g NMVOC/m^2
New installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (> 2,500 coated items a year)	70 g NMVOC/m^2
Existing installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (≤ 2,500 coated items a year)	120 g NMVOC/m^2
Existing installations, coating of new trucks and vans (without cabin) (N1, N2, N3)	> 15 (> 2,500 coated items a year)	90 g NMVOC/m^2
New installations, coating of new buses (M3)	> 15 (≤ 2,000 coated items a year)	210 g NMVOC/m^2
New installations, coating of new buses (M3)	> 15 (> 2,000 coated items a year)	150 g NMVOC/m^2
Existing installations, coating of new buses (M3)	> 15 (≤ 2,000 coated items a year)	290 g NMVOC/m^2
Existing installations, coating of new buses (M3)	> 15 (> 2,000 coated items a year)	225 g NMVOC/m^2

[a/] For a solvent consumption ≤ 15 Mg a year (coating of cars), table XIV on car refinishing applies.

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

TABLE V

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

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

a/ Limit value applies to coating applications and drying processes operated under contained conditions.

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

c/ The first value applies to drying processes, the second to coating application processes.

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

12. Coil coating:

TABLE VI

Limit values for NMVOC emissions released from coil coating

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

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

13. Dry cleaning:

TABLE VII

Limit values for NMVOC emissions released from dry cleaning

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

a/ Limit value for total emissions of NMVOCs calculated as mass of emitted solvent per mass of cleaned and dried product.

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

TABLE VIII

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

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

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

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

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

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

TABLE IX

Limit values for NMVOC emissions released from printing processes

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

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

16. Manufacturing of pharmaceutical products:

TABLE X

Limit values for NMVOC emissions released from manufacturing of pharmaceutical products

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

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

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

c/ A total limit value of 15% of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.

d/ The fugitive limit value does not include solvents sold as part of a coatings preparation in a sealed container.

17. Conversion of natural or synthetic rubber:

TABLE XI

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

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

a/ A total limit value of 25% of solvent input may be applied instead of using the waste gas concentration limit and the limit value for fugitive emissions of NMVOCs.

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

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

18. Surface cleaning:

TABLE XII

Limit values for NMVOC emissions released from surface cleaning

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

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

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

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

TABLE XIII

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

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Total limit value (kg/Mg)	
New and existing installations	> 10	Animal fat:	1.5
		Castor:	3.0
		Rape seed:	1.0
		Sunflower seed:	1.0
		Soya beans (normal crush):	0.8
		Soya beans (white flakes):	1.2
		Other seeds and vegetable material:	3.0 a/
		All fractionation processes, excl. degumming b/:	1.5
		Degumming:	4.0

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

b/ The removal of gum from the oil.

20. Vehicle refinishing:

TABLE XIV

Limit values for NMVOC emissions released from vehicle refinishing

Capacity, technique, further specification	Threshold value for solvent consumption (Mg/year)	Limit value (mg C/Nm^{3})	Limit value for fugitive emissions of NMVOCs (% of solvent input)
New and existing installations	> 0.5	50 a/	25

a/ Compliance with limit values to be proven by 15-minute average measurements.

21. Impregnation of wooden surfaces:

TABLE XV

Limit values for NMVOC emissions released from impregnation of wooden surfaces

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

a/ Does not apply to impregnation with creosote.

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

B. Canada

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

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

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

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

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

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

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

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

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

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

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

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

C. United States of America

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix I

SOLVENT MANAGEMENT PLAN

INTRODUCTION

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

PRINCIPLES

2. The solvent management plan serves the following purposes:
   - *(a)* Verification of compliance, as specified in the annex; and
   - *(b)* Identification of future reduction options.

DEFINITIONS

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

(a) Inputs of organic solvents:

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

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

(b) Outputs of organic solvents:

O1. Emission of NMVOCs in waste gases.

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

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

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

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

O6. Organic solvents contained in collected waste.

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

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

O9. Organic solvents released in other ways.

GUIDANCE ON USE OF THE SOLVENT MANAGEMENT PLAN FOR VERIFICATION OF COMPLIANCE

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

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

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

$$C = I1 - O8$$

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

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

$$E = F + O1$$

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

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

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

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

or

$$F = O2 + O3 + O4 + O9$$

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

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

$$I = I1 + I2$$

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

Appendix II

REDUCTION SCHEME

Principles

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

Practice

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

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

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

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

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

Time period		**Maximum allowed total annual emissions**
New installations	**Existing installations**	
By 31.10.2001	By 31.10.2005	Target emission x 1.5
By 31.10.2004	By 31.10.2007	Target emission

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

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

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

Activity	**Multiplication factor for use in subparagraph (b) (ii)**
Rotogravure printing; flexography printing; laminating as part of a printing activity; printing; varnishing as part of a printing activity; wood coating; coating of textiles, fabric, film or paper; adhesive coating	4
Coil coating; vehicle refinishing	3
Food contact coating; aerospace coating	2.33
Other coatings and rotary screen printing	1.5

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

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

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

Annex VII

TIMESCALES UNDER ARTICLE 3

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

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

(b) For existing stationary sources:

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

2. The timescales for the application of the limit values for fuels and new mobile sources referred to in article 3, paragraph 5, and the limit values for gas oil referred to in annex IV, table II, shall be:

- (i) In the case of a Party that is not a country with an economy in transition, the date of entry into force of the present Protocol or the dates associated with the measures specified in annex VIII and with the limit values specified in annex IV, table II, whichever is the later; and
- (ii) In the case of a Party that is a country with an economy in transition, five years after the date of entry into force of the present Protocol or five years after the dates associated with the measures specified in annex VIII and with the limit values in annex IV, table II, whichever is the later.

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

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

Annex VIII

LIMIT VALUES FOR FUELS AND NEW MOBILE SOURCES

INTRODUCTION

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

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

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

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

PASSENGER CARS AND LIGHT-DUTY VEHICLES

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

HEAVY-DUTY VEHICLES

5. Limit values for engines for heavy-duty vehicles are given in tables II and III depending on the applicable test procedures.

MOTORCYCLES AND MOPEDS

6. Limit values for motorcycles and mopeds are given in table VI and table VII.

NON-ROAD VEHICLES AND MACHINES

7. Limit values for agricultural and forestry tractors and other non-road vehicle/machine engines are listed in tables IV and V. Stage I (table IV) is based on ECE regulation 96, “Uniform provisions concerning the approval of compression-ignition (C.I.) engines to be installed in agricultural and forestry tractors with regard to the emissions of pollutants by the engine”.

FUEL QUALITY

8. Environmental quality specifications for petrol and diesel are given in tables VIII to XI.

TABLE I

Limit values for passenger cars and light-duty vehicles

				Reference mass (RW) (kg)	**Limit values**								
					Carbon monoxide		**Hydrocarbons**		**Nitrogen oxides**		**Hydrocarbons and nitrogen oxides combined**		**Particulates** [a/]
					L1 (g/km)		**L2 (g/km)**		**L3 (g/km)**		**L2+L3 (g/km)**		**L4 (g/km)**
Category		**Class**	**To be applied from** [b/]		**Petrol**	**Diesel**	**Petrol**	**Diesel**	**Petrol**	**Diesel**	**Petrol**	**Diesel**	**Diesel**
A	M [c/]		1.1.2001	All [g/]	2.3	0.64	0.20	-	0.15	0.50	-	0.56	0.05
	N_1 [d/]	I	1.1.2001 [e/]	RW ≤ 1305	2.3	0.64	0.20	-	0.15	0.50	-	0.56	0.05
		II	1.1.2002	1305 < RW ≤ 1760	4.17	0.80	0.25	-	0.18	0.65	-	0.72	0.07
		III	1.1.2002	1760 < RW	5.22	0.95	0.29	-	0.21	0.78	-	0.86	0.10
B	M [c/]		1.1.2006	All	1.0	0.50	0.10	-	0.08	0.25	-	0.30	0.025
	N_1 [d/]	I	1.1.2006 [f/]	RW ≤ 1305	1.0	0.50	0.10	-	0.08	0.25	-	0.30	0.025
		II	1.1.2007	1305 < RW ≤ 1760	1.81	0.63	0.13	-	0.10	0.33	-	0.39	0.04
		III	1.1.2007	1760 < RW	2.27	0.74	0.16	-	0.11	0.39	-	0.46	0.06

a/ For compression-ignition engines.

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

c/ Except vehicles whose maximum mass exceeds 2,500 kg.

d/ And those category M vehicles specified in note c.

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

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

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

TABLE II

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

Row	To be applied from [a/]	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulates (g/kWh)	Smoke (m-1)
A	1.10.2001	2.1	0.66	5.0	0.10 / 0.13 [b/]	0.8
B1	1.10.2006	1.5	0.46	3.5	0.02	0.5
B2	1.10.2009	1.5	0.46	2.0	0.02	0.5

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

b/ For engines with a swept volume below 0.75 dm3 per cylinder and a rated power speed above 3000 revolutions per minute.

TABLE III

Limit values for heavy-duty vehicles - European transient cycle (ETC) test [a/]

Row	To be applied from [b/]	Carbon monoxide (g/kWh)	Non-methane hydrocarbons (g/kWh)	Methane [c/] (g/kWh)	Nitrogen oxides (g/kWh)	Particulates [d/]
A (2000)	1.10.2001	5.45	0.78	1.6	5.0	0.16 / 0.21 [e/]
B1 (2005)	1.10.2006	4.0	0.55	1.1	3.5	0.03
B2 (2008)	1.10.2009	4.0	0.55	1.1	2.0	0.03

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

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

c/ For natural gas engines only.

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

e/ For engines with a swept volume below 0.75 dm^3 per cylinder and a rated power speed above 3000 revolutions per minute.

TABLE IV

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

Net power (P) (kW)	To be applied from [a/]	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
130 ≤ P < 560	31.12.1998	5.0	1.3	9.2	0.54
75 ≤ P < 130	31.12.1998	5.0	1.3	9.2	0.70
37 ≤ P < 75	31.03.1998	6.5	1.3	9.2	0.85

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

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

TABLE V

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

Net power (P) (kW)	To be applied from [a/]	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
130 ≤ P < 560	31.12.2001	3.5	1.0	6.0	0.2
75 ≤ P < 130	31.12.2002	5.0	1.0	6.0	0.3
37 ≤ P < 75	31.12.2003	5.0	1.3	7.0	0.4
18 ≤ P < 37	31.12.2000	5.5	1.5	8.0	0.8

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

TABLE VI

Limit values for motorcycles and 3- and 4-wheelers (> 50 cm^3; > 45 km/h) to be applied from 17 June 1999 [a/]

Engine type	Limit values
2-stroke	CO = 8 g/km HC = 4 g/km NO_x = 0.1 g/km
4-stroke	CO = 13 g/km HC = 3 g/km NO_x = 0.3 g/km

a/ Type approval shall be refused as from the given date if the vehicle's emissions do not meet the limit values.

Note: For 3- and 4-wheelers, the limit values have to be multiplied by 1.5.

TABLE VII

Limit values for mopeds (≤ 50 cm^3; < 45 km/h)

Stage	To be applied from [a]	Limit values	
		CO (g/km)	HC + NO$_x$ (g/km)
I	17.6.1999	6.0 [b]	3.0 [b]
II	17.6.2002	1.0 [c]	1.2

[a] Type approval shall be refused as from the given dates if the vehicle's emissions do not meet the limit values.

[b] For 3- and 4-wheelers, multiply by 2.

[c] For 3- and 4-wheelers, 3.5 g/km.

TABLE VIII

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

Type: Petrol

		Limits [a]		Test	
Parameter	Unit	Minimum	Maximum	Method [b]	Date of publication
Research octane number		95	-	EN 25164	1993
Motor octane number		85	-	EN 25163	1993
Reid vapour pressure, summer period [c]	kPa	-	60	EN 12	1993
Distillation:					
evaporated at 100°C	% v/v	46	-	EN-ISO 3405	1988
evaporated at 150°C	% v/v	75	-		
Hydrocarbon analysis:					
- olefins	% v/v	-	18.0 [d]	ASTM D1319	1995
- aromatics		-	42	ASTM D1319	1995
- benzene		-	1	project EN 12177	1995
Oxygen content	% m/m	-	2.7	EN 1601	1996
Oxygenates:					
- Methanol, stabilizing agents must be added	% v/v	-	3	EN 1601	1996
- Ethanol, stabilizing agents may be necessary	% v/v	-	5	EN 1601	1996
- Iso-propyl alcohol	% v/v	-	10	EN 1601	1996
- Tert-butyl alcohol	% v/v	-	7	EN 1601	1996
- Iso-butyl alcohol	% v/v	-	10	EN 1601	1996
- Ethers containing 5 or more carbon atoms per molecule	% v/v	-	15	EN 1601	1996
Other oxygenates [e]	% v/v	-	10	EN 1601	1996
Sulphur content	mg/kg	-	150	project EN-ISO/DIS 14596	1996

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

b/ EN - European standard; ASTM - American Society for Testing and Materials; DIS - Draft international standard.

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

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

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

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

TABLE IX

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

Type: Diesel fuel

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

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

b/ EN - European standard; IP - The Institute of Petroleum; DIS - Draft international standard.

