UNECE

Updated Handbook for the 1979 Convention on Long-range Transboundary Air Pollution and its Protocols

UNITED NATIONS

ECONOMIC COMMISSION FOR EUROPE

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

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Note

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Foreword

I clearly remember when I was a child in Denmark the debate on how acidification would destroy both our lakes and our forests. It worried me a lot. The response to this debate was the Convention on Long-range Transboundary Air Pollution. Adopted 35 years ago, it is the oldest of the UNECE environmental conventions as well as the first international legally binding instrument to address problems of air pollution on a broad regional basis. Since 1979 the Convention has been ratified by 51 Parties and has thus provided a framework for scientific collaboration and policy negotiation across the UNECE region. Through the implementation of eight protocols, which set national emission targets and identify specific measures for cutting emissions across a wide range of sectors, some of the region's major environmental problems have been successfully addressed. This includes the die-back of forests and the fish loss in lakes. Children in our region no longer have to worry as I did. Emissions of sulphur dioxide have been reduced by 70 per cent, emissions of non-methane volatile organic compounds have been cut by 50 per cent and nitrogen oxide emissions stand at 40 per cent less than their 1990 levels.

Despite the success of the Convention to this date, a lot remains to be done, as evidenced by the regular peaks of pollution registered in cities like Los Angeles, Paris or Bucharest. The impacts of air pollution on our health and the environment continue to be worrisome. In 2012, according to the World Health Organization (WHO), around 7 million people, 600,000 of those alone in the European region, died in the world as a result of air pollution exposure. Responding to the newest findings on the effects of air pollution, the Convention has widened its scope since its entry into force in 1983. Initially focused on problems of acidification and eutrophication, it now addresses a wider array of pollutants including ground-level ozone, persistent organic pollutants, heavy metals and, most recently, particulate matter.

This Handbook constitutes an updated version of the previous Handbook of the Convention and contains the most recent versions of the Convention's eight protocols as these have been amended and/or adjusted in order to maintain their relevance to the work of the Convention and/or to accommodate new Parties. The amended Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, for example, once entered into force, will be the first binding agreement to address emission reduction commitments for fine particulate matter. It also introduces flexibility to facilitate the accession of new Parties, mainly countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia. The increased ratification and implementation across the entire region is crucial in addressing transboundary air pollution effectively and remains a priority for the UNECE in the coming years.

We must strengthen our joint efforts, not only across national boundaries, but also across sectors to tackle air pollution in the pan-European region to improve our health and our environment.

Christian Friis Bach
Executive Secretary
United Nations Economic Commission for Europe

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*	The amendments concern the annex and were adopted by the Executive Body at its thirty-third session held from 8 to 11 December 2014 (ECE/EB.AIR/127, para 71 (a)). The annex to this protocol is subject to continuous review. The most up-to-date version is available online at: http://www.unece.org/env/lrtap/emep_h1.html
**	The amendments concern the technical annex and were adopted by the Executive Body 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).
****	The amendments concern Annex II and were adopted at sessions of the Executive Body as indicated in the footnotes to the annex.
*****	The protocol was amended in 2012 through the adoption of decisions 2012/5 and 2012/6 by the Executive Body at its thirty-first session
******	The protocol was amended in 2009 through the adoption of decisions 2009/1, 2009/2 and 2009/3 by the Executive Body at its twenty-seventh session.
*******	The protocol was amended in 2012 through the adoption of decisions 2012/1 and 2012/2 by the Executive Body at its thirtieth session.

List of Abbreviations

Currencies

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

Organizations, centres and programmes

CEN	Comité européen de normalisation
ECE	Economic Commission for Europe
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
EU	European Union
IMO	International Maritime Organization
ISO	International Organization for Standardization
MSC-W	Meteorological Synthesizing Centre-West
SAPRC	Statewide Air Pollution Research Center, Los Angeles, United States of America
UN	United Nations
UNEP	United Nations Environment Programme
US	United States of America
WHO	World Health Organization

Weights and measures

°C	degree Celsius
C	coulomb
cc	cubic centimetres
cm^3	cubic centimetres
dB	decibel
g	gram
GJ	gigajoule
h	hour
K	kelvin
kg	kilogram
km	kilometre
km^2	square kilometre
kN	kilonewtons
kPa	kilopascal
kt	kiloton
kW$_{el}$	kilowatt (electric)
kWh	kilowatt-hour
kW$_{th}$	kilowatt (thermal)
l	litre
m^2	square metre
m^3	cubic metre
mg	milligram
Mg	megagram
MW	megawatt
MW$_{el}$	megawatt (electric)

MWh	megawatt-hour
MW_{th}	megawatt (thermal)
Nm^3	Normal cubic metres
P	net power
ppb	parts per billion
ppmv	parts per million by volume
rpm	revolutions per minute
t	metric ton
wt-%	weight percent

Technical and scientific abbreviations

AC	Activated carbon process
AD	Air dried
AS	Ammonia scrubbing
BAT	Best available techniques
BBF	Biased-burner-firing
BE	Bitumen emulsion
BFBC	Bubbling fluidized bed combustion
BOOS	Burner-out-of-service
Ca	Calcium
CAS	Chemical Abstracts Service
$CaSO_3$	Calcium Sulfite
CCD	Charge-Coupled Device
CCGT	Combined cycle gas turbine
CFBC	Circulating fluidized bed combustion
CFC	Chlorofluorocarbon
CI	Compression ignition
CN	Combined Nomenclature
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
DBB	Dry bottom boiler
DME	Dimethyl ether
EBDS	Electron beam dry scrubbing
EGR	Exhaust gas recirculation
ELV	Emission Limit Value
ELVc	Emission Limit Value for waste gases
ELVf	Emission Limit Value for fugitive emissions
ETFE	Ethylene tetrafluoroethylene copolymer
F	Furans
FBC	Fluidized bed combustion
FGD	Flue gas desulphurization
FGR	Flue gas recirculation
H_2O	Water
HC	Hydrocarbon
HCB	Hexachlorobenzene
HCH	Hexachlorohexane
HDV	Heavy-duty vehicle
HFO	Heavy Fuel Oil
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
LFO	Light Fuel Oil
LNB	Low NO_x burner
LOTOS	Long Term Ozone Simulation
LPG	Liquefied petroleum gas
LPP	Lean/premixed/prevaporized
LTO	Landing and take-off
LWS	Lime/limestone wet scrubbing
MCR	Maximum Continous Rating
MDO	Marine Diesel Oil
MIR	Maximum incremental reactivity
NG	Natural Gas
NH_3	Ammonia
NMVOC	Non-methane Volatile Organic Compounds
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
N_2O	Dinitrogen monoxide
O_2	Oxygen
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
PCN	Polychlorinated naphtalenes
PEMA	Pollutant emission management area
PF	Pulverized fuel
PFBC	Pressurized fluidized bed combustion
POCP	Photochemical ozone creation potential
POPs	Persistent organic pollutants
PM	Particulate matter
PT	Particulates
PVC	Polyvinyl chloride
RAP	Reduced air preheat
RQL	Rich burn/quick mix/lean burn
RVP	Reid vapour pressure
S	Sulphur
SB	Solvent-borne coatings
SCR	Selective catalytic reduction
SDA	Spray dry absorption
SI	Spark-ignition
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
TEF	Toxic equivalence factor
TEQ	Total toxic equivalent
TiO_2	Titanium dioxide
TOMA	Tropospheric ozone management area
TSP	Total suspended particulate matter
UV	Ultraviolet
VOC	Volatile organic compound
WB	Water-borne coating
WBB	Wet bottom boiler
WHSC	World heavy duty steady state cycle
WL	Wellman Lord process
WSA	Wet sulphuric acid catalytic process

Introduction

The Convention on Long-range Transboundary Air Pollution was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. It was signed in 1979 and entered into force in 1983. It has since been extended by eight specific protocols. 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 updated handbook contains the Convention text and the most-up-to-date versions of all eight protocols to the Convention in their most recent amended version.

THE CONVENTION

The history of the Convention can be traced back to the 1960s, when scientists demonstrated the interrelationship between sulphur emissions in continental Europe and the acidification of Scandinavian lakes. The 1972 United Nations Conference on the Human Environment in Stockholm signalled the start for 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 Meeting within the Framework of ECE on the Protection of the Environment was held at ministerial level in November 1979 in Geneva. It resulted in the signature of the Convention on Long-range Transboundary Air Pollution by 32 Governments and the European Community. Besides laying down the general principles of international cooperation for air pollution abatement, the Convention sets up an institutional framework bringing together science and policy.

Over the past 35 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 and subsequent revision of eight protocols as well as the general development of abatement strategies, largely the remit of the Convention's Working Group on Strategies and Review.

In the past 20 years the Convention has focused upon effects-based approaches. For this the Convention has drawn upon its three core areas of scientific and technical work – observed effects, atmospheric modelling and integrated assessment modelling. The latter 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. Taking into account all these aspects, it was possible to calculate national emission cuts for emissions of sulphur, nitrogen, volatile organic compounds, ammonia and particulate matter 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 March 2015 by 51 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 (Gothenburg Protocol), which entered into force on 17 May 2005.

The latest three Protocols, namely the Protocol on Persistent Organic Pollutants, the Protocol on Heavy Metals and the Gothenburg Protocol have recently been amended and have not yet fully entered into force in their revised form.

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 ECE Environment Division.

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Section I

Convention on Long-range Transboundary Air Pollution,

done at Geneva on 13 November 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 POLLUTANTS 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;

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

(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.

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

Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP),

done at Geneva on 28 September 1984

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,[1] monitoring is carried out.

Article 2: Financing of EMEP

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

Article 3: Contributions

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

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

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

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

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

Article 4: Sharing of costs

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

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.

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.

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

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 ON LONG-TERM FINANCING OF THE COOPERATIVE PROGRAMME FOR THE MONITORING AND EVALUATION OF THE LONG-RANGE TRANSMISSION OF AIR POLLUTANTS IN EUROPE, as amended on 11 december 2014[1]

Mandatory contributions for sharing of costs for financing EMEP shall from 2015 onwards be calculated according to the scale set out in the following table.[2]

Contracting Party	**Percentage**
Albania	0.0236
Armenia	0.0165
Belarus	0.1322
Bosnia and Herzegovina	0.0401
Canada	*
Georgia	0.0165
Liechtenstein	0.0212
Monaco	0.0283
Montenegro	0.0118
Norway	2.0090
Russian Federation	5.7555
Serbia	0.0944
Switzerland	2.4717
The former Yugoslav Republic of Macedonia	0.0189
Turkey	3.1351
Ukraine	0.2337
United States	*
Austria	1.8839
Belgium	2.3560
Bulgaria	0.1110
Croatia	0.2975
Cyprus	0.1110
Czech Republic	0.9112
Denmark	1.5935
Estonia	0.0944
Finland	1.2252
France	13.2036
Germany	16.8581
Greece	1.5062
Hungary	0.6280
Ireland	0.9868
Italy	10.5006
Latvia	0.1110
Lithuania	0.1723
Luxembourg	0.1912
Malta	0.0378
Netherlands	3.9047
Poland	2.1742
Portugal	1.1190
Romania	0.5335
Slovakia	0.4037
Slovenia	0.2361
Spain	7.0185
Sweden	2.2663
United Kingdom	12.2263
European Union	3.3300
Total	**100.00**

* Voluntary.

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[1] The most up-to-date version of the annex is available online at: http://www.unece.org/env/lrtap/emep_h1.html.

[2] 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

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

done at Helsinki, Finland, on 8 July 1985

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

Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes,

done at Sofia, Bulgaria, on 31 October 1988

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 longrange 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 noncombustion 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 noncombustion energy sources (i.e. hydro, nuclear, wind, etc.) to the energy mix. However, further environmental impacts have to be considered.