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

TABLE X

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

Type: Petrol

Parameter	Unit	Limits [a/]		Test	
		Minimum	**Maximum**	**Method [b/]**	**Date of publication**
Research octane number		95		EN 25164	1993
Motor octane number		85		EN 5163	1993
Reid vapour pressure, summer period	kPa	-			
Distillation:					
evaporated at 100°C	% v/v	-	-		
evaporated at 150°C		-	-		
Hydrocarbon analysis:					
- olefins	% v/v	-			
- aromatics	% v/v	-	35	ASTM D1319	1995
- benzene	% v/v	-			
Oxygen content	% m/m	-			
Sulphur content	mg/kg	-	50	project EN-ISO/DIS 14596	1996

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

b/ EN - European standard; ASTM - American Society for Testing and Materials; DIS - Draft international standard.

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

TABLE XI

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

Type: Diesel fuel

Parameter	Unit	Limits [a/]		Test	
		Minimum	**Maximum**	**Method [b/]**	**Date of publication**
Cetane number			-		
Density at 15°C	kg/m^3		-		

Parameter	Unit	Limits [a/]		Test	
		Minimum	Maximum	Method [b/]	Date of publication
Distillation point: 95%	°C	-			
Polycyclic aromatic hydrocarbons	% m/m	-			
Sulphur content	mg/kg	-	50	project EN-ISO/DIS 14596	1996

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

b/ EN - European standard; DIS - Draft international standard.

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

B. Canada

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

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

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

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

C. United States of America

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

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

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

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

Annex IX

MEASURES FOR THE CONTROL OF EMISSIONS OF AMMONIA FROM AGRICULTURAL SOURCES

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

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

A. Advisory code of good agricultural practice

3. Within one year from the date of entry into force of the present Protocol for it, a Party shall establish, publish and disseminate an advisory code of good agricultural practice to control ammonia emissions. The code shall take into account the specific conditions within the territory of the Party and shall include provisions on:

- Nitrogen management, taking account of the whole nitrogen cycle;
- Livestock feeding strategies;
- Low-emission manure spreading techniques;
- Low-emission manure storage systems;
- Low-emission animal housing systems; and
- Possibilities for limiting ammonia emissions from the use of mineral fertilizers.

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

B. Urea and ammonium carbonate fertilizers

4. Within one year from the date of entry into force of the present Protocol for it, a Party shall take such steps as are feasible to limit ammonia emissions from the use of solid fertilizers based on urea.

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

C. Manure application

6. Each Party shall ensure that low-emission slurry application techniques (as listed in guidance document V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto) that have been shown to reduce emissions by at least 30% compared to the reference specified in that guidance document are used as far as the Party in question considers them applicable, taking account of local soil and geomorphological conditions, slurry type and farm structure. The timescales for the application of these measures shall be: 31 December 2009 for Parties with economies in transition and 31 December 2007 for other Parties.[1/]

7. Within one year from the date of entry into force of the present Protocol for it, a Party shall ensure that solid manure applied to land to be ploughed shall be incorporated within at least 24 hours of spreading as far as it considers this measure applicable, taking account of local soil and geomorphological conditions and farm structure.

D. Manure storage

8. Within one year from the date of entry into force of the present Protocol for it, a Party shall use for new slurry stores on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, low-emission storage systems or techniques that have been shown to reduce emissions by 40% or more compared to the reference (as listed in the guidance document referred to in paragraph 6), or other systems or techniques with a demonstrably equivalent efficiency.2/

9. For existing slurry stores on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, a Party shall achieve emission reductions of 40% insofar as the Party considers the necessary techniques to be technically and economically feasible.2/ The timescales for the application of these measures shall be: 31 December 2009 for Parties with economies in transition and 31 December 2007 for all other Parties.1/

E. Animal housing

10. Within one year from the date of entry into force of the present Protocol for it, a Party shall use, for new animal housing on large pig and poultry farms of 2,000 fattening pigs or 750 sows or 40,000 poultry, housing systems which have been shown to reduce emissions by 20% or more compared to the reference (as listed in the guidance document referred to in paragraph 6), or other systems or techniques with a demonstrably equivalent efficiency. 2/ Applicability may be limited for animal welfare reasons, for instance in straw-based systems for pigs and aviary and free-range systems for poultry.

Notes:

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

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

SECTION X

MINISTERIAL DECLARATIONS AND STATEMENTS

MINISTERIAL STATEMENT ON THE OCCASION OF THE SIGNING OF THE PROTOCOL ON VOLATILE ORGANIC COMPOUNDS

(Geneva, 19 November 1991)

The Ministers responsible for the Environment and Senior Officials of the Parties to the Convention on Long-range Transboundary Air Pollution express their satisfaction that the negotiations towards a Protocol concerning the Control of Emissions of Volatile Organic Compounds (VOCs) or their Transboundary Fluxes have been successfully completed. The VOC Protocol that has been signed today constitutes an important complement to the two protocols under the Geneva Convention that are already in force, viz. on the reduction and control of sulphur and of nitrogen oxide emissions.

The Parties are confident that the VOC Protocol will contribute effectively to the reduction of tropospheric ozone in the region of the Economic Commission for Europe (ECE). This will have beneficial effects on air quality, human health, crops and ecosystems throughout the region. The Parties intend to ratify the Protocol as soon as possible in order to ensure an early into force. Those Parties that are not yet in a position to sign the Protocol declare their intention to use their best efforts in order to bring their environmental policies in line with the objectives of the Protocol. Those Parties signing the Protocol today, call upon Parties which are not yet in a position to sign to do so or to accede to the Protocol as soon as possible.

The Parties to the Geneva Convention stress the need to continue to improve the protection of terrestrial and aquatic ecosystems and human health against the effects of long-range transboundary air pollution. They therefore agreed to devote particular attention to their negotiations towards joint commitments on further reductions of the emissions of sulphur, nitrogen, oxides and volatile organic compounds.

Efforts are being pursued vigorously within the Convention with a view to developing the scientific methodology to quantify the sensitivity of ecosystems against acid/and nitrogen depositions and against the impact of photochemical oxidants. Taking into account the sensitivity of ecosystems within the ECE region, considerably greater emissions reductions will be required than those achieved through commitments made so far within the framework of the Convention.

The Parties, therefore, urge timely negotiations leading to additional protocols to the Convention.

OSLO MINISTERIAL DECLARATION
(14 June 1994)

We, the Ministers and Senior Officials for the Environment from ECE countries and the European Community, attending the Oslo meeting as Parties to the Convention on Long-range Tran boundary Air Pollution:

1. Express serious concern that air pollutants continue to be transported across boundaries, causing widespread harm to human health and damage to ecosystems and natural resources of major environmental and economic importance. We regard minimization of harmful transboundary air pollution as an essential precondition for sustainable development and long-term social progress in our region.

2. Are determined to intensify our efforts to protect human health and the environment even in times of other competing priorities. In so doing, we are mindful of the positive effects that environmental policy has on economic activity and employment. We will strive to promote the necessary changes in patterns of production and consumption.

3. Acknowledge the Convention as a central instrument for protecting our common environment and as an outstanding example of intergovernmental cooperation. The Convention has served as a bridge between different political systems and as a factor of stability throughout years of political change. It has substantially contributed to the development of international environmental law through the progressive elaboration of protocols on sulphur, nitrogen oxides and volatile organic compounds, thereby creating an essential framework for the control and reduction of damage to human health, the environment and the economy, caused by transboundary air pollution.

4. Are resolved to make every effort to meet the challenges presented by the recent growth in the number of ECE States and to accommodate these States as Parties.

5. Believe that the Protocol we sign today decisively extends the frontiers of our endeavours, by:

- Involving actively a much wider range of Parties than before;

- Creating an instrument whose application, progressive extension and elaboration over the years ahead can reduce emissions to sustainable levels;

- Combining the concepts of effect-based environmental goals, cost-effectiveness, and application of limit values;

- Introducing provisions for a strong compliance regime.

6. Are mindful that the implementation of this new Protocol will require substantial efforts of the Parties. We call upon all Parties to the Convention, as well as international financial institutions, to support the implementation process through bilateral and multilateral assistance to Parties in economic transition and in post-war reconstruction.

7. Assert that the strategy for the further implementation of the Convention, in building upon the Protocol signed today, should be guided by the following key considerations:

- The goal of sustainable development, recognizing the need to respect the limits of tolerance of the natural and man-made environment, as well as human health;

- The precautionary principle;
- The complementary roles of administrative measures, technological standards and economic instruments;
- Appropriate consideration of the polluter-pays principle;
- The need for capacity-building and access to technology;
- The importance of cost-effective reduction strategies;
- The interdependence between economic progress, on the one hand, and protection and enhancement of the environment, on the other;
- The importance of taking measures which combat both local and transboundary air pollution problems.

8. Are further determined to address the significant environmental challenges confronting Parties by taking the following measures:

- To consolidate and extend the international scientific, economic and technological basis for the further reduction of transboundary air pollution;
- To make every effort to accelerate the negotiations on a second step to the 1988 Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes to further reduce the emissions of nitrogen compounds, including ammonia, and, if appropriate, volatile organic compounds, in view of their contribution to photochemical pollution, acidification and eutrophication, and their effects on human health, the environment and materials, by addressing all significant emission sources;
- To negotiate an international agreement for the control of those persistent organic pollutants and heavy metals from anthropogenic activities which pose a risk to human health and the environment, including the sensitive Arctic environment;
- To ratify without undue delay the Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes to ensure its early entry into force, and to develop the necessary further steps;
- To extend the necessary international programmes to monitor the emissions and transport of air pollutants and their environmental effects, and strengthen their financial basis, inter alia through contributions in kind;
- To further develop the scientific basis of the critical load approach and consider its possible applications for future steps under the Convention;
- To make every effort to enhance cooperation and coordination between relevant international organizations and conventions to avoid duplication of work.

9. Encourage as many countries as possible to join the Protocol and urge all signatories to ratify it without undue delay, and to take all possible measures to implement the Protocol even before its entry into force, and, if possible, to take measures beyond the obligations of the Protocol.

MINISTERIAL DECLARATION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

(24 June 1998)

We, the Ministers and Senior Officials for the Environment from UN/ECE countries and the European Community, attending the Aarhus meeting as Parties to the Convention on Long-range Transboundary Air Pollution,

* *Note* with serious concern that air pollutants, including hazardous chemical substances, continue to be transported in substantial amounts across national boundaries and over long distances, causing harm to human health and damage to ecosystems and natural resources of major environmental and economic importance;

* *Are resolved* to continue and intensify our efforts to protect human health and the environment notwithstanding the pressure from other competing priorities. In so doing we take into account the positive effects that environmental policy may have on long-term economic activity and employment;

* *Recognize* twenty years of successful cooperation between the Parties to the Convention, which sets an example for global action in environmental protection;

* *Consider* that the Convention is a key instrument for protecting our common environment by creating a scientifically based framework for gradually reducing the damage caused by air pollution to human health, the environment and the economy in the UN/ECE region;

* *Underline* that the controls contained in the 1998 Protocols on Heavy Metals and Persistent Organic Pollutants constitute a significant step towards reducing emissions of substances that may cause adverse effects on human health or the environment;

* *Stress* the importance of all the requirements in the two Protocols and welcome the recent establishment of an Implementation Committee under the Executive Body for the Convention to assist in the review of compliance with the requirements of all Protocols to the Convention;

* *Are determined* to continue our efforts to further reduce the emissions of heavy metals and persistent organic pollutants by strengthening the measures on substances already included in the two Protocols as well as by adding new substances to the Protocols pursuant to Executive Body decisions 1998/1 and 1998/2;

* *Urge* the Signatories to the Protocol on Persistent Organic Pollutants to strengthen their efforts, in cooperation with the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), to review the availability and feasibility of alternatives to DDT, and to promote the commercialization of safer alternative;

* *Encourage* countries to strengthen their efforts to identify and solve the environmental problems caused by the use of polychlorinated biphenyls (PCBs), and work together to assist countries with economies in transition in dealing with these problems;

* *Are also determined* to cooperate closely under the auspices of the United Nations Environment Programme to develop, preferably by the end of the year 2000, a global legally binding instrument on the elimination or control of certain persistent organic pollutants, including appropriate support to meet the special needs of developing countries and countries with economies in transition, taking into account measures to control the transfrontier movement of such substances;

* *Call upon* all Parties to the Convention, as well as international financial institutions, to support the implementation process of the new Protocols through bilateral and multilateral assistance to Parties with economies in transition, mindful that their implementation will require substantial efforts;

* *Encourage* Parties to the Convention to sign and ratify the new Protocols without undue delay and to do their utmost to implement them, if possible, even before their entry into force;

* *Note* the progress made in developing a multi-pollutant/multi-effects approach including the technical basis for a draft protocol on nitrogen oxides and related substances, including ammonia and volatile organic compounds, covering all relevant sectors, based on scientific information and cost-effective solutions, and support the acceleration of the negotiation of an ambitious and realistic protocol, with a view to finalizing it by mid-1999;

* *Welcome* the proposal to designate the North Sea Area as an SO_x Emission Control Area under the MARPOL 73/78 Convention;

* *Support* the future priorities of work under the Convention, as outlined by the Executive Body, with a focus on implementation and compliance as well as review and extension of existing Protocols;

* *Are keenly aware* of the need to sustain the networks and capacities of the scientists and experts who have provided the scientific foundation for these Protocols and for the obligations they lay down on national strategies, policies, programmes, measures and information, research, development and monitoring, and review by the Parties;

* *Decide to apply* the same high scientific requirements to the revision of existing Protocols and the development of any new ones;

* *Recognize* that effective implementation of Protocols and further development of cost-optimal abatement measures require our full commitment and equitable cost-sharing between all stakeholders, for research into and monitoring of the effects of air pollutants on ecosystems and human health, for refining the science on which EMEP is based and for developing further integrated assessment modelling for those pollutants for which it is appropriate.

GOTHENBURG MINISTERIAL DECLARATION
(1 December 1999)

We, the Ministers and Senior Officials for the Environment from UN/ECE countries and the European Community, attending the Gothenburg meeting as Parties to the Convention on Long-range Transboundary Air Pollution:

1. *Acknowledge* the Convention on Long-range Transboundary Air Pollution as an outstanding example of intergovernmental cooperation: it has created an effective framework for gradually reducing the damage caused by air pollution to human health, the environment and the economy in the UN/ECE region and in its first 20 years has substantially contributed to the advancement of international environmental law through the progressive development of protocols covering the major airborne pollutants that affect our region;

2. *Express satisfaction* that our joint efforts to combat acid rain are yielding tangible results, yet note with serious concern that air pollutants are still transported in large quantities across borders, causing widespread harm to human health and damage to ecosystems and natural resources of major environmental and economic importance;

3. *Are determined* to intensify our efforts to protect human health and to respond adequately to the new environmental challenges and are keenly aware that future policies must include changes in patterns of production and consumption, bearing in mind that environmental policies may also have positive effects on long-term economic activity and employment;

4. *Believe* that the Protocol that is opened for signature today breaks new ground by:

- Creating a comprehensive effect-based instrument whose application and progressive extension can reduce emissions to sustainable levels;

- Addressing several effects and several pollutants simultaneously; and

- Providing for cost-effective emission reductions to reach environmental goals;

5. *Bear in mind* that reducing the emissions of sulphur, nitrogen and volatile organic compounds helps to curb the emission of other pollutants, including transboundary particulate aerosols, which contribute to human health effects, and also that the measures taken under the United Nations Framework Convention on Climate Change and those taken under the new Gothenburg Protocol will reinforce each other;

6. *Encourage* all Parties to sign the present Protocol and urge all Signatories to ratify it without undue delay, to try to apply it even before it comes into force and, wherever possible, to take even more stringent measures than those it lays down;

7. *Are mindful* of the substantial efforts that we will have to make to meet our obligations under this new Protocol and call upon Parties to the Convention and international financial institutions to support its implementation through bilateral and multilateral assistance to Parties with economies in transition;

8. *Support* the Convention’s priorities of work, as outlined by the Executive Body, focusing on implementation and compliance as well as on reviewing and extending existing Protocols, and welcome the Convention’s new organizational structure;

9. *Are determined* to consolidate and strengthen the international scientific, economic and technological basis for further reducing transboundary air pollution, fully recognizing that it is essential to sustain the networks and capacities of the scientists and experts who provide the foundation for such action;

10. *Recognize* that the Convention’s core activities require adequate funding if the Protocols are to be implemented effectively and cost-optimal abatement measures further developed, and to this end request the Executive Body to prepare a stable, long-term funding arrangement, preserving the possibilities for contributing in kind, that includes the international coordination of health and ecosystem effect-related activities and integrated assessment modelling, for instance by appropriately extending the EMEP Protocol;

11. *Are determined* to address the emissions of air pollutants from ships and aircraft and direct the Executive Body to work with the International Maritime Organization, the International Civil Aviation Organization and other appropriate forums to achieve this goal;

12. *Encourage* relevant international organizations and conventions to cooperate and coordinate their work with a view to disseminating information and sharing experience;

13. *Recognize* the crucial role that regional environmental agreements and organizations play in protecting human health and the environment, and request the Executive Body to provide information and assistance to facilitate the development of appropriate regional agreements in other parts of the world;

14. *Pledge* to make every effort to ratify or accede to the 1998 Aarhus Protocols on Heavy Metals and on Persistent Organic Pollutants so that they can enter into force in the near future and set an example for worldwide action;

15. *Intend* to strengthen our efforts to help countries with economies in transition, in particular newly independent States, to accede to the Convention and its Protocols, and to support the effective implementation of their provisions.

SECTION XI

RECENT DECISIONS OF THE EXECUTIVE BODY

RECENT DECISION OF THE EXECUTIVE BODY

Decisions taken by the Executive Body have been formally adopted and recorded with specific reference numbers since the late 1990s and a complete set of these is to be found on the Convention's web site (www.unece.org/env/lrtap). The decisions listed here have particular relevance to the work of the Convention, for example to the structure and functions of its bodies, to some of the activities under specific protocols to the Convention, and to issues related to funding. Those not listed are generally related to individual Parties failing to meet their obligations under certain protocols to the Convention and are associated with the work of the Convention's Implementation Committee.

Decision 1997/1
(ECE/EB.AIR/53, annex I)

Rules and Conditions for Joint Implementation under the Oslo Protocol

The Executive Body,

Referring to article 2, paragraph 7, of the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions, calling upon the Executive Body to elaborate and adopt rules and conditions for joint implementation,

Noting that no obligations other than those set out in annex II to the Protocol shall be affected, and that joint implementation shall not affect the reviews foreseen under article 8, paragraph 2,

Recalling that these rules and conditions shall ensure the fulfilment of the obligations set out in article 2, paragraph 2, and also promote the achievement of the environmental objectives set out in article 2, paragraph 1,

Decides to adopt the Rules and Conditions for Joint Implementation set out below.

RULES AND CONDITIONS FOR JOINT IMPLEMENTATION

1.For the purposes of these rules and conditions,

- "Parties" means, unless the context otherwise requires, the Parties to the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions;
- "Deposition" means the sulphur deposition as calculated by EMEP;
- "Joint implementation agreement" means an agreement between two or more Parties to cooperate to implement their emission reduction obligations;
- "Third party" is a Party which is not party to the joint implementation agreement in question.

2. Only Parties to the Protocol may enter into a joint implementation agreement.

3. A proposal for a joint implementation agreement shall, as a minimum:

(a) Specify the part of its emission reduction obligation (expressed as kilotonnes of SO_2) in accordance with the Protocol which one Party will implement through reductions carried out by another Party;

(b) Specify the emission reduction (expressed as kilotonnes of SO_2) which the other Party will undertake in addition to its emission reduction obligation in accordance with the Protocol;

(c) Specify the duration of the agreement;

(d) Contain an assessment of the deposition impact of the agreement, detailing the changes in total national depositions, in deposition at grid cell resolution and in ecosystem protection as calculated by EMEP using a multi-year average; and

(e) Indicate the level of the expected cost savings resulting from the agreement and the means of compensation chosen.

4. A joint implementation agreement shall lead to a decrease in the difference between depositions of sulphur resulting from the emission ceilings listed in annex II to the Protocol and the critical sulphur depositions within the geographical scope of EMEP.

5. Joint implementation agreements shall not lead to a change in total national deposition for third parties of more than x[*/] per cent compared with the deposition resulting from the emission ceilings listed in annex II to the Protocol.

6. Joint implementation agreements shall not lead to a change in deposition at grid cell level for third parties of more than y[*/] per cent compared with the deposition resulting from the emission ceilings listed in annex II to the Protocol.

7. The deposition change for a party to a joint implementation agreement resulting from that agreement shall not be part of the calculation of its deposition change resulting from other joint implementation agreements to which it is a third party.

8. Proposals for joint implementation agreements, containing the information specified in paragraph 3 above, shall be submitted in writing to the secretariat, which shall communicate them to all Parties. Any cost associated with the submission of the proposal shall be borne by the parties to the proposed joint implementation agreement. The Parties shall consider the proposed joint implementation agreements at the next session of the Executive Body, provided that those proposals have been circulated by the secretariat to the Parties at least ninety days in advance. Parties to a proposed joint implementation agreement should notify and consult the most affected third parties well before the submission of their proposal.

9. If several proposals have been received by the secretariat for consideration at a session of the Executive Body, they shall be considered in the order in which they were received.

10. The proposals for joint implementation agreements shall be adopted by consensus of the Parties present at a session of the Executive Body, taking into consideration the conditions contained in paragraphs 4 to 7 above.

11. The secretariat shall keep a record of joint implementation agreements. The joint implementation agreements shall be reported on and monitored in accordance with articles 4 and 5 of the Protocol.

12. Compliance and disputes between Parties that have entered into joint implementation agreements or between these Parties and third parties, shall be dealt with in accordance with articles 7 and 9 of the Protocol.

13. If a Party is in non-compliance with the emission reduction obligation arising from a joint implementation agreement, this agreement shall be considered terminated.

[*/] The percentages shall be defined after some experience with the scheme has been gained. In the meantime they will have to be determined on an ad hoc basis.

DECISION 1997/2
(ECE/EB.AIR/75, annex V)

CONCERNING THE IMPLEMENTATION COMMITTEE, ITS STRUCTURE AND FUNCTIONS AND PROCEDURES FOR REVIEW OF COMPLIANCE AS AMENDED

The Executive Body,

Determined to promote and improve compliance with the existing protocols to the 1979 Convention on Long-range Transboundary Air Pollution,

Recalling article 10, paragraph 2, of the Convention, as well as article 7 of the 1994 Protocol on Further Reduction of Sulphur Emissions and article 3, paragraph 3, of the 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes,

1. *Establishes* the Implementation Committee for the review of compliance by the Parties with their obligations under the protocols to the Convention;

2. *Decides* that the structure and functions of the Implementation Committee and the procedures for review of compliance shall be those set out in the annex to this decision;

3. *Urges* the Parties to the 1994 Protocol on Further Reduction of Sulphur Emissions to decide that the structure, functions and procedures set out in the annex to this decision shall apply for the review of compliance with article 7, paragraph 3, of that Protocol, in place of the regime adopted at the special session of the Executive Body in Oslo on 14 June 1994;

4. *Urges* the Parties to the 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes to decide to use the Implementation Committee established by this decision for the purposes of article 3, paragraph 3, of that Protocol and to apply the structure, functions and procedures set out in the annex to this decision to monitor compliance with that Protocol;

5. *Resolves* that the Implementation Committee as well as the structure, functions and procedures set out in the annex to this decision shall be available for the review of compliance with future protocols in accordance with the terms of such protocols and of any decisions of the Parties thereto.

Annex

STRUCTURE AND FUNCTIONS OF THE IMPLEMENTATION COMMITTEE AND PROCEDURES FOR REVIEW OF COMPLIANCE

STRUCTURE

1. The Committee shall consist of nine Parties to the Convention; each member of the Committee shall be Party to at least one protocol. The Executive Body shall elect Parties for terms of two years. Outgoing Parties may be re-elected for one consecutive term, unless in a given case the Executive Body decides otherwise. The Committee shall elect its own Chairman and Vice-Chairman.

MEETINGS

2. The Committee shall, unless it decides otherwise, meet twice a year. The secretariat shall arrange for and service its meetings.

FUNCTIONS OF THE COMMITTEE

3. The Committee shall:

(a) Review periodically compliance by the Parties with the reporting requirements of the protocols;

(b) Consider any submission or referral made in accordance with paragraphs 4 and 5 below with a view to securing a constructive solution;

(c) Where it deems it necessary, be satisfied, before it adopts a report or recommendation on such a submission or referral, that the quality of data reported by a Party has been evaluated by a relevant technical body under the Executive Body and/or, where appropriate, by an expert nominated by the Bureau of the Executive Body; and

(d) Prepare, at the request of the Executive Body, and based on any relevant experience acquired in the performance of its functions under subparagraphs (a), (b) and (c) above, a report on compliance with or implementation of specified obligations in an individual protocol.

SUBMISSIONS BY PARTIES

4. A submission may be brought before the Committee by:

(a) One or more Parties to a protocol that have reservations about another Party’s compliance with its obligations under that instrument. Such a submission shall be addressed in writing to the secretariat and supported by corroborating information. The secretariat shall, within two weeks of receiving a submission, send a copy of it to the Party whose compliance is at issue. Any reply and information in support thereof shall be submitted to the secretariat and to the Parties involved within three months or such longer period as the circumstances of a particular case may require. The secretariat shall transmit the submission and the reply, as well as all corroborating and supporting information, to the Committee, which shall consider the matter as soon as practicable; or

(b) A Party that concludes that, despite its best endeavours, it is or will be unable to comply fully with its obligations under a protocol. Such a submission shall be addressed in writing to the secretariat and explain, in particular, the specific circumstances that the Party considers to be the cause of its non-compliance. The secretariat shall transmit the submission to the Committee, which shall consider it as soon as practicable.

REFERRALS BY THE SECRETARIAT

5. Where the secretariat, in particular upon reviewing the reports submitted in accordance with a protocol's reporting requirements, becomes aware of possible non-compliance by a Party with its obligations, it may request the Party concerned to furnish necessary information about the matter. If there is no response or the matter is not resolved within three months or such longer period as the circumstances of the matter may require, the secretariat shall bring the matter to the attention of the Committee.

INFORMATION GATHERING

6. To assist the performance of its functions under paragraph 3 above, the Committee may:

(a) Request further information on matters under its consideration, through the secretariat;

(b) Undertake, at the invitation of the Party concerned, information gathering in the territory of that Party; and

(c) Consider any information forwarded by the secretariat concerning compliance with the protocols.

7. The Committee shall ensure the confidentiality of any information that has been provided to it in confidence.

ENTITLEMENT TO PARTICIPATE

8. A Party in respect of which a submission or referral is made shall be entitled to participate in the consideration by the Committee of that submission or referral, but shall not take part in the preparation and adoption of any report or recommendations of the Committee in accordance with paragraph 9 below.