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.

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[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.

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];

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[2] Typical retrofit measures, with limited efficiency and applicability.

[3] State-of-the-art in new plants.

(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 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.

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[4] Implemented in single large commercial plants; operational experience still limited.

[5] For combustion turbines.

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_2O 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_2O.

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/m3, or 50 mg/kg of NH3 on the fly ash, which can be met easily with SCR systems. However, with SNCR systems the NH3 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.

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.

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[6] Replaced by Regulation No. 83.

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							

Energy source	Uncontrolled Emissions		Process and Combustion Modifications			Flue Gas Treatment					
						(a) Non-catalytic			(b) Catalytic (after primary measures)		
	mg/m³ [1/]	g/GJ [1/]	mg/m³ [1/]	g/GJ [1/]	ECU/ kW$_{el}$ [2/]	mg/m³ [1/]	g/GJ [1/]	ECU/ kW$_{el}$ [2/]	mg/m³ [1/]	g/GJ [1/]	ECU/kW$_{el}$ [2/]
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						
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									
Pickling:											
Brass		25 [10/]									
Stainless steel		0.3									
Carbon steel		0.1									

Energy source	Uncontrolled Emissions		Process and Combustion Modifications (a) Non-catalytic			Flue Gas Treatment (b) Catalytic (after primary measures)			Flue Gas Treatment		
	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/^{m3} [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)
NH_3 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

Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes,

done at Geneva on 18 November 1991

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 or 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					
	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
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
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 refinerie			
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	III	Low
	Adsorption		
	Membrane technique		
	Incineration in process furnace		
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	V	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	100	–
	(9.6 g/km)	(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 (per cent)[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)
$130 \leq P < 560$	1.3
$75 \leq P < 130$	1.3
$37 \leq P < 75$	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)
$130 \leq P < 560$	1.0
$75 \leq P < 130$	1.0
$37 \leq P < 75$	1.3
$18 \leq P < 37$	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
Aldehydes	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		**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	-
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 day** *[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	–	–
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

				UK		Sweden			
VOC	**OH Scale** *[a]*	**Canada by mass** *[b]*	**SAPRC MIR** *[c]*	**POCP** *[d]*	**range** *[e]*	**max diff.** *[f]*	**0-4 day** *[g]*	**EMEP** *[h]*	**LOTOS** *[i]*
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	–	–
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	–	–

				UK		Sweden			
VOC	**OH Scale** *[a]*	**Canada by mass** *[b]*	**SAPRC MIR** *[c]*	**POCP** *[d]*	**range** *[e]*	**max diff.** *[f]*	**0-4 day** *[g]*	**EMEP** *[h]*	**LOTOS** *[i]*
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

Protocol on Further Reduction of Sulphur Emissions,

done at Oslo, Norway, on 14 June 1994

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° 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$_{\text{th}}$ 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$_{\text{th}}$ 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.

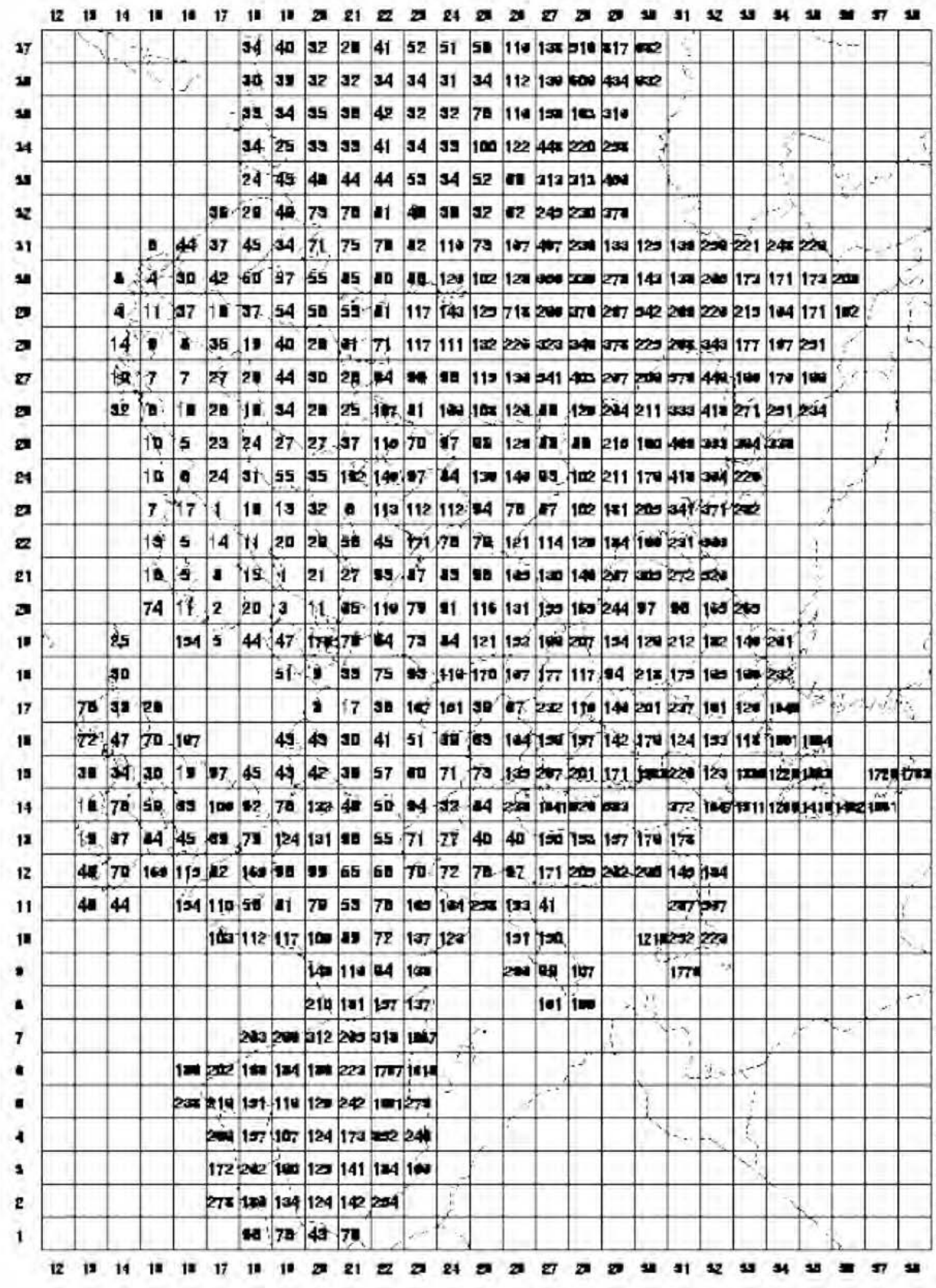
Article 17: AUTHENTIC TEXTS

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 ($TiO2$), 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, 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.

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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.

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 ($kW_{el}/103\ m^3/h$)	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%.

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.

[**] 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.

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° K and a pressure of 101.3 kPa, after correction for the water vapour content.

Section VII

1998 Protocol on Heavy Metals,

as amended on 13 December 2012

1998 Protocol on Heavy Metals as amended on 13 December 2012

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 (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 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 for a Party of the present Protocol. A Party may decide not to treat as a new stationary source any stationary source for which approval has already been given by the appropriate competent national authority at the time of entry into force of the Protocol for that Party and provided that the construction or substantial modification is commenced within five years of that date. 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 1 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.

12. The terms "this Protocol", "the Protocol" and "the present Protocol" mean the 1998 Protocol on Heavy Metals, as amended from time to time.

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. Subject to paragraphs 2 bis and 2 ter, 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 guidance adopted by the Parties at a session of the Executive Body 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 guidance adopted by the Parties at a session of the Executive Body 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.

2 bis. A Party that was already a Party to the present Protocol prior to the entry into force of an amendment that introduces new source categories may apply the limit values applicable to an "existing stationary source" to any source in such a new category the construction or substantial modification of which is commenced before the expiry of two years from the date of entry into force of that amendment for that Party, unless and until that source later undergoes substantial modification.

2 ter. A Party that was already a Party to the present Protocol prior to the entry into force of an amendment that introduces new limit values applicable to a "new stationary source" may continue to apply the previously applicable limit values to any source the construction or substantial modification of which is commenced before the expiry of two years from the date of entry into force of that amendment for that Party, unless and until that source later undergoes substantial modification.

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. Parties within the geographical scope of EMEP shall use the methodologies specified in guidelines prepared by the Steering Body of EMEP and adopted by the Parties at a session of the Executive Body. Parties in areas outside the geographical scope of EMEP shall use as guidance the methodologies developed through the workplan 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.

8. Each Party should actively participate in programmes under the Convention on the effects of air pollution on human health and the environment and programmes on atmospheric monitoring and modelling.

Article 3 bis: Flexible transitional arrangements

1. Notwithstanding article 3, paragraphs 2 (c) and 2 (d), a Party to the Convention that becomes a Party to the present Protocol between 1 January 2014 and 31 December 2019 may apply flexible transitional arrangements for the implementation of best available techniques and limit values to existing stationary sources in specific stationary source categories under the conditions specified in this article.

2. Any Party electing to apply the flexible transitional arrangements under this article shall indicate in its instrument of ratification, acceptance, approval or accession to the present Protocol the following:

(a) The specific stationary source categories listed in annex II for which the Party is electing to apply flexible transitional arrangements, provided that no more than four such categories may be listed;

(b) Stationary sources for which construction or the last substantial modification commenced prior to 1990 or an alternative year of the period 1985-1995 inclusive, specified by a Party upon ratification, acceptance, approval or accession, which are eligible for flexible transitional arrangements as set out in paragraph 5; and

(c) An implementation plan consistent with paragraphs 3 and 4 identifying a timetable for full implementation of the specified provisions.

3. A Party shall, as a minimum, apply best available techniques for existing stationary sources in categories 1, 2, 5 and 7 of annex II no later than eight years after the entry into force of the present Protocol for the Party, or 31 December 2022, whichever is sooner, except as provided in paragraph 5.

4. In no case may a Party's application of best available techniques or limit values for any existing stationary sources be postponed past 31 December 2030.

5. With respect to any source or sources indicated pursuant to paragraph 2 (b), a Party may decide, no later than eight years after entry into force of the present Protocol for the Party, or 31 December 2022, whichever is sooner, that such source or sources will be closed down. A list of such sources shall be provided as part of the Party's next report pursuant to paragraph 6. Requirements for application of best available techniques and limit values will not apply to any such source or sources, provided the source or sources are closed down no later than 31 December 2030. For any such source or sources not closed down as of that date, a Party must thereafter apply the best available techniques and limit values applicable to new sources in the applicable source category.

6. A Party electing to apply the flexible transitional arrangements under this article shall provide the Executive Secretary of the Commission with triennial reports of its progress towards implementation of best available techniques and limit values to the stationary sources in the stationary source categories identified pursuant to this article. The Executive Secretary of the Commission will make such triennial reports available to the Executive Body.