COMMITTEE REPORT TO THE EXECUTIVE BODY

9. The Committee shall report at least once a year on its activities to the Executive Body and make such recommendations as it considers appropriate, taking into account the circumstances of the matter, regarding compliance with the protocols. Each report shall be finalized by the Committee no later than ten weeks in advance of the session of the Executive Body at which it is to be considered.

COMPETENCE OF COMMITTEE MEMBERS

10. Only those Committee members that are Parties to the protocol in respect of which compliance procedures in accordance with paragraphs 3, 6, 7 and 9 above are being undertaken may participate in those procedures. If as a result of the operation of this paragraph the size of the Committee is reduced to five members or less, the Committee shall forthwith refer the matter in question to the Executive Body.

CONSIDERATION BY THE EXECUTIVE BODY

11. The Parties to the protocol concerned, meeting within the Executive Body, may, upon consideration of a report and any recommendations of the Committee, decide upon measures of a non-discriminatory nature to bring about full compliance with the protocol in question, including measures to assist a Party's compliance. Any such decision shall be taken by consensus.

RELATIONSHIP TO SETTLEMENT OF DISPUTES

12. Application of the present compliance procedures shall be without prejudice to the settlement of disputes provisions of the protocols.

DECISION 1997/3
(ECE/EB.AIR/53, annex IV)

COMPLIANCE MONITORING FOR THE VOC PROTOCOL

The Parties to the 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes meeting within the Executive Body decide to use the Implementation Committee established by the Executive Body at its fifteenth session for the purposes of article 3, paragraph 3, of that Protocol and to apply the structure, functions and procedures set out in the annex to the decision of the Executive Body establishing the Implementation Committee to monitor compliance with that Protocol.

DECISION 1998/1
(ECE/EB.AIR/61)

CRITERIA AND PROCEDURES FOR ADDING HEAVY METALS AND PRODUCTS TO THE PROTOCOL ON HEAVY METALS

The Executive Body,

Resolved to act as early as possible to develop criteria and procedures for adding heavy metals and products to the forthcoming protocol on heavy metals,

Adopts with reference to article 13, paragraphs 6 and 7 of the protocol, the criteria and procedures for adding heavy metals and products to annexes I, VI, or VII set out below.

CRITERIA AND PROCEDURES FOR ADDING HEAVY METALS AND PRODUCTS TO ANNEXES I, VI OR VII TO THE PROTOCOL ON HEAVY METALS

1. A Party submitting a proposal to amend:

(a) Annex I to add a heavy metal; or
(b) Annex VI to add a product control measure; or
(c) Annex VII to add a product or product group

to the protocol in accordance with article 13, paragraph 6, shall provide the Executive Body with information in accordance with paragraphs 2, 3 or 4 below, as appropriate.

2. Proposals to amend annex I to add a heavy metal shall include:

(a) A risk profile and the following information:

(i) Environmental measurement and source apportionment data in areas remote from anthropogenic sources or data on long-range transboundary atmospheric transport modelling, including methodology, for the species that has known adverse effects which demonstrate the potential for long-range transboundary atmospheric transport;
(ii) Partitioning in environmental compartments, bioavailability, transformation processes, biomagnification, and accumulation which demonstrate environmental fate at locations remote from anthropogenic sources; and
(iii) Toxicity data which demonstrate the potential to cause adverse effects on human health or the environment;

(b) Information, as available, on:

(i) Production/use/emissions;
(ii) Proposed control measures (e.g. technological equipment, process modification, and alternatives);
(iii) The efficacy, applicability, risks and the quantifiable and non-monetary costs and benefits of the proposed control measures and alternatives; and
(iv) The handling and disposal of the heavy metal resulting from the control measures.

3. Proposals to amend annex VI to add a product control measure shall include:

(a) A description of:

(i) The product or product group, including its Harmonized Tariff Code, if applicable, to be subject to the control measure; and
(ii) The proposed product control measure;

(b) Information, as available, on:

(i) The manufacture, use and disposal of the product or product group to be subject to the control measure;
(ii) The contribution of the product or product group to the total emissions of a heavy metal listed in annex I within the territory of the Party to the Convention and the UNECE region as a whole prior to any product management measure to reduce such contribution and the methodology used; and
(iii) The efficacy, applicability, risks and quantifiable and non-monetary costs and benefits of taking the proposed measure.

4. Proposals to amend annex VII to add a product or product group shall include:

(a) A description of:

The action taken by any Party to the Convention to reduce emissions to the atmosphere from the product or product group; and
The product or product group, including its Harmonized Tariff Code, if applicable, which is subject to the action taken;

(b) Information, as available, on:

The contribution of the product or product group to the total emissions of a heavy metal listed in annex I within the territory of the Party to the Convention and the UNECE region as a whole prior to any product management measure to reduce such contribution and the methodology used; and
The rationale for the action taken, including the perceived risk and the cost or benefit of such a measure and the emission reduction achieved.

5. Upon receipt of a proposal prepared in accordance with paragraph 2, 3, or 4 above, and if the risk profile is deemed acceptable, the Parties shall, at a meeting of the Executive Body and by consensus, ensure that one or more technical reviews of the proposal are conducted if, on the basis of the proposal and any other relevant information submitted to the Executive Body, further consideration of the heavy metal, product, product group or product control measure is determined to be warranted. Any such technical reviews shall be in writing and evaluate:

(a) For addition of a heavy metal to annex I:

(i) The monitoring or equivalent scientific evidence documenting long-range transboundary atmospheric transport from anthropogenic sources;
(ii) Whether emissions to the atmosphere of the heavy metal have the potential to lead to a bioavailable form which can accumulate or biomagnify to harmful levels;
(iii) Whether sufficient information exists that the levels resulting from the long-range transboundary atmospheric transport of the heavy metal have the potential to cause significant adverse effects on human health or the environment;

(iv) Information concerning the sources of the heavy metal in the atmosphere, including the use of products, estimates of the total emissions from these sources and the methodologies used; and

(v) Whether measures exist to reduce the risk of adverse effects on human health and/or the environment as a result of its long-range transboundary atmospheric transport, and whether they are technically feasible, as well as their associated effects and costs;

(b) For addition of a product control measure to annex VI:

(i) Whether the product or product group intentionally contains one or more of the heavy metals specified in annex I;

(ii) Whether atmospheric emissions occurring during manufacture, processing, distribution in commerce, use, and disposal of the product or product group, have the potential to lead to a bioavailable form and, taking into account controls in place at each point of this process, account for a significant contribution to total transboundary atmospheric emissions of a heavy metal specified in annex I within the UNECE region that cause adverse effects on human health or the environment; and

(iii) The extent to which the proposed measure reduces emissions, and an assessment of its costs, benefits, and, as appropriate, its efficacy and risks or the extent to which suitable alternative measures exist;

(c) For addition of a product or product group to annex VII:

(i) Whether it intentionally contains one or more of the heavy metals specified in annex I;

(ii) The action taken by any Party to the Convention and its estimated efficiency in reducing emissions to the atmosphere of the heavy metal;

(iii) The rationale, emissions reduction, costs and benefits of this action; and

(iv) Whether its atmospheric emissions have the potential to lead to a bioavailable form, occurring during its manufacture, processing, distribution in commerce, use, and disposal, and taking into account controls in place at each point of this process, account for a significant contribution to total atmospheric emissions of a heavy metal specified in annex I within the territory of the Party to the Convention that cause adverse effects on human health or the environment.

6. The term risk profile mentioned in paragraphs 2 and 5 above refers to a comprehensive review of the scientific information related to the determination of general human health and environmental risks associated with the uses and releases of a substance. Such a review need not explicitly address risks associated with long-range transboundary air pollution, but must provide suitable information for the assessment of such risk.

7. On the basis of the submission specified in paragraph 2, 3, or 4 above and any technical reviews that may have been prepared in accordance with paragraph 5 above, the Parties shall, at a meeting of the Executive Body, complete their evaluation of the proposal taking into account the objective of the protocol set out in article 2.

DECISION 1998/2
(ECE/EB.AIR/60)

INFORMATION TO BE SUBMITTED AND THE PROCEDURE FOR ADDING SUBSTANCES TO ANNEXES I, II OR III TO THE PROTOCOL ON PERSISTENT ORGANIC POLLUTANTS

The Executive Body,

Resolved to act as early as possible to develop criteria and procedures for adding substances to the forthcoming protocol on persistent organic pollutants,

Adopts, with reference to article 14, paragraph 6, of the protocol, the requirements for information to be submitted and the procedure for adding substances to annexes I, II or III to the protocol on persistent organic pollutants set out below.

INFORMATION TO BE SUBMITTED AND THE PROCEDURE FOR ADDING SUBSTANCES TO ANNEXES I, II OR III TO THE PROTOCOL ON PERSISTENT ORGANIC POLLUTANTS

1. A Party submitting a proposal to amend annexes I, II or III in accordance with article 14, paragraph 6, shall provide the Executive Body with a risk profile on the substance and information on the characteristics below, following the guidance and indicative numerical values, which demonstrate:

(a) Potential for long-range transboundary atmospheric transport: evidence that the substance has a vapour pressure below 1,000 Pa and an atmospheric half-life greater than two days. Alternatively, monitoring data showing that the substance is found in remote regions; and

(b) Toxicity: potential to adversely affect human health and/or the environment; and

(c) Persistence: evidence that the substance's half-life in water is greater than two months, or that its half-life in soils is greater than six months, or that its half-life in sediments is greater than six months. Alternatively, evidence that the substance is otherwise sufficiently persistent to be of concern within the scope of the protocol; and

(d) Bio-accumulation:

(i) Evidence that the BCF or BAF for the substance is greater than 5,000 or the log Kow is greater than 5; or
(ii) Alternatively, if the bio-accumulative potential is significantly lower than (i) above, other factors, such as the high toxicity of the substance, that make it of concern within the scope of the protocol.

The proposal shall also contain a summary report and include, as available, information on:

(i) Production/uses/emissions, measured environmental levels in areas distant from sources, abiotic and biotic degradation processes and rates, degradation products, bio-availability; and
(ii) Socio-economic factors related to the alternatives and/or the techniques available to reduce the emissions of the proposed substance including:
  - Alternatives to the existing uses and their efficacy;
  - Any known adverse environmental or human health effects associated with the alternatives;

- Process changes, control technologies, operating practices and other pollution prevention techniques which can be used to reduce the emissions of the substance, and their applicability and effectiveness; and
- The non-monetary costs and benefits as well as the quantifiable costs and benefits associated with the use of these alternatives and/or techniques.

2. Upon receipt of a submission prepared in accordance with paragraph 1 above and if the risk profile is deemed acceptable, the Parties shall, at a meeting of the Executive Body and by consensus, ensure that one or more technical reviews of the proposal are conducted if, on the basis of the submission and any other relevant information submitted to the Executive Body, further consideration of the substance is determined to be warranted. Any such technical reviews shall be in writing and evaluate, inter alia:

(a) The monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport; and

(b) Whether sufficient information exists to suggest that the substance is likely to have significant adverse human health and/or environmental effects as a result of its long-range transboundary atmospheric transport; and

(c) A list of the sources of the substance in the atmosphere, including the use of products, estimates of the total emissions from these sources and the methodologies used; and

(d) Whether measures exist to reduce the risk of adverse effects on human health and/or the environment as a result of its long-range transboundary atmospheric transport, and whether they are technically feasible, as well as their associated effects and costs.

3. The term risk profile mentioned in paragraphs 1 and 2 above refers to a comprehensive review of the scientific information related to the determination of general human health and environmental risks associated with the uses and releases of a substance. Such a review need not explicitly address risks associated with long-range transboundary air pollution, but must provide suitable information for the assessment of such risk.

4. On the basis of the submission specified in paragraph 1 above and any technical review(s) that may have been prepared in accordance with paragraph 2 above, the Parties shall, at a meeting of the Executive Body, complete their evaluation of the proposal taking into account the objective of the protocol set out in article 2.

DECISION 1998/3
(EB.AIR/WG.5/52, annex III)

PROCEDURE FOR AMENDING DECISIONS PERTAINING TO THE IMPLEMENTATION COMMITTEE

The Executive Body,

Recalling its decision to apply the Rules of Procedure of the Economic Commission for Europe (ECE/EB.AIR/1, para. 14), and

Recalling also decision 1997/2 concerning the Implementation Committee, its structure and functions and procedures for review of compliance;

Decides that, notwithstanding Rule 35 of the Rules of Procedure of the Economic Commission for Europe, any amendment to decision 1997/2, and any other decision of the Executive Body pertaining to the Implementation Committee or its procedures, shall be made by consensus of the Parties to the Convention meeting within the Executive Body.

DECISION 1998/4
(ECE/EB.AIR/55, annex)

GUIDELINES AND PROCEDURES FOR DATA RELEASE

1. The objective of the effect-oriented activities is to supply the best available data to Parties for the negotiations in a transparent way.

2. Data used in the negotiations of the multi-pollutant/multi-effect protocol, including related scenario analyses, can be obtained by interested Parties subject to available resources. The critical loads data used in integrated assessment modelling are available electronically from the Coordination Center for Effects.

3. Further data requests should be submitted to the secretariat, which will forward the request to the appropriate national focal centre or data centre and inform the relevant subsidiary body accordingly.

4. The Parties and their national focal centres/data centres are encouraged to facilitate the availability of data. This facilitation might imply a need for additional financing or programme meetings.

DECISION 1998/5
(ECE/EB.AIR/59, annex I)

THE REVIEW FORESEEN UNDER ARTICLE 8 OF THE OSLO PROTOCOL

The Executive Body,

Referring to the review requirement contained in article 8 of the 1994 Oslo Protocol,

Recalling its 1996 decision that the first review of the 1994 Oslo Protocol should be completed within six months after the first session of the Executive Body following the entry into force of the Protocol (ECE/EB.AIR/49, para. 74),

Noting that the 1994 Oslo Protocol entered into force on 5 August 1998,

Recognizing that many elements of the review required by article 8 of the 1994 Oslo Protocol have been considered or will be considered during the negotiations for the multi-pollutant, multi-effect protocol,

1. *Requests* the Working Group on Strategies, with the assistance of the Implementation Committee, to confirm by June 1999 that it has reviewed for the purposes of article 8 of the 1994 Oslo Protocol, in the context of the negotiations of the multi-pollutant, multi-effect protocol and in accordance with paragraph 2 (b) of article 8:

(a) The information supplied by the Parties and EMEP;

(b) The data on the effects of depositions of sulphur and other acidifying compounds; and

(c) The obligations set out in the Protocol, including

The obligations in relation to calculated and internationally optimized allocations of emission reductions referred to in article 5, paragraph 5; and
The adequacy of the obligations and the progress made towards achieving the objectives of the Protocol.

2. *Requests* its bureau to review the outcome of this work and report to it at its seventeenth session.

DECISION 1998/6
(ECE/EB.AIR/59, annex II)

THE APPLICATION OF THE COMPLIANCE PROCEDURE TO THE OSLO PROTOCOL

The Parties to the 1994 Protocol on Further Reduction of Sulphur Emissions meeting within the Executive Body decide that the structure, functions and procedures set out in the annex to decision 1997/2 shall apply to the review of compliance with article 7, paragraph 3, of that Protocol, in place of the regime adopted at the special session of the Executive Body in Oslo on 14 June 1994.

DECISION 1999/2
(ECE/EB.AIR/68, annex III)

THE STRUCTURE AND ORGANIZATION OF WORK

INTRODUCTION

1. At its fifteenth session, the Executive Body decided on its future priorities for the period after the completion of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, and requested its Bureau to prepare a proposal for a new structure (ECE/EB.AIR/53, para. 46). The Bureau submitted a proposal for the Executive Body at its sixteenth session (EB.AIR/1998/5). The Executive Body approved the general approach and requested its Bureau to revise it on the basis of the discussions and to draft mandates for the bodies that would work with the new structure for its seventeenth session (ECE/EB.AIR/59, para. 58).

2. The Protocol's negotiations having been completed, the Executive Body's priorities for the next few years will shift to:

(a) Review and extension of existing protocols;
(b) Implementation of and compliance with existing agreements.

3. These two policy-related tasks require sound scientific support with emphasis on three areas, the core activities:

(a) Atmospheric measurements and modelling;

(b) Effects; and

(c) Integrated assessment, including modelling and economic benefit evaluation.

4. To ensure the scientific basis needed, it will be crucial to maintain the scientific networks that have developed during the preparation of the protocols. An active information strategy, focusing on the Convention's achievements and on new threats to health and the environment, with specific reference to economic benefits, should be implemented with a view to increasing political awareness to back this up. To this end, targeted awareness-raising activities, also involving non-governmental organizations, should be included in the annual work plans adopted by the Executive Body.

5. It will most likely not be possible to count on the same level of political attention in the implementation phase as during negotiations. Basic funding of the core activities, nevertheless, has to be secured to give these activities a long-term perspective. Recent efforts have shown that it is not feasible to establish new legal instruments, similar to the EMEP Protocol, to cover effect-related activities and integrated assessment modelling. In the medium and long term, however, it is necessary to seek a stable financial mechanism, e.g. in the form of a financial agreement covering all core activities.

ORGANIZATION OF WORK

6. Work under the Executive Body will be organized in two segments: one providing the necessary scientific and technical support, the other providing a forum for policy-making (see chart).

(a) Scientific and technical segment

7. The Working Group on Effects (WGE) will remain as it is, coordinating the work of its Task Force on the Health Aspects of Air Pollution (TFH) and International Cooperative Programmes (ICPs): on Mapping of Critical Levels and Loads with the Coordination Center for Effects (CCE); on Effects of Air Pollution on Materials, including Historic and Cultural Monuments; on Assessment and Monitoring of Acidification of Rivers and Lakes; on Assessment and Monitoring of Air Pollution Effects on Forests; on Effects of Air Pollution on Natural Vegetation and Crops; and on Integrated Monitoring of Air Pollution Effects on Ecosystems, as well as their centres. It will provide the scientific basis for the review of the effects, including recovery of the environment and human health following emission reductions in line with protocols, and carry out damage and benefit evaluations. It will also alert the Executive Body to any perceived additional, or changed, threats caused by air pollution that may require policy response.

8. The Steering Body to EMEP (EMEP-SB) will have a task force on emission inventories and projections (TFEIP), a task force on measurements and modelling (TFMM), two Meteorological Synthesizing Centres - east and west (MSC-E and MSC-W) - and the Chemical Coordinating Centre (CCC). The continuity of the functions performed by the Task Force on Integrated Assessment Modelling (TFIAM) should be safeguarded, including its streamlined cooperation with the European Commission. To this end, the Task Force will be retained for the time being. A centre for integrated assessment modelling (CIAM), which will support the Task Force on Integrated Assessment Modelling, will build on past modelling work, in particular the RAINS modelling, and cooperate closely with the EMEP centres and CCE. To provide cost calculations for integrated assessment modelling, expert groups and workshops can be set up under it. These will explore new measures to reduce emissions, including structural changes.

9. To coordinate the preparation of annual work plans and budgets for the scientific and technical segment, joint bureau meetings of the Working Group on Effects and the EMEP Steering Body will be held. The joint bureau, which should invite leaders of appropriate technical centres, when relevant to the discussion, will submit proposals to the Executive Body.

(b) Policy-making segment

10. The Working Group on Strategies and Review (WGSR) will initiate proposals to review existing protocols and to possibly negotiate new ones. It will also initiate and review any necessary revisions of technical and other annexes to protocols for which ad hoc expert groups can be established. In this context it will, in collaboration with the Implementation Committee, organize activities to review the performance of existing abatement policies by Parties and prepare recommendations for possible new approaches.

11. The Working Group on Strategies and Review will prepare proposals for any strategic development under the Convention for consideration by the Executive Body. The frequency of its sessions will be decided by the Executive Body.

12. The Working Group on Strategies and Review and the secretariat will be given responsibility, as appropriate, for coordinating activities related to the exchange of technology, with a view to promoting such work, inter alia, by organizing workshops on selected issues and providing information to relevant national and international institutions.

13. The Implementation Committee, according to its mandate, reviews Parties' compliance with obligations and makes recommendations to facilitate compliance, when necessary. It also advises on reporting by Parties on their strategies and policies for air pollution abatement. The Implementation Committee reports directly to the Executive Body.

14. The Bureau of the Executive Body will prepare policy-oriented proposals, as necessary, and will function as an inter-sessional forum for initiating action and for securing necessary operational coordination. To enable the Executive Body to respond flexibly and efficiently to pressing new challenges, an arrangement will be introduced whereby its Bureau can decide upon urgent matters, as appropriate, based on scientific input from the Bureaux of its subsidiary bodies. Such decisions should subsequently be considered and confirmed, as appropriate, by the Executive Body itself.

REPORTING AND COMMUNICATION LINES

15. Proper functioning of the new structure presupposes open communication between all bodies. Close informal and formal links should be maintained between all bodies, as is the case in the present organization. To strengthen multi-disciplinary cooperation, cross-sectoral meetings will be organized, as required, as well as joint bureau meetings. The Executive Body's Bureau will assume responsibility for such integrational activities.

MANDATES

16. The mandates for the main bodies under the Executive Body are appended below.

OUTREACH

17. The Convention has an important role to play as an example for similar action beyond the UNECE region. The secretariat, as guided by the Executive Body, will coordinate the dissemination of information and take an active part in raising awareness in other regions.

Appendix I

MANDATE OF THE BUREAU OF THE EXECUTIVE BODY

The Bureau of the Executive Body prepares policy-oriented proposals and functions as an inter-sessional forum for initiating strategic action and for securing operational coordination. To promote multi-disciplinary cooperation and integration, it cooperates actively with the Bureaux of the subsidiary bodies under the Executive Body. To respond flexibly and efficiently to pressing new challenges, the Bureau can decide upon urgent matters, as appropriate, based on scientific input from the Bureaux of the Executive Body's subsidiary bodies. Such decisions should subsequently be considered and confirmed, as appropriate, by the Executive Body itself.

Appendix II

MANDATE OF THE WORKING GROUP ON STRATEGIES AND REVIEW

1. At the request of the Executive Body, the Working Group on Strategies and Review assists it on policy-oriented matters. In particular, it provides a forum for:

(a) Assessing ongoing scientific and technical activities relating to the potential needs for revising existing protocols and for preparing new protocols, primarily based on information provided by the Working Group on Effects and the EMEP Steering Body;
(b) Negotiating revisions of existing protocols, including their annexes and related guidance documents, and the preparation of new protocols at the request of the Executive Body;
(c) Promoting the exchange of technology;
(d) Preparing proposals for any strategic development under the Convention.

2. The Working Group may set up ad hoc expert groups to address matters related to strategy and review.

3. The Working Group works in close collaboration with the Executive Body's other subsidiary bodies and with other relevant organizations.

Appendix III

MANDATE OF THE EMEP STEERING BODY

1. The EMEP Steering Body uses as a basis for its work the main objective of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) under the Convention on Long-range Transboundary Air Pollution, which is to provide sound scientific support for the Convention, in particular in the areas of atmospheric monitoring and modelling, emission inventories and emission projections, and integrated assessment.

2. The EMEP Steering Body takes the necessary steps to provide information on emissions, concentrations and depositions of air pollutants, as well as on the quantity and significance of their long-range transport across boundaries. EMEP also includes integrated assessment modelling, which brings together all relevant scientific information developed under the Convention, and evaluates current and new emission scenarios, including their long-term costs and economic benefits, taking into account uncertainties. The results of EMEP are intended to help Parties when they negotiate protocols to the Convention and when they develop and implement particular national air pollution control measures and consider international emission control strategies and agreements and their implementation.

3. The EMEP Steering Body works in close collaboration with the Executive Body's other subsidiary bodies and with other relevant organizations.

4. The EMEP Steering Body:

(a) Provides the Executive Body and other subsidiary bodies annually with an overall analysis of transboundary air pollution;

(b) Plans, supervises, assesses and guides the work of the EMEP centres and its Task Forces;

(c) Prepares the annual draft work-plan for EMEP and the annual budgets for the EMEP centres and assesses the mandatory contributions from the Parties for final approval by the Executive Body;

(d) Develops the EMEP work-plans on integrated assessment modelling, other areas where appropriate, in cooperation with the other subsidiary bodies under the Convention;

(e) Considers suggestions by Parties on short- and long-term financial and scientific voluntary contributions to EMEP and, based on the proposals by its Bureau, approves those to be included in the annual EMEP work-plan;

(f) Derestricts the EMEP technical reports and notes, thus enabling EMEP results to be posted on the EMEP Internet homepage to ensure the wide dissemination of its achievements among the Parties and the general public;

(g) Based on the recommendations by its Bureau, approves the mandatory contributions in kind to EMEP;

(h) At its annual sessions, its task force meetings and workshops, provides a forum for discussion and assessment of new scientific developments, the sharing of information and the coordination of work between EMEP and other national and international research programmes and organizations that work in the same field, as well as for the development of EMEP-related activities at national level.

5. The EMEP Steering Body elects its Bureau, which, inter alia:

(a) Monitors, evaluates and directs the work of the EMEP centres and their use of the financial and other resources between the Steering Body's sessions;

(b) Prepares substance and financial matters for the annual sessions of the Steering Body and guides the preparation of documents and reports for the sessions;

(c) Approves the work-plan elements to be carried out as contributions in kind and prepares proposals for voluntary contributions to be included in the EMEP work-plan.

Appendix IV

MANDATE OF THE WORKING GROUP ON EFFECTS

1. At the request of the Executive Body and as required for the effective implementation of the Convention, the Working Group on Effects collects, assesses and further develops knowledge and information on:

(a) The present status and long-term trends in the degree and geographical extent of the impact of air pollution, in particular its long-range transboundary impact;
(b) Dose-response relationships for agreed air pollutants;
(c) Critical loads, levels and limits for agreed air pollutants;
(d) Damage and benefits, as a basis for the further development of air pollution abatement strategies.

2. The Working Group on Effects carries out work to:

(a) Assess the results and effectiveness of the implementation of the existing protocols to the Convention;

(b) Identify the most endangered areas, ecosystems and receptors and the extent of the effects of air pollution on human health and terrestrial and aquatic ecosystems and materials;

(c) Provide scientific substantiation for the review and further development of protocols.

3. The Working Group works in close collaboration with the Executive Body's other subsidiary bodies and with other relevant organizations. The Working Group on Effects provides information for related scientific activities outside the Convention and/or for joint efforts with other bodies/organizations.

4. The Bureau of the Working Group on Effects undertakes the detailed planning, coordination, assessment and reporting of activities as defined in the work-plan for the implementation of the Convention and carried out by its subsidiary units.