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 socioeconomic 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 the 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. Moreover:

(i) Where a Party applies different emission reduction strategies under article 3 paragraphs 2 (b), (c) or (d), it shall document the strategies applied and its compliance with the requirements of those paragraphs;

(ii) Where a Party judges the application of certain limit values, as specified in accordance with article 3 paragraph 2 (d), not to be technically and economically feasible, it shall report and justify this;

(b) Each Party within the geographical scope of EMEP shall report to EMEP, through the Executive Secretary of the Commission, information on the levels of emissions of heavy metals listed in annex I, using the methodologies specified in guidelines prepared by the Steering Body of EMEP and adopted by the Parties at a session of the Executive Body. Parties in areas outside the geographical scope of EMEP shall report available information on levels of emissions of the heavy metals listed in annex I. Each Party shall also provide information on the levels of emissions of the substances listed in annex I for the reference year specified in that annex;

(c) Each Party within the geographical scope of EMEP should report available information to the Executive Body, through the Executive Secretary of the Commission, on its air pollution effects programmes on human health and the environment and atmospheric monitoring and modelling programmes under the Convention using guidelines adopted by the Executive Body;

(d) Parties in areas outside the geographical scope of EMEP should make available information similar to that specified in subparagraph (c), if requested to do so by 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. Upon the request of and in accordance with timescales decided by the Executive Body, EMEP and other subsidiary bodies shall provide relevant information on the long-range transport and deposition of heavy metals.

Article 8: Calculations

Upon the request of and in accordance with timescales decided by the Executive Body, EMEP and its technical bodies and centres shall, using appropriate models and measurements, 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 as 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 consider, based on the conclusion of the reviews referred to in paragraph 3 above and as soon as practicable after completion of the review, developing a workplan on further steps.

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 12 months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

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

Article 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 90 days in advance.

3. Amendments to the present Protocol other than to annexes III and VII 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 those that were Parties at the time of their adoption 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 180 days from the date of its communication to all Parties by the Executive Secretary of the Commission, an amendment to any such annex shall become effective for those Parties which have not submitted to the Depositary a notification in accordance with the provisions of paragraph 5 below, provided that at least 16 Parties have not submitted such a notification.

5. Any Party that is unable to approve an amendment to annex III or VII shall so notify the Depositary in writing within 180 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.

5 bis. For those Parties having accepted it, the procedure set out in paragraph 5 ter supersedes the procedure set out in paragraph 3 in respect of amendments to annexes II, IV, V and VI;

5 ter. Amendments to annexes II, IV, V and VI shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of one year 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 subparagraph (a):

(a) Any Party that is unable to approve an amendment to annexes II, IV, V and VI shall so notify the Depositary in writing within one year 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;

(b) Any amendment to annexes II, IV, V and VI shall not enter into force if an aggregate number of 16 or more Parties have either:

(i) Submitted a notification in accordance with the provisions of subparagraph (a); or

(ii) Not accepted the procedure set out in this paragraph and not yet deposited an instrument of acceptance in accordance with the provisions of paragraph 3.

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 60 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.

3. A State or regional economic integration organization shall declare in its instrument of ratification, acceptance, approval or accession if it does not intend to be bound by the procedures set out in article 13, paragraph 5 ter, as regards the amendment of annexes II, IV, V and VI.

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, zinc and silico- and ferro-manganese alloys 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

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. Further description of and guidance on such best available techniques are provided in a guidance document adopted by the Parties at a session of the Executive Body and may be updated as necessary by a consensus of the Parties meeting within the Executive Body.

2. The expression "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 the basis for emission limit values (and other permit conditions) designed to prevent and, where that is not practicable, to reduce emissions and their impact on the environment as a whole:

(a) "Techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(b) "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;

(c) "Best" means most effective in achieving a high general level of protection of the environment as a whole.

3. Criteria for determining BAT are as follows:

(a) The use of low-waste technology;

(b) The use of less hazardous substances;

(c) The furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;

(d) Comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;

(e) Technological advances and changes in scientific knowledge and understanding;

(f) The nature, effects and volume of the emissions concerned;

(g) The commissioning dates for new or existing installations;

(h) The length of time needed to introduce the best available technique;

(i) The consumption and nature of raw materials (including water) used in the process and energy efficiency;

(j) The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;

(k) The need to prevent accidents and to minimize their consequences for the environment;

(l) Information published by national and international organizations.

The concept of BAT 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.

4. Experience with new products and new plants incorporating low-emission techniques, as well as with the retrofitting of existing plants, is growing continuously; the guidance document referred to in paragraph 1 may, therefore, need updating.

Annex IV
Timescales for the application of limit values and best available techniques to new and existing stationary sources

1. 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 for a Party;

(b) For existing stationary sources: two years after the date of entry into force of the present Protocol for a Party or 31 December 2020, whichever is the later.

2. Notwithstanding paragraph 1, but subject to paragraph 3, a Party to the Convention that becomes a Party to the present Protocol between 1 January 2014 and 31 December 2019 may declare upon ratification, acceptance, approval of, or accession to the present Protocol that it will extend the timescales for application of the limit values referred to in article 3, paragraph 2 (d), up to 15 years after the date of entry into force of the present Protocol for the Party in question.

3. A Party that has made an election pursuant to article 3 bis of the present Protocol with respect to a particular stationary source category may not also make a declaration pursuant to paragraph 2 applicable to the same source category.

Annex V

Limit values for controlling emissions from major stationary sources

1. Two types of limit value are important for heavy metal emission control:

   (a) Values for specific heavy metals or groups of heavy metals; and

   (b) 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 matter limit values are of great practical importance and are also laid down in this annex in most cases to complement specific limit values for cadmium, lead or mercury.

3. Section A applies to Parties other than the United States of America. Section B applies to the United States of America.

A. Parties other than the United States of America

4. In this section only, "dust" means the mass of particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions.

5. For the purpose of this section, "emission limit value" (ELV) or "limit value" means the quantity of dust and specific heavy metals under this Protocol 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 waste gas, the values given for selected major stationary source categories 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.

6. Emissions shall be monitored in all cases via measurements or through calculations achieving at least the same accuracy. Compliance with limit values shall be verified through continuous or discontinuous measurements, or any other technically sound method including verified calculation methods. Measurements of relevant heavy metals shall be made at least once every three years for each industrial source. Guidance documents on the methods for undertaking measurements and calculations adopted by the Parties at the session of the Executive Body shall be taken into account. In case of continuous measurements, compliance with the limit value is achieved if the validated monthly emission average does not exceed the ELV. In case of discontinuous measurements or other appropriate determination or calculation procedures, compliance with the ELVs 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. The inaccuracy of the measurement methods may be taken into account for verification purposes. Indirect monitoring of substances is also possible via sum parameters/cumulative parameters (e.g., dust as a sum parameter for heavy metals). In some cases using a certain technique to treat emissions can assure a value/limit value is maintained or met.

7. Monitoring of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated measuring systems and the reference measurements to calibrate those systems, shall be carried out in accordance with CEN standards. If CEN standards are not available, ISO standards, national standards or international standards which will ensure the provisions of data of an equivalent scientific quality shall apply.

Combustion plants (boilers and process heaters) with a rated thermal input exceeding 50 MW_{th}[1] (annex II, category 1)

8. Limit values for dust emissions for combustion of solid and liquid fuels, other than biomass and peat:[2]

Table 1

Fuel type	Thermal input (MW_{th})	ELV for dust (mg/m^3)[a]
Solid fuels	50–100	New plants: 20 (coal, lignite and other solid fuels) Existing plants: 30 (coal, lignite and other solid fuels)
	100–300	New plants: 20 (coal, lignite and other solid fuels) Existing plants: 25 (coal, lignite and other solid fuels)
	>300	New plants: 10 (coal, lignite and other solid fuels) Existing plants: 20 (coal, lignite and other solid fuels)
Liquid fuels	50–100	New plants: 20 Existing plants: 30 (in general) 50 for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants

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[1] The rated thermal input of the combustion plant is calculated as the sum of the input of all units connected to a common stack. Individual units below 15 MWth shall not be considered when calculating the total rated thermal input.

[2] In particular, the ELVs shall not apply to:
- Plants using biomass and peat as their only fuel source;
- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials;
- Post-combustion plants designed to purify the waste gases by combustion which are not operated as independent combustion plants;
- 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;
- Recovery boilers within installations for the production of pulp;
- Waste incinerators; and
- Plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

Fuel type	Thermal input (MW_{th})	ELV for dust (mg/m^3)[a]
Liquid fuels	100–300	New plants: 20 Existing plants: 25 (in general) 50 for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants
	>300	New plants: 10 Existing plants: 20 (in general) 50 for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants

[a] Limit values refer to an oxygen content of 6% for solid fuels and 3% for liquid fuels.

9. Special provisions for combustion plants referred to in paragraph 8:

(a) A Party may derogate from the obligation to comply with the ELVs provided for in paragraph 8 in the following cases:

(i) For combustion plants normally using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility;

(ii) For existing combustion plants not operated more than 17,500 operating hours, starting from 1 January 2016 and ending no later than 31 December 2023;

(b) Where a combustion plant is extended by at least 50 MWth, the ELV specified in paragraph 8 for new installations shall apply to the extensional part affected by the change. The ELV is calculated as an average weighted by the actual thermal input for both the existing and the new part of the plant;

(c) Parties shall ensure that provisions are made for procedures relating to malfunction or breakdown of the abatement equipment;

(d) In the case of a multi-fuel firing combustion plant involving the simultaneous use of two or more fuels, the ELV shall be determined as the weighted average of the ELVs for the individual fuels, on the basis of the thermal input delivered by each fuel.

Primary and secondary iron and steel industry (annex II, category 2 and 3)

10. Limit values for dust emissions:

Table 2

Activity	ELV for dust (mg/m^3)
Sinter plant	50
Pelletization plant	20 for crushing, grinding and drying 15 for all other process steps
Blast furnace: hot stoves	10
Basic oxygen steelmaking and casting	30
Electric steelmaking and casting	15 (existing) 5 (new)

Iron foundries (annex II, category 4)

11. Limit values for dust emissions for iron foundries:

Table 3

Activity	ELV for dust (mg/m³)
Iron foundries: all furnaces (cupola, induction, rotary); all mouldings (lost, permanent)	20
Hot rolling	20 50 where a bag filter cannot be applied due to the presence of wet fumes

Production and processing of copper, zinc and silico- and ferro- manganese alloys, including Imperial Smelting furnaces (annex II, categories 5 and 6)

12. Limit value for dust emissions for copper, zinc and silico- and ferro-manganese alloys production and processing:

Table 4

	ELV for dust (mg/m³)
Non-ferrous metal production and processing	20

Production and processing of lead (annex II, categories 5 and 6)

13. Limit value for dust emissions for lead production and processing:

Table 5

	ELV for dust (mg/m³)
Lead production and processing	5

Cement industry (annex II, category 7)

14. Limit values for dust emissions for cement production:

Table 6

	ELV for dust (mg/m³)[a)]
Cement installations, kilns, mills and clinker coolers	20
Cement installations, kilns, mills and clinker coolers using co-incineration of waste	20

[a] Limit values refer to an oxygen content of 10%.

Glass industry (annex II, category 8)

15. Limit values for dust emissions for glass manufacturing:

Table 7

	ELV for dust (mg/m^3)[a)]
New installations	20
Existing installations	30

[a] Limit values refer to an oxygen content of 8% for continuous melting and 13% for discontinuous melting.

16. Limit value for lead emissions for glass manufacturing: 5 mg/m3.

Chlor-alkali industry (annex II, category 9)

17. Existing chlor-alkali plants using the mercury cell process shall convert to use of mercury free technology or close by 31 December 2020; during the period up until conversion the levels of mercury released by a plant into the air of 1 g per Mg[3] chlorine production capacity apply.

18. New chlor-alkali plants are to be operated mercury free.

Waste incineration (annex II, categories 10 and 11)

19. Limit value for dust emissions for waste incineration:

Table 8

	ELV for dust (mg/m^3)[a)]
Municipal, non-hazardous, hazardous and medical waste incineration	10

[a] Limit value refers to an oxygen content of 11%.