Appendix V

MANDATE OF THE IMPLEMENTATION COMMITTEE

1. The Implementation Committee promotes and improves compliance with the existing protocols to the 1979 Convention on Long-range Transboundary Air Pollution. Its main task is to review compliance by the Parties with their obligations under these protocols, pursuant to Executive Body decision 1997/2 concerning the Implementation Committee, its structure and functions and procedures for review of compliance (ECE/EB.AIR/53, annex III) and any amendments thereto.

2. The Committee assists the Executive Body by making recommendations on measures to facilitate compliance, when necessary, and by advising on the reporting by Parties on their strategies and policies for abating air pollution.

3. Where necessary to fulfil its functions, the Committee may inform the Working Group on Strategies and Review about its activities and seek guidance from it. Within its area of competence, the Committee also assists the Working Group on Strategies and Review and the Bureau of the Executive Body in any matter that the Working Group or the Bureau refers to it.

DECISION 2002/1
(ECE/EB.AIR/77/Add.1, Annex I)

FINANCING OF CORE ACTIVITIES

The Executive Body,

Noting that the 1979 Convention on Long-range Transboundary Air Pollution and, with one exception, its Protocols do not contain any provision for the long-term financing of core activities,

Recalling that in 1984 the Parties adopted a Protocol to the 1979 Convention to provide for long-term financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP),

Considering that in the 1999 Gothenburg Ministerial Declaration the Parties noted that the efficient operation of the Convention and its Protocols required there to be stable, long-term funding arrangements for their core activities,

Convinced that it is necessary to make appropriate arrangements regarding this matter,

1. *Decides* that, for the purposes of this decision:

(a) “Financial year” means the financial year of the United Nations, and “annual budget” shall be construed accordingly;

(b) “General Trust Fund” means the General Trust Fund for the Financing of the Implementation of the Convention, which has been established by the Secretary-General of the United Nations;

(c) “Designated international centres” means the international centres for the coordination of effect-related activities and integrated assessment modelling under the Convention that are specified in appendix I below;

(d) “Costs of core activities” means the costs of the international coordination of health, materials and ecosystem effect-related activities and integrated assessment modelling at the designated international centres that are covered by the work-plan adopted by the Executive Body, but excluding costs covered by the EMEP Protocol;

(e) “Contributions in kind” means contributions made by a Party or Signatory to the Convention directly to a designated international centre in respect of its work on core activities, as well as any other contributions recognized in decisions by the Executive Body as contributions in kind for the purpose of the present decision;

2. *Also decides* that an annual budget for the costs of core activities should be adopted by the Executive Body by consensus in advance of the beginning of the financial year to which it applies and, at the same time, provisional budget totals drawn up for each of the two succeeding financial years;

3. *Furthermore decides* that the costs of core activities specified in the annual budget should be met from contributions made in cash and/or in kind by any Party or Signatory to the Convention, as well as, subject to approval by the Executive Body on the recommendation of the Working Group on Effects or the EMEP Steering Body, by any other country, organization or individual wishing to contribute to the costs of core activities;

4. *Calls for* all contributions in cash to be deposited in the General Trust Fund account;

5. *Recommends* that the contributions referred to in paragraph 3 should be made in accordance with the scale of contributions set out in appendix II below;

6. *Requests* the secretariat to present for the consideration of the Executive Body at each annual session a list of the contributions, whether in cash or in kind, made in the preceding financial year towards the costs of core activities under the Convention and its Protocols. The secretariat should list contributions in kind to a designated international centre based on information provided to it by the contributing Party and confirmed by the centre receiving the contribution;

7. *Decides* to review, at its twenty-third session, the need for adopting a protocol on the financing of core activities in the light of the effectiveness of the present decision in achieving long-term stable funding for the core activities of the Convention and its Protocols.

Appendix I

DESIGNATED INTERNATIONAL CENTRES

Programme Coordination Centre for the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops: *at the Centre for Ecology and Hydrology, Bangor, United Kingdom.*

Programme Centre for the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems: *at the Finnish Environment Institute, Helsinki, Finland.*

Programme Main Coordinating Centre for the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests: *at the Federal Research Centre for Forestry and Forest Products, Hamburg, Germany.*

Programme Centre for the International Cooperative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes: *at the Norwegian Institute for Water Research, Oslo, Norway.*

Main Research Centre for the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments: *at the Swedish Corrosion Institute, Stockholm, Sweden.*

Coordination Center for Effects for the International Cooperative Programme on Modelling and Mapping: *at the National Institute of Public Health and the Environment, Bilthoven, Netherlands.*

Centre for Integrated Assessment Modelling for the Task Force on Integrated Assessment Modelling: *at the International Institute for Applied Systems Analysis, Laxenburg, Austria.*

Centre for Work on the Health Effects of Air Pollution: *at the World Health Organization's European Centre for Environmental Health, Bonn, Germany.*

Appendix II

SCALE OF RECOMMENDED CONTRIBUTIONS

The following is the scale of contributions referred to in paragraph 5:

Parties to the Convention [a/]	Per cent
Armenia	0.005
Azerbaijan	0.009
Belarus	0.044
Bosnia and Herzegovina	0.009
Bulgaria	0.030
Croatia	0.091
Cyprus	0.088
Czech Republic	0.472
Estonia	0.023
Georgia	0.012
Hungary	0.279
Iceland	0.077
Kazakhstan	0.065
Kyrgyzstan	0.002
Latvia	0.023
Liechtenstein	0.014
Lithuania	0.039
Malta	0.035
Monaco	0.009
Norway	1.501
Poland	0.878
Republic of Moldova	0.005
Romania	0.135
Russian Federation	2.788
Slovakia	0.100
Slovenia	0.188
Switzerland	2.960
The FYR of Macedonia	0.014
Turkey	1.022
Ukraine	0.123
Yugoslavia	0.046
Austria	2.200
Belgium	2.623
Denmark	1.740
Finland	1.213
France	15.021
Germany	22.694
Greece	1.252
Ireland	0.683
Italy	11.766
Luxembourg	0.186
Netherlands	4.037
Portugal	1.073
Spain	5.851
Sweden	2.385
United Kingdom	12.860
European Community	3.330

[a/] Canada and United States: voluntary contributions.

DECISION 2003/10
(ECE/EB.AIR/79/Add.1, annex X)

ESTABLISHING A TASK FORCE ON PERSISTENT ORGANIC POLLUTANTS

The Executive Body,

Noting that the Protocol on Persistent Organic Pollutants (POPs) entered into force on 23 October 2003,

Recalling the requirements of the Parties to the Protocol on POPs to meet their obligations under articles 10 and 14, and annexes I, II and III,

1. *Establishes* a task force, under the leadership of a Party or Parties to the Protocol on POPs, as identified in the annual work-plan, to address the technical needs of the reviews and reassessments required by the Protocol: The lead country or countries will assume the principal responsibility for coordinating the work of the Task Force, for organizing its meetings, for designating its chair(s), for communications with participating experts and observers, and for other organizational arrangements in accordance with the work-plan;

2. *Decides* that the Task Force will carry out the tasks specified for it in the work-plan adopted annually by the Executive Body and will report thereon to the Working Group on Strategies and Review;

3. *Also decides* that the Task Force will be composed of experts from the Parties to the Convention. Each Party will nominate a national focal point and notify his/her name to the secretariat. The meetings of the Task Force will be open to individuals designated as authorized representatives of intergovernmental or accredited non-governmental organizations, who may participate as observers. The chair(s) may also invite individuals with expertise relevant to the work of the Task Force to attend a meeting as observers. If invited by the chair(s), observers may participate in the discussions of the Task Force;

4. *Furthermore decides* that the functions of the Task Force will be to:

(a) Plan and conduct the technical work necessary for the review of sufficiency and effectiveness of the obligations set out in the Protocol on POPs as foreseen in its article 10, paragraph 3, and prepare a technical review for submission to the Working Group on Strategies and Review;

(b) Plan and conduct the technical work necessary for the use reassessments, re-evaluations and reviews foreseen under the Protocol, in particular those scheduled in annexes I, II and III, and prepare technical reviews thereon for submission to the Working Group on Strategies and Review;

(c) Prepare technical reviews on dossiers of new substances proposed by Parties for inclusion into annexes I, II or III, in accordance with the relevant provisions of the Protocol and paragraphs 1, 2 and 3 of Executive Body decision 1998/2, and present relevant documentation on the proposals to the Working Group on Strategies and Review; and

(d) Carry out such other tasks related to the Protocol as the Executive Body may assign to it in the annual work-plan;

5. *Decides* that technical documents related to dossiers of new substances to be considered at a meeting of the Task Force shall be distributed by the secretariat to the focal point nominated by each Party to the Convention at least 60 days in advance of the meeting. Where this has not occurred, the

report of the meeting will indicate that the relevant documents were not provided in sufficient time for consideration, unless the Task Force decides otherwise by consensus;

6. *Also decides* that, at the end of each meeting, the Task Force will approve those parts of its report that constitutes the key elements of its deliberations relating to the tasks assigned to it by the Executive Body. The report will be distributed by the secretariat to the focal points nominated by the Parties to the Convention and to the observers and experts who were present at the meeting;

7. *Furthermore decides* that technical reports prepared by the Task Force for the Working Group on Strategies and Review will reflect the full range of views expressed during its meetings.

DECISION 2003/11
(ECE/EB.AIR/79/Add.1, annex XI)

FACILITATION OF PARTICIPATION OF COUNTRIES WITH ECONOMIES IN TRANSITION

1. Broad participation by Parties in the activities under the Executive Body is essential to ensure progress in work under the Convention. To facilitate the participation of certain countries with economies in transition which would otherwise not be in a position to take part, Parties are invited to contribute to the Trust Fund for this purpose.

2. The secretariat is authorized to fund, subject to available resources, the participation of one governmentally designated representative from each of the following countries: Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Romania, Russian Federation, Serbia and Montenegro, the former Yugoslav Republic of Macedonia and Ukraine, to meetings of the Executive Body and its three main subsidiary bodies, giving highest priority to negotiating groups and other meetings directly linked to preparatory or ongoing negotiations. Upon their accession to the Convention and their expressed intention to take part in the work of the Executive Body, the following countries may also qualify for funding: Albania, Tajikistan, Turkmenistan and Uzbekistan.

3. Participation in other meetings may qualify for funding at the discretion of the Bureau of the Executive Body provided funds are available. However, for task force and expert group meetings Parties are encouraged to sponsor directly the participating experts from countries in the above list.

4. To make efficient use of the limited funds available for travel, Parties are encouraged, to the extent possible, to finance their own participation in activities under the Convention.

5. The countries mentioned in paragraph 2 above that have applied for membership of the European Union and/or the Organisation for Economic Co-operation and Development (OECD) are, in principle, expected to finance their own participation, and should only exceptionally make use of this offer.

6. The secretariat is authorized to decide, in consultation with the Chairman of the Executive Body, on the extent of funding (travel and/or daily subsistence allowance, or lump sum), on the basis of available funds and forecasts for requests and contributions for each year, and taking due account of United Nations regulations.

SECTION XII

STATUS OF THE CONVENTION AND THE PROTOCOLS

1979 Convention on Long-range Transboundary Air Pollution
(Adopted 13.11.1979 in Geneva)

	Signature	Ratification*	
Armenia		21.02.1997	(Ac)
Austria	13.11.1979	16.12.1982	(R)
Azerbaijan		03.07.2002	(Ac)
Belarus	14.11.1979	13.06.1980	(R)
Belgium	13.11.1979	15.07.1982	(R)
Bosnia and Herzegovina		06.03.1992	(Sc)
Bulgaria	14.11.1979	09.06.1981	(R)
Canada	13.11.1979	15.12.1981	(R)
Croatia		08.10.1992	(Sc)
Cyprus		20.11.1991	(Ac)
Czech Republic		01.01.1993	(Sc)
Denmark	14.11.1979	18.06.1982	(R)
Estonia		07.03.2000	(Ac)
Finland	13.11.1979	15.04.1981	(R)
France	13.11.1979	03.11.1981	(Ap)
Georgia		11.02.1999	(Ac)
Germany	13.11.1979	15.07.1982	(R)(2)
Greece	14.11.1979	30.08.1983	(R)
Holy See	14.11.1979		
Hungary	13.11.1979	22.09.1980	(R)
Iceland	13.11.1979	05.05.1983	(R)
Ireland	13.11.1979	15.07.1982	(R)
Italy	14.11.1979	15.07.1982	(R)
Kazakhstan		11.01.2001	(Ac)
Kyrgyzstan		25.05.2000	(Ac)
Latvia		15.07.1994	(Ac)
Liechtenstein	14.11.1979	22.11.1983	(R)
Lithuania		25.01.1994	(Ac)
Luxembourg	13.11.1979	15.07.1982	(R)
Malta		14.03.1997	(Ac)
Monaco		27.08.1999	(At)
Netherlands	13.11.1979	15.07.1982	(At)(3)
Norway	13.11.1979	13.02.1981	(R)
Poland	13.11.1979	19.07.1985	(R)(2)
Portugal	14.11.1979	29.09.1980	(R)
Republic of Moldova		09.06.1995	(Ac)
Romania	14.11.1979 (1)	27.02.1991	(R)
Russian Federation	13.11.1979	22.05.1980	(R)
San Marino	14.11.1979		
Serbia and Montenegro		12.03.2001	(Sc)
Slovakia		28.05.1993	(Sc)
Slovenia		06.07.1992	(Sc)
Spain	14.11.1979	15.07.1982	(R)
Sweden	13.11.1979	12.02.1981	(R)

1979 Convention on Long-range Transboundary Air Pollution
(Adopted 13.11.1979 in Geneva)

	Signature	**Ratification***	
Switzerland	13.11.1979	06.05.1983	(R)
The FYR of Macedonia**		30.12.1997	(Sc)
Turkey	13.11.1979	18.04.1983	(R)
Ukraine	14.11.1979	05.06.1980	(R)
United Kingdom	13.11.1979	15.07.1982	(R)(4)
United States	13.11.1979	30.11.1981	(At)
European Community	14.11.1979	15.07.1982	(Ap)
Total:	32	49	

***** R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession

** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.
(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)
(Adopted 28.9.1984 in Geneva)

	Signature	Ratification*	
Armenia			
Austria		04.06.1987	(Ac)
Azerbaijan			
Belarus	28.09.1984	04.10.1985	(At)
Belgium	25.02.1985	05.08.1987	(R)
Bosnia and Herzegovina		06.03.1992	(Sc)
Bulgaria	04.04.1985	26.09.1986	(Ap)
Canada	03.10.1984	04.12.1985	(R)
Croatia		08.10.1992	(Sc)
Cyprus		20.11.1991	(Ac)
Czech Republic		01.01.1993	(Sc)
Denmark	28.09.1984	29.04.1986	(R)
Estonia		07.12.2001	(Ac)
Finland	07.12.1984	24.06.1986	(R)
France	22.02.1985	30.10.1987	(R)
Georgia			
Germany	26.02.1985	07.10.1986	(R)(2)
Greece		24.06.1988	(Ac)
Holy See			
Hungary	27.03.1985	08.05.1985	(Ap)
Iceland			
Ireland	04.04.1985	26.06.1987	(R)
Italy	28.09.1984	12.01.1989	(R)
Kazakhstan			
Kyrgyzstan			
Latvia		18.02.1997	(Ac)
Liechtenstein		01.05.1985	(Ac)
Lithuania		07.11.2003	(Ac)
Luxembourg	21.11.1984	24.08.1987	(R)
Malta		14.03.1997	(Ac)
Monaco		27.08.1999	(At)
Netherlands	28.09.1984	22.10.1985	(At)(3)
Norway	28.09.1984	12.03.1985	(At)
Poland		14.09.1988	(Ac)
Portugal		10.01.1989	(Ac)
Republic of Moldova			
Romania		28.04.2003	(Ac)
Russian Federation	28.09.1984	21.08.1985	(At)
San Marino			
Serbia and Montenegro		12.03.2001	(Sc)
Slovakia		28.05.1993	(Sc)
Slovenia		06.07.1992	(Sc)
Spain		11.08.1987	(Ac)
Sweden	28.09.1984	12.08.1985	(R)

Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)
(Adopted 28.9.1984 in Geneva)

	Signature	Ratification*	
Switzerland	03.10.1984	26.07.1985	(R)
The FYR of Macedonia**			
Turkey	03.10.1984	20.12.1985	(R)
Ukraine	28.09.1984	30.08.1985	(At)
United Kingdom	20.11.1984	12.08.1985	(R)
United States	28.09.1984	29.10.1984	(At)
European Community	28.09.1984	17.07.1986	(Ap)
Total	22	41	

* R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession

** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.
(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (Adopted 8.7.1985 in Helsinki)

	Signature	Ratification*	
Armenia			
Austria	9.7.1985	04.06.1987	(R)
Azerbaijan			
Belarus	9.7.1985	10.09.1986	(At)
Belgium	9.7.1985	09.06.1989	(R)
Bosnia and Herzegovina			
Bulgaria	9.7.1985	26.09.1986	(Ap)
Canada	9.7.1985	04.12.1985	(R)
Croatia			
Cyprus			
Czech Republic		01.01.1993	(Sc)
Denmark	9.7.1985	29.04.1986	(R)
Estonia		07.03.2000	(Ac)
Finland	9.7.1985	24.06.1986	(R)
France	9.7.1985	13.03.1986	(Ap)
Georgia			
Germany	9.7.1985	03.03.1987	(R)(2)
Greece			
Holy See			
Hungary	9.7.1985	11.09.1986	(R)
Iceland			
Ireland			
Italy	9.7.1985	05.02.1990	(R)
Kazakhstan			
Kyrgyzstan			
Latvia			
Liechtenstein	9.7.1985	13.02.1986	(R)
Lithuania			
Luxembourg	9.7.1985	24.08.1987	(R)
Malta			
Monaco			
Netherlands	9.7.1985	30.04.1986	(At)(3)
Norway	9.7.1985	04.11.1986	(R)
Poland			
Portugal			
Republic of Moldova			
Romania			
Russian Federation	9.7.1985	10.09.1986	(At)
San Marino			
Serbia and Montenegro			
Slovakia		28.05.1993	(Sc)
Slovenia			
Spain			
Sweden	9.7.1985	31.03.1986	(R)

Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent
(Adopted 8.7.1985 in Helsinki)

	Signature	Ratification*	
Switzerland	9.7.1985	21.09.1987	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	9.7.1985	02.10.1986	(At)
United Kingdom			
United States			
European Community			
Total	19	22	

Notes:

* R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession
** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.
(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol concerning the Control of Emissions of Nitrogen Oxides (NOx) or their Transboundary Fluxes
(Adopted 31.10.1988 in Sofia)

	Signature	Ratification*	
Armenia			
Austria	1.11.1988	15.01.1990	(R)
Azerbaijan			
Belarus	1.11.1988	08.06.1989	(At)
Belgium	1.11.1988	31.10.2000	(R)
Bosnia and Herzegovina			
Bulgaria	1.11.1988	30.03.1989	(R)
Canada	1.11.1988	25.01.1991	(R)
Croatia			
Cyprus		02.09.2004	(Ac)
Czech Republic		01.01.1993	(Sc)
Denmark	1.11.1988	01.03.1993	(At)(6)
Estonia		07.03.2000	(Ac)
Finland	1.11.1988	01.02.1990	(R)
France	1.11.1988	20.07.1989	(Ap)
Georgia			
Germany	1.11.1988	16.11.1990	(R)
Greece	1.11.1988	29.04.1998	(R)
Holy See			
Hungary	3.05.1989	12.11.1991	(Ap)
Iceland			
Ireland	1.05.1989	17.10.1994	(R)
Italy	1.11.1988	19.05.1992	(R)
Kazakhstan			
Kyrgyzstan			
Latvia			
Liechtenstein	1.11.1988	24.03.1994	(R)
Lithuania			
Luxembourg	1.11.1988	04.10.1990	(R)
Malta			
Monaco			
Netherlands	1.11.1988	11.10.1989	(At)(3)
Norway	1.11.1988	11.10.1989	(R)
Poland	1.11.1988		
Portugal			
Republic of Moldova			
Romania			
Russian Federation	1.11.1988	21.06.1989	(At)
San Marino			
Serbia and Montenegro			
Slovakia		28.05.1993	(Sc)
Slovenia			
Spain	1.11.1988	04.12.1990	(R)
Sweden	1.11.1988	27.07.1990	(R)

Protocol concerning the Control of Emissions of Nitrogen Oxides (NOx) or their Transboundary Fluxes
(Adopted 31.10.1988 in Sofia)

	Signature	Ratification*	
Switzerland	1.11.1988	18.09.1990	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	1.11.1988	24.07.1989	(At)
United Kingdom	1.11.1988	15.10.1990	(R)(4)
United States	1.11.1988(1)	13.07.1989	(At)
European Community		17.12.1993	(Ac)
Total	25	29	

Notes:

* R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession
** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.
(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes
(Adopted 18.11.1991 in Geneva)

	Signature	Ratification*	
Armenia			
Austria	19.11.1991	23.08.1994	(R)
Azerbaijan			
Belarus			
Belgium	19.11.1991	31.10.2000	(R)
Bosnia and Herzegovina			
Bulgaria	19.11.1991	27.02.1998	(R)
Canada	19.11.1991		
Croatia			
Cyprus			
Czech Republic		01.07.1997	(Ac)
Denmark	19.11.1991	21.05.1996	(At)(6)
Estonia		07.03.2000	(Ac)
Finland	19.11.1991	11.01.1994	(At)
France	19.11.1991	12.06.1997	(Ap)
Georgia			
Germany	19.11.1991	08.12.1994	(R)
Greece	19.11.1991		
Holy See			
Hungary	19.11.1991	10.11.1995	(R)
Iceland			
Ireland			
Italy	19.11.1991	30.06.1995	(R)
Kazakhstan			
Kyrgyzstan			
Latvia			
Liechtenstein	19.11.1991	24.03.1994	(R)
Lithuania			
Luxembourg	19.11.1991	11.11.1993	(R)
Malta			
Monaco		26.07.2001	(Ac)
Netherlands	19.11.1991	29.09.1993	(At)
Norway	19.11.1991	07.01.1993	(R)
Poland			
Portugal	02.04.1992		
Republic of Moldova			
Romania			
Russian Federation			
San Marino			
Serbia and Montenegro			
Slovakia		15.12.1999	(Ac)
Slovenia			
Spain	19.11.1991	01.02.1994	(R)
Sweden	19.11.1991	08.01.1993	(R)

Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes
(Adopted 18.11.1991 in Geneva)

	Signature	Ratification*	
Switzerland	19.11.1991	21.03.1994	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	19.11.1991		
United Kingdom	19.11.1991	14.06.1994	(R)(5)
United States	19.11.1991		
European Community	02.04.1992		
Total	23	21	

Notes:

* R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession
** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.
(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol on Further Reduction of Sulphur Emissions (Adopted 14.6.1994 in Oslo)

	Signature	Ratification*	
Armenia			
Austria	14.06.1994	27.08.1998	(R)
Azerbaijan			
Belarus			
Belgium	14.06.1994 (1)	31.10.2000	(R)
Bosnia and Herzegovina			
Bulgaria	14.06.1994		
Canada	14.06.1994	08.07.1997	(R)
Croatia	14.06.1994	27.04.1999	(At)
Cyprus			
Czech Republic	14.06.1994	19.06.1997	(R)
Denmark	14.06.1994	25.08.1997	(Ap) (6)
Estonia			
Finland	14.06.1994	08.06.1998	(At)
France	14.06.1994	12.06.1997	(Ap)
Georgia			
Germany	14.06.1994	03.06.1998	(R)
Greece	14.06.1994	24.02.1998	(R)
Holy See			
Hungary	09.12.1994	11.03.2002	(R)
Iceland			
Ireland	17.10.1994	04.09.1998	(R)
Italy	14.06.1994	14.09.1998	(R)
Kazakhstan			
Kyrgyzstan			
Latvia			
Liechtenstein	14.06.1994	27.08.1997	(At)
Lithuania			
Luxembourg	14.06.1994	14.06.1996	(R)
Malta			
Monaco		09.04.2002	(Ac)
Netherlands	14.06.1994	30.05.1995	(At)(2)
Norway	14.06.1994	03.07.1995	(R)
Poland	14.06.1994		
Portugal			
Republic of Moldova			
Romania			
Russian Federation	14.06.1994		
San Marino			
Serbia and Montenegro			
Slovakia	14.06.1994	01.04.1998	(R)
Slovenia	14.06.1994	07.05.1998	(R)
Spain	14.06.1994	07.08.1997	(R)
Sweden	14.06.1994	19.07.1995	(R)

Protocol on Further Reduction of Sulphur Emissions
(Adopted 14.6.1994 in Oslo)

	Signature	Ratification*	
Switzerland	14.06.1994	23.01.1998	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	14.06.1994		
United Kingdom	14.06.1994	17.12.1996	(R)
United States			
European Community	14.06.1994	24.04.1998	(Ap) (2)
Total	28	25	

Notes:

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(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol on Heavy Metals
(Adopted 24.6.1998 in Aarhus, Denmark)

	Signature	Ratification*	
Armenia	18.12.1998		
Austria	24.06.1998	17.12.2003	(R)
Azerbaijan			
Belarus			
Belgium	24.06.1998 (1)		
Bosnia and Herzegovina			
Bulgaria	24.06.1998	28.10.2003	(R)
Canada	24.06.1998	18.12.1998	(R) (2)
Croatia	24.06.1998		
Cyprus	24.06.1998	02.09.2004	(R)
Czech Republic	24.06.1998	06.08.2002	(R)
Denmark	24.06.1998	12.07.2001	(Ap)
Estonia			
Finland	24.06.1998	20.06.2000	(At) (2)
France	24.06.1998	26.07.2002	(Ap)
Georgia			
Germany	24.06.1998	30.09.2003	(R)
Greece	24.06.1998		
Holy See			
Hungary	18.12.1998		
Iceland	24.06.1998		
Ireland	24.06.1998		
Italy	24.06.1998		
Kazakhstan			
Kyrgyzstan			
Latvia	24.06.1998		
Liechtenstein	24.06.1998	23.12.2003	(At)
Lithuania	24.06.1998		
Luxembourg	24.06.1998	01.05.2000	(R) (2)
Malta			
Monaco		13.11.2003	(Ac)
Netherlands	24.06.1998	23.06.2000	(At)
Norway	24.06.1998	16.12.1999	(R) (2)
Poland	24.06.1998		
Portugal	24.06.1998		
Republic of Moldova	24.06.1998	01.10.2002	(R)
Romania	24.06.1998	05.09.2003	(R)
Russian Federation			
San Marino			
Serbia and Montenegro			
Slovakia	24.06.1998	30.12.2002	(At) (2)
Slovenia	24.06.1998	09.02.2004	(R)
Spain	25.06.1998		
Sweden	24.06.1998	19.01.2000	(R)