20. Limit value for mercury emissions for waste incineration: 0.05 mg/m^3.

21. Limit value for mercury emissions for co-incineration of waste in source categories 1 and 7: 0.05 mg/m^3.

B. United States of America

22. Limit values for controlling emissions of particulate matter and/or specific heavy metals from stationary sources in the following stationary source categories, and the sources to which they apply, are specified in the following documents:

(a) Steel Plants: Electric Arc Furnaces — 40 C.F.R. Part 60, Subpart AA and Subpart AAa;

(b) Small Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart AAAA;

(c) Glass Manufacturing — 40 C.F.R. Part 60, Subpart CC;

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

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

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

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[3] 1 Mg = 1 tonne.

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

(h) Portland Cement — 40 C.F.R. Part 60, Subpart F;

(i) Secondary Lead Smelters — 40 C.F.R. Part 60, Subpart L;

(j) Basic Oxygen Process Furnaces — 40 C.F.R. Part 60, Subpart N;

(k) Basic Process Steelmaking Facilities (after 20 January 1983) — 40 C.F.R. Part 60, Subpart Na;

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

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

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

(o) Ferroalloy Production Facilities — 40 C.F.R. Part 60, Subpart Z;

(p) Other Solid Waste Incineration Units (after 9 December 2004) — 40 C.F.R. Part 60, Subpart EEEE;

(q) Secondary lead smelters — 40 C.F.R. Part 63, Subpart X;

(r) Hazardous waste combustors — 40 C.F.R. Part 63, Subpart EEE;

(s) Portland cement manufacturing — 40 C.F.R. Part 63, Subpart LLL;

(t) Primary copper — 40 C.F.R. Part 63, Subpart QQQ;

(u) Primary lead smelting — 40 C.F.R. Part 63, Subpart TTT;

(v) Iron and steel foundries — 40 C.F.R. Part 63, Subpart EEEEE;

(w) Integrated iron and steel manufacturing — 40 C.F.R. Part 63, Subpart FFFFF;

(x) Electric Arc Furnace Steelmaking Facilities — 40 C.F.R. Part 63, Subpart YYYYY;

(y) Iron and steel foundries — 40 C.F.R. Part 63, Subpart ZZZZZ;

(z) Primary Copper Smelting Area Sources — 40 C.F.R. Part 63, Subpart EEEEEE;

(aa) Secondary Copper Smelting Area Sources — 40 C.F.R. Part 63, Subpart FFFFFF;

(bb) Primary Nonferrous Metals Area Sources: Zinc, Cadmium, and Beryllium — 40 C.F.R. Part 63, Subpart GGGGGG;

(cc) Glass manufacturing (area sources) — 40 C.F.R. Part 63, Subpart SSSSSS;

(dd) Secondary Nonferrous Metal Smelter (Area Sources) — 40 C.F.R. Part 63, Subpart TTTTTT;

(ee) Ferroalloys Production (Area Sources) — 40 C.F.R. Part 63, Subpart YYYYYY;

(ff) Aluminum, Copper, and Nonferrous Foundries (Area Sources) — 40 C.F.R. Part 63, Subpart ZZZZZZ;

(gg) Standards of Performance for Coal Preparation and Processing Plants — 40 C.F.R. Part 60, Subpart Y;

(hh) Industrial, Commercial, Institutional and Process Heaters — 40 C.F.R. Part 63, Subpart DDDDD;

(ii) Industrial, Commercial and Institutional Boilers (Area Sources) — 40 C.F.R. Part 63, Subpart JJJJJJ;

(jj) Mercury Cell Chlor-Alkali Plants — 40 C.F.R. Part 63, Subpart IIIII; and

(kk) Standards of Performance Commercial and Industrial Solid Waste Incineration Units for which Construction is Commenced after November 30, 1999, or for which Modification or Reconstruction is Commenced on or after 1 June 2001 — 40 C.F.R. Part 60, Subpart CCCC.

Annex VI
Product control measures

1. No later than the date of entry into force of the present Protocol for a Party, 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.

[Paragraph 3 is deleted.]

4. Notwithstanding paragraph 1, 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 the date of entry into force of this Protocol for that Party, 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 0°C or above 50°C, 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 measures

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,

as amended on 18 December 2009

1998 Protocol on Persistent Organic Pollutants, as amended on 18 December 2009

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: (a) possess toxic characteristics; (b) are persistent; (c) bioaccumulate; (d) are prone to long-range transboundary atmospheric transport and deposition; and (e) 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 for a Party of: (a) the present Protocol; or (b) an amendment to the present Protocol that, with respect to a stationary source, either introduces new limit values in part II of annex IV or introduces the category in annex VIII in which that source falls. 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 annexes 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 guidance adopted by the Parties at a session of the Executive Body 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 guidance adopted by the Parties at a session of the Executive Body 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) – deleted]

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;

(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;

(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;

(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;

(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;

(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 the procedure for adding substances to annexes 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

1. 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.

2. 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. Annex V is 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 those that were Parties at the time of their adoption 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. This paragraph shall be subject to paragraphs 5 bis and 5 ter below.

4. Amendments to annex V 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 annex V 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 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.

5 bis. For those Parties having accepted it, the procedure set out in paragraph 5ter below shall supersede the procedure set out in paragraph 3 above in respect of amendments to annexes I to IV, VI and VIII.

5 ter. (a) Amendments to annexes I to IV, VI and VIII shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of one year 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 subparagraph (b) below;

(b) Any Party that is unable to approve an amendment to annexes I to IV, VI and VIII shall so notify the Depositary in writing within one year 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;

(c) Any amendment to annexes I to IV, VI and VIII shall not enter into force if an aggregate number of sixteen or more Parties have either:

(i) Submitted a notification in accordance with the provisions of subparagraph (b) above; or

(ii) Not accepted the procedure set out in this paragraph and not yet deposited an instrument of acceptance in accordance with the provisions of paragraph 3 above.

6. In the case of a proposal to amend annexes 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;

(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.

3. A State or Regional Economic Integration Organization shall declare in its instrument of ratification, acceptance, approval or accession if it does not intend to be bound by the procedures set out in article 14, paragraph 5ter as regards the amendment of annexes I to IV, VI and VIII.

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 (a) as contaminants in products; or (b) in articles manufactured or in use by the implementation date; or (c) 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	None
	Use	None
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
Hexabromobiphenyl CAS: 36355-01-8	Production	None
	Use	None
Hexachlorobenzene CAS: 118-74-1	Production	None
	Use	None
Hexachlorobutadiene CAS: 87-68-3	Production	None
	Use	None
Hexachlorocyclohexanes (HCH) (CAS: 608-73-1), including lindane (CAS: 58-89-9)	Production	None
	Use	None, except for the gamma isomer of HCH (lindane), used as topical insecticide for public health purposes. Such uses shall be re-evaluated under this Protocol in 2012 or one year after the amendment enters into force, whichever is later.
Hexabromodiphenyl ether[a/] and heptabromodiphenyl ether[a/]	Production	None
	Use	1. A Party may allow recycling of articles that contain or may contain any of these substances, and the use and final disposal of articles manufactured from recycled materials that contain or may contain any of these substances, provided that the recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of any of these substances for the purpose of their reuse. 2. Commencing in 2013 and every four years subsequently until the above condition is removed or otherwise expires, the Executive Body shall evaluate the progress that Parties have made towards achieving their ultimate objective of elimination of these substances contained in articles and review the continued need for the condition, which shall in any case expire at the latest in 2030.
Mirex CAS: 2385-85-5	Production	None
	Use	None

Substance	**Implementation requirements**	
	Elimination of	**Conditions**
Tetrabromodiphenyl ether[b/] and pentabromodiphenyl ether[b/]	Production	None
	Use	1. A Party may allow recycling of articles that contain or may contain any of these substances, and the use and final disposal of articles manufactured from recycled materials that contain or may contain any of these substances, provided that the recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of any of these substances for the purpose of their reuse. 2. Commencing in 2013 and every four years subsequently until the above condition is removed or otherwise expires, the Executive Body shall evaluate the progress that Parties have made towards achieving their ultimate objective of elimination of these substances contained in articles and review the continued need for the condition, which shall in any case expire at the latest in 2030.
Pentachlorobenzene CAS : 608-93-5	Production	None
	Use	None
Perfluorooctane sulfonate (PFOS)[c/]	Production	None, except for production for the uses (a) to (c) below, and (a) to (e) in annex II.
	Use	None, except for the following uses and uses (a) to (e) in annex II: (a) Chromium electroplating, chromium anodizing and reverse etching until 2014; (b) Electroless nickel-polytetrafluoroethylene plating until 2014; (c) Etching of plastic substrates prior to their metalization until 2014; (d) Firefighting foams, but only if they have been manufactured or were in use by 18 December 2009; With respect to firefighting foams: (i) Parties should endeavour to eliminate by 2014 firefighting foams containing PFOS that were manufactured or in use by 18 December 2009 and shall report on their progress to the Executive Body in 2014; (ii) Based on the reports of the Parties and paragraph (i), the Executive Body shall in 2015 assess whether the use of firefighting foams containing PFOS that were manufactured or in use by 18 December 2009 should be subject to additional restrictions.
Polychlorinated biphenyls (PCBs)[d/]	Production	None
	Use	None Concerning PCBs in use by the implementation date, Parties shall: 1. 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 dm3 and having a concentration of 0.05% PCBs or greater, as soon as possible but no later than 31 December 2010, or 31 December 2015 for countries with economies in transition; (b) The destruction or decontamination in an environmentally sound manner of: (i) 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; (ii) All liquid PCBs referred to in paragraph 2(a) no later than 31 December 2029; (c) The decontamination or disposal of equipment referred in subparagraphs 1 (a) and 2 (a) in an environmentally sound manner. 2. Endeavour to: (a) Identify and remove from use equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) containing more than 0.005% PCBs and volumes greater than 0.05 dm3, as soon as possible but no later than 31 December 2025; (b) Identify other articles containing more than 0.005% PCBs (e.g. cable sheaths, cured caulk and painted objects) and manage them in accordance with article 3, paragraph 3.

Substance	Implementation requirements	
	Elimination of	**Conditions**
Polychlorinated biphenyls (PCBs)[d/]	Production	None
	Use	3. Ensure that the equipment described in subparagraphs 1 (a) and 2 (a) is not exported or imported other than for the purpose of environmentally sound waste management. 4. Promote the following to reduce exposure and risk to control the use of PCBs: (a) Use PCBs only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimized and quickly remedied; (b) Not use PCBs in equipment in areas associated with the production or processing of food or feed; When PCBs are used in populated areas, including schools and hospitals, take all reasonable measures to prevent electrical failures that could result in a fire, and regularly inspect equipment for leaks.
Polychlorinated naphthalenes (PCN)	Production	None
	Use	None
Short-chain chlorinated paraffins[e/]	Production	None, except for production for the uses specified in annex II.
	Use	None, except for the uses specified in annex II.
Toxaphene CAS: 8001-35-2	Production	None
	Use	None

[a/] "Hexabromodiphenyl ether and heptabromodiphenyl ether" mean 2,2′,4,4′,5,5′-hexabromodiphenyl ether (BDE-153, CAS No: 68631-49-2), 2,2′,4,4′,5,6′-hexabromodiphenyl ether (BDE-154, CAS No: 207122-15-4), 2,2′,3,3′,4,5′,6 heptabromodiphenyl ether (BDE-175, CAS No: 446255-22-7), 2,2′,3,4,4′,5′,6-heptabromodiphenyl ether (BDE-183, CAS No: 207122-16-5) and other hexa- and heptabromodiphenyl ethers present in commercial octabromodiphenyl ether.

[b/] "Tetrabromodiphenyl ether and pentabromodiphenyl ether" means 2,2′,4,4′-tetrabromodiphenyl ether (BDE-47, CAS No: 40088-47-9) and 2,2′,4,4′,5-pentabromodiphenyl ether (BDE-99, CAS No: 32534-81-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether.

[c/] "Perfluorooctane sulfonate (PFOS)" means substances defined by the molecular formula C8F17SO2X, where X=OH, metal salt, halide, amide or other derivatives including polymers.

[d/] "Polychlorinated biphenyls" means aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced by up to 10 chlorine atoms.

[e/] "Short-chain chlorinated paraffins" means chlorinated alkanes with a carbon chain length of 10 to 13 carbon atoms and the degree of chlorination of more than 48% by weight.

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: (a) as contaminants in products; or (b) in articles manufactured or in use by the implementation date; or (c) as site-limited chemical intermediates in the manufacture of one or more different substances and are thus chemically transformed. Unless otherwise specifie , each obligation below is effective upon the date of entry into force of the Protocol.

Substance	Implementation requirements	
	Restricted to uses	**Conditions**
Perfluorooctane sulfonate (PFOS)[a/]	(a) Photo-resist or anti-reflective coatings for photolithography processes; (b) Photographic coatings applied to films, papers or printing plates; (c) Mist suppressants for non-decorative hard chromium (VI) plating and wetting agents for use in controlled electroplating systems; (d) Hydraulic fluids for aviation; (e) Certain medical devices (such as ethylene tetrafluoroethylene copolymer (ETFE) layers and radio-opaque ETFE production, in vitro diagnostic medical devices, and CCD colour filters).	1. Parties should take action to eliminate these uses once suitable alternatives are available. 2. No later than 2015 and every four years thereafter, each Party that uses these substances shall report on progress made to eliminate them and submit information on such progress to the Executive Body. Based on these reports, these restricted uses shall be reassessed.
Short-chain chlorinated paraffins[b/]	(a) Fire retardants in rubber used in conveyor belts in the mining industry; (b) Fire retardants in dam sealants.	Parties should take action to eliminate these uses once suitable alternatives are available. No later than 2015 and every four years thereafter, each Party that uses these substances shall report on progress made to eliminate them and submit information on such progress to the Executive Body. Based on these reports, these restricted uses shall be reassessed.

[a/] “Perfluorooctane sulfonate (PFOS)” means substances defined by the molecular formula C8F17SO2X, where X=OH, metal salt, halide, amide or other derivatives including polymers.

[b/] “Short-chain chlorinated paraffins” means chlorinated alkanes with a carbon chain length of 10 to 13 carbon atoms and the degree of chlorination of more than 48% by weight.

Annex III
Substances referred to in article 3, paragraph 5 (a), and the reference year for the obligation

Substance	Reference year
PAHs[a/]	1990; or an alternative year from 1985 to 1995 inclusive, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party and as specified by that Party upon ratification, acceptance, approval or accession.
Dioxins/furans[b/]	1990; or an alternative year from 1985 to 1995 inclusive, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party and as specified by that Party upon ratification, acceptance, approval or accession.
Hexachlorobenzene CAS: 118-74-1	1990; or an alternative year from 1985 to 1995 inclusive, or for countries with economies in transition, an alternative year from 1985 to the year of the entry into force of the Protocol for a Party and as specified by that Party upon ratification, acceptance, approval or accession.
PCBs[c/]	2005; or an alternative year from 1995 to 2010 inclusive, or for countries with economies in transition, an alternative year from 1995 to the year of the entry into force of the Protocol for a Party, and as specified by that Party upon ratification, acceptance, approval or accession.

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

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

[c/] Polychlorinated biphenyls, as defined in annex I, when formed and released unintentionally from anthropogenic sources.

Annex IV
Limit values for dioxins and furans 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, dry gas, and for a given oxygen content).

3. Limit values relate to the normal operating situation. For batch operations, limit values relate to average levels as recorded during the whole batch process – including, for example, pre-heating, heating and cooling.

4. Sampling and analysis of all pollutants shall be carried out according to the applicable standards laid down by, for example, the Comité européen de normalisation (CEN), the International Organization for Standardization (ISO), or the corresponding United States or Canadian reference methods.

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.

5. Emissions of PCDD/F are given in total toxic equivalents (TEQ).[1] The toxic equivalence factor values to be used for the purposes of this Protocol shall be consistent with applicable international standards, including the World Health Organization 2005 mammalian toxic equivalence factor values for PCDD/F.

II. Limit values for major stationary sources

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

Municipal solid waste (existing stationary source burning more than 3 tonnes per hour and every new stationary source)
0.1 ng TEQ/m3

Medical solid waste (existing stationary source burning more than 1 tonne per hour and every new stationary source)

New stationary source: 0.1 ng TEQ/m^3
Existing stationary source: 0.5 ng TEQ/m^3

Hazardous waste (existing stationary source burning more than 1 tonne per hour and every new stationary source)

New stationary source: 0.1 ng TEQ/m^3
Existing stationary source: 0.2 ng TEQ/m^3

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[1] The total toxic equivalent (TEQ) is operationally defined by the sum of the products of the concentration of each compound multiplied by its toxic equivalence factor (TEF) value and is an estimate of the total 2-, 3-,7-, and 8-TCDD-like activity of the mixture. Total toxic equivalent was previously abbreviated as TE.

Non hazardous industrial waste[2,3]

New stationary source: 0.1 ng TEQ/m^3
Existing stationary source: 0.5 ng TEQ/m^3

8. The following limit value, which refers to 16% O^2 concentration in flue gas, applies to sinter-plants: 0.5 ng TEQ/m^3.

9. The following limit value, which refers to the actual O^2 concentration in flue gas, applies to the following source:

Secondary steel production – electric arc furnaces with a capacity to produce more than 2.5 tonnes per hour of molten steel for further processing: 0.5 ng TEQ/m^3.

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[2] Including incinerators treating biomass waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular biomass waste originating from construction and demolition waste, but excluding incinerators only treating other biomass waste.

[3] Countries with economies in transition may exclude co-combustion of non-hazardous industrial waste in industrial processes where such waste is used as an additional fuel contributing up to 10% of the energy.

Annex V
Best available techniques to control emissions of Persistent Organic Pollutants from major stationary sources

I. Introduction

1. The purpose of this annex is to provide the Parties to the Convention with guidance in identifying best available techniques to allow them to meet the obligations in article 3, paragraph 5, of the Protocol. Further description of, and guidance regarding, such best available techniques is provided in a guidance document adopted by the Parties at a session of the Executive Body and may be updated as necessary by a consensus of the Parties meeting within the Executive Body.

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 guidance document referred to in paragraph 1 above 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 guidance document referred to in paragraph 1 above 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;

(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);

(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;

(c) Use of chlorinated fuels in furnace installations.

[III. GENERAL APPROACHES TO CONTROLLING EMISSIONS OF POPS – part III is deleted; its contents moved into the guidance document referred to in paragraph 1 above].

[IV. CONTROL TECHNIQUES FOR THE REDUCTION OF PCDD/F EMISSIONS – part IV is deleted; its contents moved into the guidance document referred to in paragraph 1 above].

[V. CONTROL TECHNIQUES FOR THE REDUCTION OF PAH EMISSIONS – part IV is deleted; its contents moved into the guidance document referred to in paragraph 1 above].

Annex VI
Timescales for the application of limit values and best available techniques to new and existing stationary sources

1. 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 for a Party;

(b) For existing stationary sources:

(i) Eight years after the date of entry into force of the present Protocol for a Party. If necessary, this period may be extended for specific existing stationary sources in accordance with the amortization period provided for by national legislation; or

(ii) For a Party that is a country with an economy in transition, up to fifteen years after the date of entry into force of the present Protocol for that Party.

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

(a) For new stationary sources, two years after the date of entry into force of the relevant amendment for a Party;

(b) For existing stationary sources:

(i) Eight years after the date of entry into force of the relevant amendment for a Party; or

(ii) For a Party that is a country with an economy in transition, up to fifteen years after the date of entry into force of the relevant amendment for that Party.

[Annex VII
Recommended control measures for reducing emissions of Persistent Organic Pollutants from mobile sources

– Annex VII was deleted]

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 the guidance document referred to in annex V.

II. List of categories

Category	Description of the category
1	Waste incineration, including co-incineration, of municipal, hazardous, non-hazardous and medical wastes and 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).
13	Specific chemical production processes releasing unintentionally formed persistent organic pollutants, especially the production of chlorophenols and chloranil.
14	Thermal processes in the metallurgical industry, chlorine-based methods.

Section IX

1999 Protocol to Abate Acidification Eutrophication and Ground-level Ozone,

as amended on 4 May 2012

1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, as amended on 4 May 2012

The Parties,

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

Aware that nitrogen oxides, sulphur, volatile organic compounds, reduced nitrogen compounds and particulate matter 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 and particulate matter 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, volatile organic compounds, ammonia and directly emitted particulate matter, as well as secondarily formed pollutants such as ozone, particulate matter and the reaction products of ammonia, are transported in the atmosphere over long distances and may have adverse transboundary effects,

Recognizing the assessments of scientific knowledge by international organizations, such as the United Nations Environment Programme, and by the Arctic Council, about the human health and climate co-benefits of reducing black carbon and ground-level ozone, particularly in the Arctic and in the Alpine regions,

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 addressing cross-border air pollution under the Canada-United States Air Quality Agreement, which includes commitments by both countries to reduce emissions of sulphur dioxide, nitrogen oxides and volatile organic compounds, and that the two countries are considering the inclusion of commitments to reduce emissions of particulate matter,

Recognizing furthermore that Canada is committed to achieving reductions of sulphur dioxide, nitrogen oxides, volatile organic compounds and particulate matter to meet the Canadian Ambient Air Quality Standards for ozone and particulate matter and the national objective to reduce acidification, and that the United States is committed to the implementation of programmes to reduce emissions of nitrogen oxides, sulphur dioxide, volatile organic compounds and particulate matter necessary to meet national ambient air quality standards for ozone and particulate matter, to make continued progress in reducing acidification and eutrophication effects and to improve visibility in national parks and urban areas alike,

Resolved to apply a multi-effect, multi-pollutant approach to preventing or minimizing the exceedances of critical loads and levels,

Taking into account the scientific knowledge about the hemispheric transport of air pollution, the influence of the nitrogen cycle and the potential synergies with and trade-offs between air pollution and climate change,

Aware that emissions from shipping and aviation contribute significantly to adverse effects on human health and the environment and are important issues under consideration by the International Maritime Organization and the International Civil Aviation Organization, *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, volatile organic compounds and particulate matter 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 and particulate matter, including black carbon,

Noting that measures taken to reduce the emissions of nitrogen oxides and reduced nitrogen compounds should involve consideration of the full biogeochemical nitrogen cycle and, so far as possible, not increase emissions of reactive nitrogen, including nitrous oxide and nitrate levels in ecosystems, 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 ground-level 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;

1 bis. The terms "this Protocol", "the Protocol" and "the present Protocol" mean the 1999 Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone, as amended from time to time;

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, expressed as ammonia (NH_3);

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;

11 bis. "Particulate matter" or "PM" is an air pollutant consisting of a mixture of particles suspended in the air. These particles differ in their physical properties (such as size and shape) and chemical composition. Unless otherwise stated, all references to particulate matter in the present Protocol refer to particles with an aerodynamic diameter equal to or less than 10 microns (µm) (PM_{10}), including those with an aerodynamic diameter equal to or less than 2.5 µm ($PM_{2.5}$);

11 ter. "Black carbon" means carbonaceous particulate matter that absorbs light;

11 quater. "Ozone precursors" means nitrogen oxides, volatile organic compounds, methane and carbon monoxide;

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 or fluxes to receptors 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, ammonia or particulate matter 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 for a Party of the present Protocol. A Party may decide not to treat as a new stationary source any stationary source for which approval has already been given by the appropriate competent national authorities at the time of entry into force of the Protocol for that Party and provided that the construction or substantial modification is commenced within five years of that date. It shall be a matter for the competent national authorities to decide whether a modification is substantial or not, taking account of such factors as the environmental benefits of the modification.