Protocol on Heavy Metals
(Adopted 24.6.1998 in Aarhus, Denmark)

	Signature	Ratification*	
Switzerland	24.06.1998	14.11.2000	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	24.06.1998		
United Kingdom	24.06.1998		
United States	24.06.1998	10.01.2001	(At)
European Community	24.06.1998	03.05.2001	(Ap)
Total	36	22	

Notes:

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(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol on Persistent Organic Pollutants
(Adopted 24.6.1998 in Aarhus, Denmark)

	Signature	Ratification*	
Armenia	18.12.1998		
Austria	24.06.1998	27.08.2002	(R) (2)
Azerbaijan			
Belarus			
Belgium	24.06.1998 (1)		
Bosnia and Herzegovina			
Bulgaria	24.06.1998	05.12.2001	(R)
Canada	24.06.1998	18.12.1998	(R) (2)
Croatia	24.06.1998		
Cyprus	24.06.1998	02.09.2004	(R)
Czech Republic	24.06.1998	06.08.2002	(R)
Denmark	24.06.1998	06.07.2001	(Ap)
Estonia			
Finland	24.06.1998	03.09.2002	(At) (2)
France	24.06.1998	25.07.2003	(Ap)
Georgia			
Germany	24.06.1998	25.04.2002	(R)
Greece	24.06.1998		
Holy See			
Hungary	18.12.1998	07.01.2004	(R)
Iceland	24.06.1998	29.05.2003	(R)
Ireland	24.06.1998		
Italy	24.06.1998		
Kazakhstan			
Kyrgyzstan			
Latvia	24.06.1998		
Liechtenstein	24.06.1998	23.12.2003	(At)
Lithuania	24.06.1998		
Luxembourg	24.06.1998	01.05.2000	(R) (2)
Malta			
Monaco			
Netherlands	24.06.1998	23.06.2000	(At)
Norway	24.06.1998	16.12.1999	(R) (2)
Poland	24.06.1998		
Portugal	24.06.1998		
Republic of Moldova	24.06.1998	01.10.2002	(R)
Romania	24.06.1998	05.09.2003	(R)
Russian Federation			
San Marino			
Serbia and Montenegro			
Slovakia	24.06.1998	30.12.2002	(At) (2)
Slovenia	24.06.1998		
Spain	25.06.1998		
Sweden	24.06.1998	19.01.2000	(R)

Protocol on Persistent Organic Pollutants (Adopted 24.6.1998 in Aarhus, Denmark)

	Signature	Ratification*	
Switzerland	24.06.1998	14.11.2000	(R)
The FYR of Macedonia**			
Turkey			
Ukraine	24.06.1998		
United Kingdom	24.06.1998		
United States	24.06.1998		
European Community	24.06.1998	30.04.2004	(Ap)
Total	36	21	

Notes:

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** The former Yugoslav Republic of Macedonia.

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(2) With declaration upon ratification.
(3) For the Kingdom in Europe.
(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.
(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.
(6) Not applying for Faeroe Islands and Greenland.

Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Adopted 30.11.1999 in Gothenburg, Sweden)

	Signature	Ratification*	
Armenia	01.12.1999		
Austria	01.12.1999		
Azerbaijan			
Belarus			
Belgium	4.2.2000 (1)		
Bosnia and Herzegovina			
Bulgaria	01.12.1999		
Canada	01.12.1999		
Croatia	01.12.1999		
Cyprus			
Czech Republic	01.12.1999	12.08.2004	(R)
Denmark	01.12.1999	11.06.2002	(Ap)(6)
Estonia			
Finland	01.12.1999	23.12.2003	(At)
France	01.12.1999		
Georgia			
Germany	01.12.1999		
Greece	1.03.2000		
Holy See			
Hungary	01.12.1999		
Iceland			
Ireland	01.12.1999		
Italy	01.12.1999		
Kazakhstan			
Kyrgyzstan			
Latvia	01.12.1999	25.05.2004	(At)
Liechtenstein	01.12.1999		
Lithuania		02.04.2004	(Ac)
Luxembourg	01.12.1999	07.08.2001	(R)
Malta			
Monaco			
Netherlands	01.12.1999	05.02.2004	(At) (3)
Norway	01.12.1999	30.01.2002	(R)
Poland	30.05.2000		
Portugal	01.12.1999		
Republic of Moldova	23.05.2000		
Romania	01.12.1999	05.09.2003	(R)
Russian Federation			
San Marino			
Serbia and Montenegro			
Slovakia	01.12.1999		
Slovenia	01.12.1999	04.05.2004	(R)
Spain	01.12.1999		
Sweden	01.12.1999	28.03.2002	(R)

Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Adopted 30.11.1999 in Gothenburg, Sweden)

	Signature	Ratification*	
Switzerland	01.12.1999		
The FYR of Macedonia**			
Turkey			
Ukraine			
United Kingdom	01.12.1999		
United States	01.12.1999		
European Community		23.06.2003	(Ac)
Total	31	12	

Notes:

* R = Ratification, Ac = Accession, Ap = Approval, At = Acceptance, Sc = Succession

** The former Yugoslav Republic of Macedonia.

(1) With declaration upon signature.

(2) With declaration upon ratification.

(3) For the Kingdom in Europe.

(4) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man, Gibraltar, the United Kingdom Sovereign Base Areas of Akrotiri and Dhekhelia on the Island of Cyprus.

(5) Including the Bailiwicks of Jersey and Guernsey, the Isle of Man.

(6) Not applying for Faeroe Islands and Greenland.

SECTION XIII

STRUCTURE OF THE CONVENTION

STRUCTURE OF THE CONVENTION

Since its very beginning the Convention has developed a structure suitable for its needs at the time. Subsidiary bodies have been created, changed and terminated as the requirements for their work has changed. Even as this document is being prepared, the Convention's Expert Group on Heavy Metals is envisaged as having completed its work since the Protocol on Heavy Metals has now entered into force. There are already moves to establish a new task force on heavy metals with a mandate to carry out the new work required for preparing information for the review of the Protocol - a requirement of the Protocol following entry into force.

The Executive Body for the Convention, which is the meeting of the Parties to the Convention, also provides the forum for the meeting of the Parties to all the Convention's protocols. This framework enables the Convention to make use of its subsidiary bodies across the whole range of requirements of the different protocols and pollutants.

Under the Executive Body the current structure provides for three main areas of work. Two of these areas are mainly scientific - the EMEP Steering Body and the Working Group on Effects. The third is policy-focused - the Working Group on Strategies and Review - and is the Convention's main negotiating body.

Under each of the main subsidiary bodies there are a number of other bodies that perform more detailed technical and scientific work:

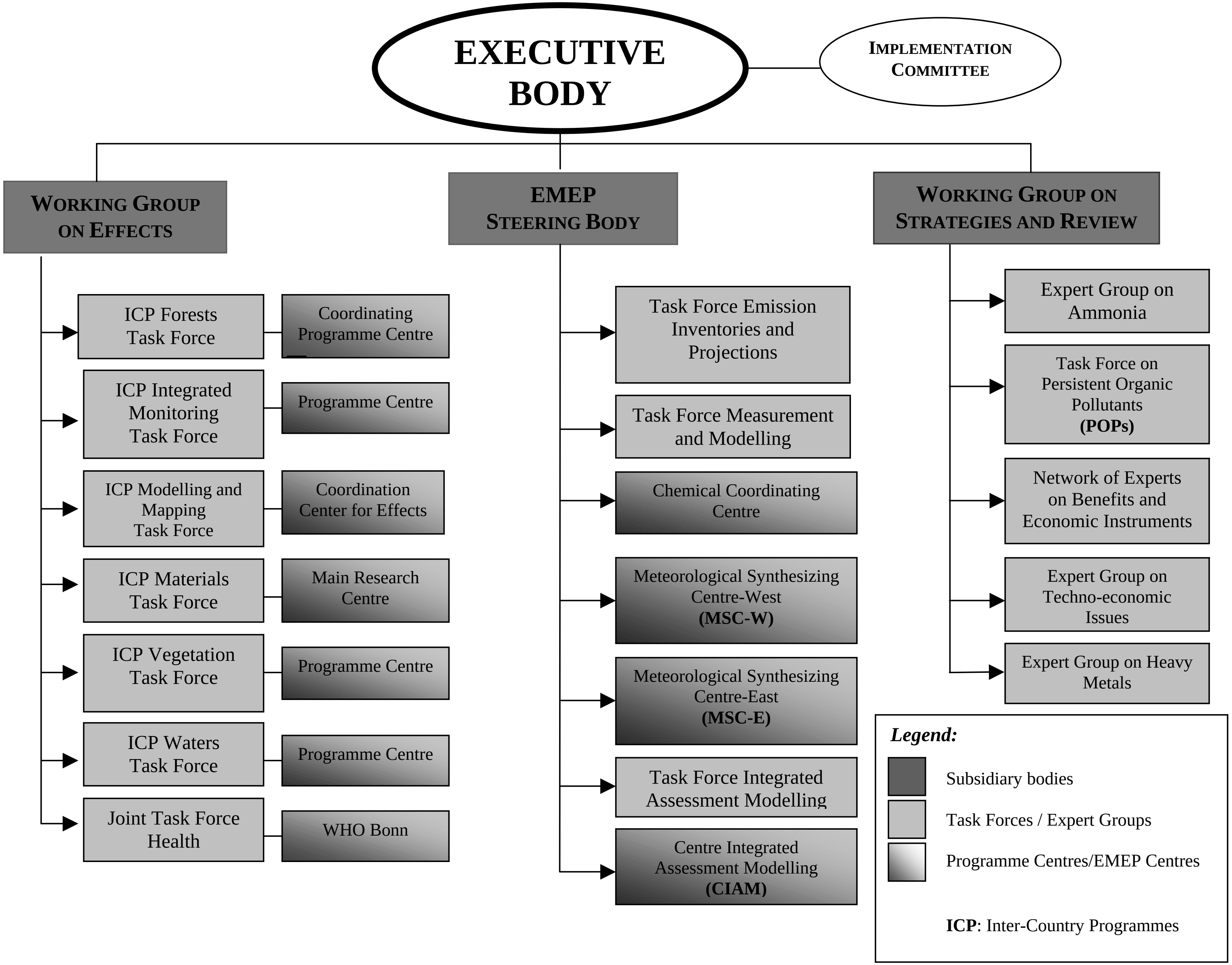
(a) The Working Group on Effects receives reports from its six International Cooperative Programmes (ICP), each led by a Task Force, and a joint WHO/Executive Body Task Force on the Health Aspects of Air Pollution. Each ICP is led by a Party to the Convention, which nominates a Chairperson, and each has a programme centre that provides international coordination of the scientific work;

(b) The Steering Body of EMEP is responsible for the Convention's atmospheric monitoring and modelling, and integrated assessment modelling activities. It has three Task Forces, again with lead Parties, that deliberate on the scientific and technical work and four EMEP centres that share responsibilities for coordinating the scientific modelling activities by maintaining databases and developing models;

(c) The Working Group on Strategies and Review currently has four Expert Groups (or Network of Experts) and one Task Force, which provide it with technical information for its work. The Working Group on Effects and the EMEP Steering Body also provide information to the Working Group on Strategies and Review to aid it in its discussions on reviews of protocols and negotiations of new or revised instruments.

In addition to the three main subsidiary bodies, the Convention's Implementation Committee also reports directly to the Executive Body. The Committee, established under decision 1997/2 (see page 291) considers issues of non-compliance with the Convention's protocols, and prepares reports that have included recommendations for decisions by the Executive Body. This has successfully encouraged Parties to meet their obligations.

For the past twenty-five years the Convention's Executive Body has met at least once a year and its subsidiary bodies have met similarly in order to be able to provide their up-to-date reports to the Executive Body. This cycle of meetings has provided Parties with the latest information on the progress made on scientific, technical and policy issues, and has enabled Parties to plan effectively the Convention’s work for the coming year. The broad range of issues addressed by the Convention and the continued improvements in scientific and technical knowledge have proved a driving force for maintaining this annual cycle of review and planning. While the Convention has achieved a lot in the past 25 years, Parties recognize that it still has much important work to do in the future.


EXECUTIVE BODY
IMPLEMENTATION COMMITTEE
WORKING GROUP ON EFFECTS
EMEP STEERING BODY
WORKING GROUP ON STRATEGIES AND REVIEW
ICP Forests Task Force
Coordinating Programme Centre
ICP Integrated Monitoring Task Force
Programme Centre
ICP Modelling and Mapping Task Force
Coordination Center for Effects
ICP Materials Task Force
Main Research Centre
ICP Vegetation Task Force
Programme Centre
ICP Waters Task Force
Programme Centre
Joint Task Force Health
WHO Bonn
Task Force Emission Inventories and Projections
Task Force Measurement and Modelling
Chemical Coordinating Centre
Meteorological Synthesizing Centre-West (MSC-W)
Meteorological Synthesizing Centre-East (MSC-E)
Task Force Integrated Assessment Modelling
Centre Integrated Assessment Modelling (CIAM)
Expert Group on Ammonia
Task Force on Persistent Organic Pollutants (POPs)
Network of Experts on Benefits and Economic Instruments
Expert Group on Techno-economic Issues
Expert Group on Heavy Metals
Legend:
Subsidiary bodies
Task Forces / Expert Groups
Programme Centres/EMEP Centres
ICP: Inter-Country Programmes