Article 2: OBJECTIVE

1. The objective of the present Protocol is to control and reduce emissions of sulphur, nitrogen oxides, ammonia, volatile organic compounds and particulate matter that are caused by anthropogenic activities and are likely to cause adverse effects on human health and the environment, natural ecosystems, materials, crops and the climate in the short and long term, due to acidification, eutrophication , particulate matter 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, that allow ecosystem recovery;

(b) For Parties within the geographical scope of EMEP, the critical loads of nutrient nitrogen, as described in annex I, that allow ecosystem recovery;

(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 Canadian Ambient Air Quality Standard for ozone; and
- (iii) For the United States of America, the National Ambient Air Quality Standards for ozone;

(d) For particulate matter:

- (i) For Parties within the geographical scope of EMEP, the critical levels of particulate matter, as given in annex I;
- (ii) For Canada, the Canadian Ambient Air Quality Standards for particulate matter; and
- (iii) For the United States of America, the National Ambient Air Quality Standards for particulate matter;

(e) For Parties within the geographical scope of EMEP, the critical levels of ammonia, as given in annex I; and

(f) For Parties within the geographical scope of EMEP, the acceptable levels of air pollutants to protect materials, as given in annex I.

2. A further objective is that Parties should, in implementing measures to achieve their national targets for particulate matter, give priority, to the extent they consider appropriate, to emission reduction measures which also significantly reduce black carbon in order to provide benefits for human health and the environment and to help mitigation of near-term climate change.

Article 3: BASIC OBLIGATIONS

1. Each Party having an emission reduction commitment in any table in annex II shall reduce and maintain the reduction in its annual emissions in accordance with that commitment 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. In taking steps to reduce emissions of particulate matter, each Party should seek reductions from those source categories known to emit high amounts of black carbon, to the extent it considers appropriate.

2. Subject to paragraphs 2 bis and 2 ter, each Party shall apply the limit values specified in annexes IV, V, VI and X 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.

2 bis. A Party that was already a Party to the present Protocol prior to entry into force of an amendment that introduces new source categories may apply the limit values applicable to an "existing stationary source" to any source in such a new category the construction or substantial modification of which is commenced before the expiry of one year from the date of entry into force of that amendment for that Party, unless and until that source later undergoes substantial modification.

2 ter. A Party that was already a Party to the present Protocol prior to entry into force of an amendment that introduces new limit values applicable to a "new stationary source" may continue to apply the previously applicable limit values to any source the construction or substantial modification of which is commenced before the expiry of one year from the date of entry into force of that amendment for that Party, unless and until that source later undergoes substantial modification.

3. Each Party shall, insofar as it is technically and economically feasible and taking into consideration the costs and advantages, apply the limit values specified in annexes IV, V, VI and X 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. [Paragraph 4 has been deleted in the revised 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 covered by annex VIII and to each stationary source covered by annexes IV, V, VI and X, and, as it considers appropriate, measures to control black carbon as a component of particulate matter, taking into account guidance adopted by the Executive Body.

7. Each Party shall, insofar as it is technically and economically feasible, and taking into consideration the costs and advantages, apply the limit values for VOC contents of products as identified in annex XI in accordance with the timescales specified in annex VII.

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 adopted by the Executive Body. Special attention should be given to reductions of ammonia emissions from significant sources of ammonia for that Party.

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, volatile organic compounds and/or particulate matter contributing to acidification, eutrophication, ozone formation or increased levels of particulate matter 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, volatile organic compounds and/or particulate matter) 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 ratification, acceptance or approval of, or accession to the present Protocol or the amendment contained in decision 2012/2 submit to the Executive Body their respective emission reduction commitments with respect to sulphur, nitrogen oxides, volatile organic compounds and particulate matter for automatic incorporation into annex II.

11 bis. Canada shall also upon ratification, acceptance or approval of, or accession to the present Protocol, submit to the Executive Body relevant limit values for automatic incorporation into annexes IV, V, VI, VIII, X and XI.

11 ter. Each Party shall develop and maintain inventories and projections for the emissions of sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds, and particulate matter. Parties within the geographic scope of EMEP shall use the methodologies specified in guidelines prepared by the Steering Body of EMEP and adopted by the Parties at a session of the Executive Body. Parties in areas outside the geographic scope of EMEP shall use as guidance the methodologies developed through the workplan of the Executive Body.

11 quater. Each Party should actively participate in programmes under the Convention on the effects of air pollution on human health and the environment.

11 quinquies. For the purposes of comparing national emission totals with emission reduction commitments as set out in paragraph 1, a Party may use a procedure specified in a decision of the Executive Body. Such a procedure shall include provisions on the submission of supporting documentation and on review of the use of the procedure.

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 3 bis: Flexible transitional arrangements

1. Notwithstanding article 3, paragraphs 2, 3, 5 and 6, a Party to the Convention that becomes a Party to the present Protocol between 1 January 2013 and 31 December 2019 may apply flexible transitional arrangements for the implementation of limit values specified in annexes VI and/or VIII under the conditions specified in this article.

2. Any Party electing to apply the flexible transitional arrangements under this article shall indicate in its instrument of ratification, acceptance or approval of or accession to the present Protocol the following:

(a) The specific provisions of annex VI and/or VIII for which the Party is electing to apply flexible transitional arrangements; and

(b) An implementation plan identifying a timetable for full implementation of the specified provisions.

3. An implementation plan under paragraph 2 (b) shall, at a minimum, provide for implementation of the limit values for new and existing stationary sources specified in tables 1 and 5 of annex VI and tables 1, 2, 3, 13 and 14 of annex VIII no later than eight years after entry into force of the present Protocol for the Party, or by 31 December 2022, whichever is sooner.

4. In no case may a Party's implementation of any limit values for new and existing stationary sources specified in annex VI or annex VIII be postponed past 31 December 2030.

5. A Party electing to apply the flexible transitional arrangements under this article shall provide the Executive Secretary of the Commission with a triennial report of its progress towards implementation of annex VI and/or annex VIII. The Executive Secretary of the Commission will make such triennial reports available to the Executive Body.

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, volatile organic compounds and particulate matter, including black carbon, by promoting, inter alia:

(a) The development and updating of databases on best available techniques, including those that increase energy efficiency, low-emission burners, good environmental practice in agriculture and measures that are known to mitigate emissions of black carbon as a component of particulate matter;

(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, volatile organic compounds and particulate matter, including black carbon, and progress towards compliance with the emission reduction commitments and 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 ground-level ozone and particulate matter;

(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; and

(e) The environmental and human health improvements associated with attaining emission reduction commitments for 2020 and beyond as listed in annex II. For countries within the geographical scope of EMEP, information on such improvements will be presented in guidance adopted by the Executive Body.

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) Human health, environmental and climate effects associated with reduction of 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, volatile organic compounds and particulate matter;

(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 adopted by the Executive Body;

(g) Encourage the implementation of management programmes to reduce emissions, including voluntary programmes, and the use of economic instruments, taking into account guidance adopted by the Executive Body;

(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, volatile organic compounds and particulate matter 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) Ambient concentrations and depositions of sulphur and nitrogen compounds;

(b) Ambient concentrations of ozone, volatile organic compounds and particulate matter; and

(c) If practicable, estimates of exposure to ground-level ozone and particulate matter.

Each Party shall, if practicable, also collect and maintain information on the effects of all of these pollutants on human health, terrestrial and aquatic ecosystems, materials and the climate. Parties within the geographic scope of EMEP should use guidelines adopted by the Executive Body. Parties outside the geographic scope of EMEP should use as guidance the methodologies developed through the workplan of the Executive Body.

2 bis. Each Party should, to the extent it considers appropriate, also develop and maintain inventories and projections for emissions of black carbon, using guidelines adopted by the Executive Body.

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, paragraphs 3 and 7, 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 to EMEP through the Executive Secretary of the Commission the following information for the emissions of sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds and particulate matter on the basis of guidelines prepared by the Steering Body of EMEP and adopted by the Executive Body:

(i) Levels of emissions using, as a minimum, the methodologies and the temporal and spatial resolution specified y the Steering Body of EMEP;

(ii) Levels of emissions in the reference year specified in annex II using the same methodologies and temporal and spatial resolution;

(iii) Data on projected emissions; and

(iv) An Informative Inventory Report containing detailed information on reported emission inventories and emission projections;

(b bis) Each Party within the geographical scope of EMEP should report available information to the Executive Body, through the Executive Secretary of the Commission, on its air pollution effects programmes on human health and the environment and atmospheric monitoring and modelling programmes under the Convention, using guidelines adopted by the Executive Body;

(c) Parties in areas outside the geographical scope of EMEP shall report available information on levels of emissions, including for the reference year as specified in annex II and appropriate to the geographic area covered by its emission reduction commitments. Parties in areas outside the geographical scope of EMEP should make available information similar to that specified in subparagraph (b bis), if requested to do so by the Executive Body;

(d) Each Party should also report, where available, its emissions inventories and projections for emissions of black carbon, using guidelines adopted 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. Upon the request of and in accordance with the timescales decided by the Executive Body, EMEP and other subsidiary bodies shall provide the Executive Body with relevant information on:

(a) Ambient concentrations and depositions of sulphur and nitrogen compounds, as well as, where available, ambient concentrations of particulate matter, including black carbon, volatile organic compounds and ozone;

(b) Calculations of sulphur and oxidized and reduced nitrogen budgets and relevant information on the long-range transport of particulate matter, ground-level ozone and their precursors;

(c) Adverse effects on human health, natural ecosystems, materials and crops, including interactions with climate change and the environment related to the substances covered by the present Protocol, and progress in achieving human health and environmental improvements as described in guidance adopted by the Executive Body; and

(d) The calculation of nitrogen budgets, nitrogen use efficiency and nitrogen surpluses and their improvements within the geographical area of EMEP, using guidance adopted 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 and particulate matter.

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 and particulate matter concentrations and the critical levels of ozone and particulate matter specified in annex I, or such alternative assessment methods as approved by the Parties at a session of the Executive Body.

6. Notwithstanding article 7, paragraph 1 (b), a Party may request the Executive Body for permission to report a limited inventory for a particular pollutant or pollutants if:

(a) The Party did not previously have reporting obligations under the present Protocol or any other protocol for that pollutant; and

(b) The limited inventory of the Party includes, at a minimum, all large point sources of the pollutant or pollutants within the Party or any relevant PEMA.

The Executive Body shall grant such a request annually for up to five years after entry into force of the present Protocol for a Party, but in no case for reporting of emissions for any year after 2019. Such a request will be accompanied by information on progress toward developing a more complete inventory as part of the Party's annual reporting.

Article 8: Research, development and monitoring

1. 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 particulate matter, including black carbon, 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, volatile organic compounds and particulate matter, including black carbon, 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;

(d bis) The improvement of the scientific understanding of the potential co-benefits for climate change mitigation associated with potential reduction scenarios for air pollutants (such as methane, carbon monoxide and black carbon) which have near-term radiative forcing and other climate effects;

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

(f) Strategies for the further reduction of emissions of sulphur, nitrogen oxides, ammonia, volatile organic compounds and other ozone precursors, and particulate matter 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, volatile organic compounds and particulate matter and photochemical pollution on human health, 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, particulate matter and ground-level 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, human health and the impacts on climate resulting from the reduction of emissions of sulphur, nitrogen oxides, ammonia, volatile organic compounds and particulate matter; 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, nitrogen compounds and particulate matter 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 human health effects, climate co-benefits, 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 particulate matter, 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.

3. The Executive Body shall include in its reviews under this article an evaluation of mitigation measures for black carbon emissions, no later than at the second session of the Executive Body after entry into force of the amendment contained in decision 2012/2.

4. The Parties shall, no later than at the second session of the Executive Body after entry into force of the amendment contained in decision 2012/2, evaluate ammonia control measures and consider the need to revise annex IX.

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 12 months following notification by one party to another that a dispute exists between them the parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

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

Article 12: *Annexes*

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

Article 13: *Adjustments*

1. 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. Any Party may propose an adjustment of its emission reduction commitments already listed in annex II. Such a proposal must include supporting documentation, and shall be reviewed, as specified in a decision of the Executive Body. This review shall take place prior to the proposal being discussed by the Parties in accordance with paragraph 4.

3. Any Party eligible under article 3, paragraph 9, may propose an adjustment to annex III to add one or more PEMAs or make changes to a PEMA under its jurisdiction that is listed in that annex.

4. Proposed 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 adjustments at the next session of the Executive Body, provided that those proposals have been circulated by the Executive Secretary to the Parties at least 90 days in advance.

5. Adjustments 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 13 bis: *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 shall discuss the proposed amendments at the next session of the Executive Body, provided that those proposals have been circulated by the Executive Secretary to the Parties at least 90 days in advance.

3. Amendments to the present Protocol other than to annexes I and III 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 those that were Parties at the time of their adoption 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 I and III to the present Protocol shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of 180 days from the date of its communication to all Parties by the Executive Secretary of the Commission, an amendment to any such annex shall become effective for those Parties which have not submitted to the Depositary a notification in accordance with the provisions of paragraph 5, provided that at least 16 Parties have not submitted such a notification.

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

6. For those Parties having accepted it, the procedure set out in paragraph 7 supersedes the procedure set out in paragraph 3 in respect of amendments to annexes IV to XI.

7. Amendments to annexes IV to XI shall be adopted by consensus of the Parties present at a session of the Executive Body. On the expiry of one year 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 subparagraph (a):

(a) Any Party that is unable to approve an amendment to annexes IV to XI shall so notify the Depositary in writing within one year 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;

(b) Any amendment to annexes IV to XI shall not enter into force if an aggregate number of 16 or more Parties have either:

(i) Submitted a notification in accordance with the provisions of subparagraph (a); or

(ii) Not accepted the procedure set out in this paragraph and not yet deposited an instrument of acceptance in accordance with the provisions of paragraph 3.

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.

4. A State or regional economic integration organization shall declare in its instrument of ratification, acceptance, approval or accession if it does not intend to be bound by the procedures set out in article 13 bis, paragraph 7, as regards the amendment of annexes IV to XI.

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 18 bis: *TERMINATION OF PROTOCOLS*

When all of the Parties to any of the following Protocols have deposited their instruments of ratification, acceptance, approval of or accession to the present Protocol with the Depository in accordance with article 15, that Protocol shall be considered as terminated:

(a) The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent;

(b) The 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes;

(c) The 1991 Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes;

(d) The 1994 Oslo Protocol on Further Reduction of Sulphur Emissions.

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 Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*. 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 are loads that — in the long term — will not cause adverse effects to the structure and functions of ecosystems. A combined sulphur and nitrogen critical load of acidity considers nitrogen only when the nitrogen deposition is greater than ecosystem nitrogen removal processes, such as uptake by vegetation. All critical loads reported by Parties, and approved by the Executive Body, are summarized for use in the integrated assessment modelling employed to provide guidance for setting the emission reduction commitments in annex II.

B. For Parties in North America

2. In Canada, critical acid deposition loads and geographical areas where they are exceeded are determined and mapped for lakes and upland forest ecosystems using scientific methodologies and criteria similar to those in the Convention's *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*. Critical load values for total sulphur plus nitrogen and exceedance levels have been mapped across Canada (south of 60° N latitude) and are expressed in acid equivalents per hectare per year (eq/ha/yr) (2004 Canadian Acid Deposition Science Assessment; 2008 Canadian Council of Ministers of the Environment). The province of Alberta has also adapted the generic critical load classification systems used for soils in Europe for potential acidity to define soils as highly sensitive, moderately sensitive and not sensitive to acidic deposition. Critical, target and monitoring loads are defined for each soil class and management actions are prescribed as per the Alberta Acid Deposition Management Framework, as appropriate.

3. These loads and effects are used in integrated assessment activities, including providing data for international efforts to assess ecosystem response to loading of acidifying compounds, and provide guidance for setting the emission reduction commitments for Canada in annex II.

4. For the United States of America, the effects of acidification are evaluated through an assessment of the sensitivity and response of ecosystems to the loading of acidifying compounds, using peer-reviewed scientific methodologies and criteria, and accounting for the uncertainties associated with nitrogen cycling processes within ecosystems. Adverse impacts on vegetation and ecosystems are then considered in establishing secondary national ambient air quality standards for nitrogen oxides (NO_x) and SO_2. Integrated assessment modelling and the air quality standards are used in providing guidance for setting the emission reduction commitments for the United States of America in annex II.

II. Critical loads of nutrient nitrogen

A. 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 Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*. They are the maximum amount of eutrophying nitrogen deposition that — in the long term — will not cause adverse effects to the structure and functions of ecosystems. All critical loads reported by Parties are summarized for use in the integrated assessment modelling employed to provide guidance for setting the emission reduction commitments in annex II.

B. For Parties in North America

5 bis. For the United States of America, the effects of nutrient nitrogen (eutrophication) for ecosystems are evaluated through an assessment of the sensitivity and response of ecosystems to the loading of nitrogen compounds, using peer-reviewed scientific methodologies and criteria, and accounting for uncertainties associated with nitrogen cycling within ecosystems. Adverse impacts on vegetation and ecosystems are then considered in establishing secondary national ambient air quality standards for NO_x. Integrated assessment modelling and the air quality standards are used in providing guidance for setting the emission reduction commitments for the United States of America 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 Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*. They are expressed in terms of the cumulative value of either stomatal fluxes or concentrations at the top of the canopy. Critical levels are preferably based on stomatal fluxes, as these are considered more biologically relevant since they take into account the modifying effect of climate, soil and plant factors on the uptake of ozone by vegetation.

7. Critical levels of ozone have been derived for a number of species of crops, (semi-)natural vegetation and forest trees. The critical levels selected are related to the most important environmental effects, e.g., loss of security of food supplies, loss of carbon storage in the living biomass of trees and additional adverse effects on forest and (semi-)natural ecosystems.

8. The critical level of ozone for human health is determined in accordance with the World Health Organization (WHO) air quality guidelines to protect human health from a wide range of health effects, including increased risk of premature death and morbidity.

B. For Parties in North America

9. For Canada, it is understood that there is no lower threshold for human health effects from ozone. That is, adverse effects have been observed at all ozone concentrations experienced in Canada. The Canadian Ambient Air Quality Standard for ozone was set to aid management efforts nationally, and by jurisdictions, to significantly reduce the effects on human health and the environment.

10. For the United States of America, critical levels are established in the form of primary and secondary national ambient air quality standards for ozone in order to protect public health with an adequate margin of safety and to protect public welfare, including vegetation, from any known or expected adverse effects. Integrated assessment modelling and the air quality standards are used in providing guidance for setting the emission reduction commitments for the United States of America in annex II.

IV. Critical levels of particulate matter

A. For Parties in the geographical scope of EMEP

11. The critical level of PM for human health is determined in accordance with the WHO air quality guidelines as the mass concentration of $PM_{2.5}$. Attainment of the guideline level is expected to effectively reduce health risks. The long-term $PM_{2.5}$ concentration, expressed as an annual average, is proportional to the risk to health, including reduction of life expectancy. This indicator is used in integrated modelling to provide guidance for emission reduction. In addition to the annual guideline level, a short-term (24-hour mean) guideline level is defined to protect against peaks of pollution which have significant impact on morbidity or mortality.

B. For Parties in North America

12. For Canada, it is understood that there is no lower threshold for human health effects from PM. That is, adverse effects have been observed at all concentrations of PM experienced in Canada. The Canadian national standard for PM was set to aid management efforts nationally, and by jurisdictions, to significantly reduce the effects on human health and the environment.

13. For the United States of America, critical levels are established in the form of primary and secondary national ambient air quality standards for PM in order to protect public health with an adequate margin of safety, and to protect public welfare (including visibility and man-made materials) from any known or expected adverse effects. Integrated assessment modelling and the air quality standards are used in providing guidance for setting the emission reduction commitments for the United States of America in annex II.

V. Critical levels of ammonia

14. Critical levels (as defined in article 1) of ammonia are determined to protect plants in accordance with the Convention's *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*.

VI. Acceptable levels of air pollutants to protect materials

15. Acceptable levels of acidifying pollutants, ozone and PM are determined to protect materials and cultural heritage in accordance with the Convention's *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends.* The acceptable levels of pollutants are the maximum exposure a material can tolerate in the long term without resulting in damage above specified target corrosion rates. This damage, which can be calculated by available dose-response functions, is the result of several pollutants acting together in different combinations depending on the material: acidity (sulphur dioxide (SO_2), nitric acid (HNO_3)), ozone and PM.

Annex II
Emission reduction commitments

1. The emission reduction commitments listed in the tables below relate to the provisions of article 3, paragraphs 1 and 10, of the present Protocol.

2. Table 1 includes the emission ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and volatile organic compounds (VOCs) for 2010 up to 2020 expressed in thousands of metric tons (tonnes) for those Parties that ratified the present Protocol prior to 2010.

3. Tables 2-6 include emission reduction commitments for SO_2, NO_x, NH_3, VOCs and $PM_{2.5}$ for 2020 and beyond. These commitments are expressed as a percentage reduction from the 2005 emission level.

4. The 2005 emission estimates listed in tables 2-6 are in thousands of tonnes and represent the latest best available data reported by the Parties in 2012. These estimates are given for information purposes only, and may be updated by the Parties in the course of their reporting of emission data under the present Protocol if better information becomes available. The secretariat will maintain and regularly update on the Convention's website a table of the most up-to-date estimates reported by Parties, for information. The percentage emission reduction commitments listed in tables 2-6 are applicable to the most up-to-date 2005 estimates as reported by the Parties to the Executive Secretary of the Commission.

5. If in a given year a Party finds that, due to a particularly cold winter, a particularly dry summer or unforeseen variations in economic activities, such as a loss of capacity in the power supply system domestically or in a neighbouring country, it cannot comply with its emission reduction commitments, it may fulfil those commitments by averaging its national annual emissions for the year in question, the year preceding that year and the year following it, provided that this average does not exceed its commitment.

Table 1
Emission ceilings for 2010 up to 2020 for Parties that ratified the present Protocol prior to 2010 (expressed in thousands of tonnes per year)

	Party	Ratification	SO_2	NO_x	NH_3	VOCs
1	Belgium	2007	106	181	74	144
2	Bulgaria	2005	856	266	108	185
3	Croatia	2008	70	87	30	90
4	Cyprus	2007	39	23	9	14
5	Czech Republic	2004	283	286	101	220
6	Denmark	2002	55	127	69	85
7	Finland	2003	116	170	31	130
8	France	2007	400	860	780	1100
9	Germany	2004	550	1081	550	995
10	Hungary	2006	550	198	90	137
11	Latvia	2004	107	84	44	136
12	Lithuania	2004	145	110	84	92
13	Luxembourg	2001	4	11	7	9
14	Netherlands	2004	50	266	128	191
15	Norway	2002	22	156	23	195
16	Portugal	2005	170	260	108	202
17	Romania	2003	918	437	210	523
18	Slovakia	2005	110	130	39	140
19	Slovenia	2004	27	45	20	40
20	Spain[a]	2005	774	847	353	669
21	Sweden	2002	67	148	57	241
22	Switzerland	2005	26	79	63	144
23	United Kingdom of Great Britain and Northern Ireland	2005	625	1 181	297	1 200
24	United States of America	2004	[b]	[c]		[d]
25	European Union	2003	7 832	8 180	4 294	7 585

[a] Figures apply to the European part of the country.

[b] Upon acceptance of the present Protocol in 2004, the United States of America provided an indicative target for 2010 of 16,013,000 tons for total sulphur emissions from the PEMA identified for sulphur, the 48 contiguous United States and the District of Columbia. This figure converts to 14,527,000 tonnes.

[c] Upon acceptance of the present Protocol in 2004, the United States of America provided an indicative target for 2010 of 6,897,000 tons for total NO_x emissions from the PEMA identified for NO_x, Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin. This figure converts to 6,257,000 tonnes.

[d] Upon acceptance of the present Protocol in 2004, the United States of America provided an indicative target for 2010 of 4,972,000 tons for total VOC emissions from the PEMA identified for VOCs, Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin. This figure converts to 4,511,000 tonnes.

Table 2
Emission reduction commitments for sulphur dioxide for 2020 and beyond

	Convention Party	Emission levels 2005 in thousands of tonnes of SO_2	Reduction from 2005 level (%)
1	Austria	27	26
2	Belarus	79	20
3	Belgium	145	43
4	Bulgaria	777	78
5	Canada[a]		
6	Croatia	63	55
7	Cyprus	38	83
8	Czech Republic	219	45
9	Denmark	23	35
10	Estonia	76	32
11	Finland	69	30
12	France	467	55
13	Germany	517	21
14	Greece	542	74
15	Hungary	129	46
16	Ireland	71	65
17	Italy	403	35
18	Latvia	6.7	8
19	Lithuania	44	55
20	Luxembourg	2.5	34
21	Malta	11	77
22	Netherlands[b]	65	28
23	Norway	24	10
24	Poland	1 224	59
25	Portugal	177	63
26	Romania	643	77
27	Slovakia	89	57
28	Slovenia	40	63
29	Spain[b]	1 282	67
30	Sweden	36	22
31	Switzerland	17	21
32	United Kingdom of Great Britain and Northern Ireland	706	59
33	United States of America[c]		
34	European Union	7 828	59

[a] Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall provide: (a) a value for total estimated sulphur emission levels for 2005, either national or for its PEMA, if it has submitted one; and (b) an indicative value for a reduction of total sulphur emission levels for 2020 from 2005 levels, either at the national level or for its PEMA. Item (a) will be included in the table and item (b) will be included in a footnote to the table. The PEMA, if submitted, will be offered as an adjustment to annex III to the Protocol.

[b] Figures apply to the European part of the country.

[c] Upon ratification, acceptance, or approval of, or accession to the amendment adding this table to the present Protocol, the United States of America shall provide: (a) a value for total estimated sulphur emission levels for 2005, either national or for a PEMA; (b) an indicative value for a reduction of total sulphur emission levels for 2020 from identified 2005 levels; and (c) any changes to the PEMA identified when the United States became a Party to the Protocol. Item (a) will be included in the table, item (b) will be included in a footnote to the table and item (c) will be offered as an adjustment to annex III.

Table 3
Emission reduction commitments for nitrogen oxides for 2020 and beyond[a]

	Convention Party	Emission levels 2005 in thousands of tonnes of NO_2	Reduction from 2005 level (%)
1	Austria	231	37
2	Belarus	171	25
3	Belgium	291	41
4	Bulgaria	154	41
5	Canada[b]		
6	Croatia	81	31
7	Cyprus	21	44
8	Czech Republic	286	35
9	Denmark	181	56
10	Estonia	36	18
11	Finland	177	35
12	France	1 430	50
13	Germany	1 464	39
14	Greece	419	31
15	Hungary	203	34
16	Ireland	127	49
17	Italy	1 212	40
18	Latvia	37	32
19	Lithuania	58	48
20	Luxembourg	19	43
21	Malta	9.3	42
22	Netherlands[c]	370	45
23	Norway	200	23
24	Poland	866	30
25	Portugal	256	36
26	Romania	309	45
27	Slovakia	102	36
28	Slovenia	47	39
29	Spain[c]	1 292	41
30	Sweden	174	36
31	Switzerland[d]	94	41
32	United Kingdom of Great Britain and Northern Ireland	1 580	55
33	United States of America[e]		
34	European Union	11 354	42

[a] Emissions from soils are not included in the 2005 estimates for European Union member States.

[b] Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall provide: (a) a value for total estimated nitrogen oxide emission levels for 2005, either national or for its PEMA, if it has submitted one; and (b) an indicative value for a reduction of total nitrogen oxide emission levels for 2020 from 2005 levels, either at the national level or for its PEMA. Item (a) will be included in the table and item (b) will be included in a footnote to the table. The PEMA, if submitted, will be offered as an adjustment to annex III to the Protocol.

[c] Figures apply to the European part of the country.

[d] Including emissions from crop production and agricultural soils (NFR 4D).

[e] Upon ratification, acceptance, or approval of, or accession to the amendment adding this table to the present Protocol, the United States of America shall provide: (a) a value for total estimated nitrogen oxides emission levels for 2005, either national or for a PEMA; (b) an indicative value for a reduction of total nitrogen oxides emission levels for 2020 from identified 2005 levels; and (c) any changes to the PEMA identified when the United States became a Party to the Protocol. Item (a) will be included in the table, item (b) will be included in a footnote to the table and item (c) will be offered as an adjustment to annex III.

Table 4
Emission reduction commitments for ammonia for 2020 and beyond

	Convention Party	Emission levels 2005 in thousands of tonnes of NH_3	Reduction from 2005 level (%)
1	Austria	63	1
2	Belarus	136	7
3	Belgium	71	2
4	Bulgaria	60	3
5	Croatia	40	1
6	Cyprus	5.8	10
7	Czech Republic	82	7
8	Denmark	83	24
9	Estonia	9.8	1
10	Finland	39	20
11	France	661	4
12	Germany	573	5
13	Greece	68	7
14	Hungary	80	10
15	Ireland	109	1
16	Italy	416	5
17	Latvia	16	1
18	Lithuania	39	10
19	Luxembourg	5.0	1
20	Malta	1.6	4
21	Netherlands [a]	141	13
22	Norway	23	8
23	Poland	270	1
24	Portugal	50	7
25	Romania	199	13
26	Slovakia	29	15
27	Slovenia	18	1
28	Spain [a]	365	3
29	Sweden	55	15
30	Switzerland	64	8
31	United Kingdom of Great Britain and Northern Ireland	307	8
32	European Union	3 813	6

[a] Figures apply to the European part of the country.

Table 5
Emission reduction commitments for Volatile Organic Compounds for 2020 and beyond

Convention Party		Emission levels 2005 in thousands of tonnes of VOC	Reduction from 2005 level (%)
1	Austria	162	21
2	Belarus	349	15
3	Belgium	143	21
4	Bulgaria	158	21
5	Canada[a]		
6	Croatia	101	34
7	Cyprus	14	45
8	Czech Republic	182	18
9	Denmark	110	35
10	Estonia	41	10
11	Finland	131	35
12	France	1 232	43
13	Germany	1 143	13
14	Greece	222	54
15	Hungary	177	30
16	Ireland	57	25
17	Italy	1 286	35
18	Latvia	73	27
19	Lithuania	84	32
20	Luxembourg	9.8	29
21	Malta	3.3	23
22	Netherlands[b]	182	8
23	Norway	218	40
24	Poland	593	25
25	Portugal	207	18
26	Romania	425	25
27	Slovakia	73	18
28	Slovenia	37	23
29	Spain[b]	809	22
30	Sweden	197	25
31	Switzerland[c]	103	30
32	United Kingdom of Great Britain and Northern Ireland	1 088	32
33	United States of America[d]		
34	European Union	8 842	28

[a] Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall provide: (a) a value for total estimated VOC emission levels for 2005, either national or for its PEMA, if it has submitted one; and (b) an indicative value for a reduction of total VOC emission levels for 2020 from 2005 levels, either at the national level or for its PEMA. Item (a) will be included in the table and item (b) will be included in a footnote to the table. The PEMA, if submitted, will be offered as an adjustment to annex III to the Protocol.

[b] Figures apply to the European part of the country.

[c] Including emissions from crop production and agricultural soils (NFR 4D).

[d] Upon ratification, acceptance, or approval of, or accession to the amendment adding this table to the present Protocol, the United States of America shall provide: (a) a value for total estimated VOC emission levels for 2005, either national or for a PEMA; (b) an indicative value for a reduction of total VOC emission levels for 2020 from identified 2005 levels; and (c) any changes to the PEMA identified when the United States became a Party to the Protocol. Item (a) will be included in the table, item (b) will be included in a footnote to the table and item (c) will be offered as an adjustment to annex III.

Table 6
Emission reduction commitments for $PM_{2.5}$ for 2020 and beyond

Convention Party		Emission levels 2005 in thousands of tonnes of $PM_{2.5}$	Reduction from 2005 level (%)
1	Austria	22	20
2	Belarus	46	10
3	Belgium	24	20
4	Bulgaria	44	20
5	Canada[a]		
6	Croatia	13	18
7	Cyprus	2.9	46
8	Czech Republic	22	17
9	Denmark	25	33
10	Estonia	20	15
11	Finland	36	30
12	France	304	27
13	Germany	121	26
14	Greece	56	35
15	Hungary	31	13
16	Ireland	11	18
17	Italy	166	10
18	Latvia	27	16
19	Lithuania	8.7	20
20	Luxembourg	3.1	15
21	Malta	1.3	25
22	Netherlands[b]	21	37
23	Norway	52	30
24	Poland	133	16
25	Portugal	65	15
26	Romania	106	28
27	Slovakia	37	36
28	Slovenia	14	25
29	Spainb	93	15
30	Sweden	29	19
31	Switzerland	11	26
32	United Kingdom of Great Britain and Northern Ireland	81	30
33	United States of America[c]		
34	European Union	1 504	22

[a] Upon ratification, acceptance or approval of, or accession to, the present Protocol, Canada shall provide: (a) a value for total estimated PM emission levels for 2005, either national or for its PEMA, if it has submitted one; and (b) an indicative value for a reduction of total emission levels of PM for 2020 from 2005 levels, either at the national level or for its PEMA. Item (a) will be included in the table and item (b) will be included in a footnote to the table. The PEMA, if submitted, will be offered as an adjustment to annex III to the Protocol.

[b] Figures apply to the European part of the country.

[c] Upon ratification, acceptance, or approval of, or accession to the amendment adding this table to the present Protocol, the United States of America shall provide: (a) a value for total estimated PM2.5 emission levels for 2005, either national or for a PEMA; and (b) an indicative value for a reduction of total PM2.5 emission levels for 2020 from identified 2005 levels. Item (a) will be included in the table and item (b) will be included in a footnote to the table.

Annex III

Designated pollutant emissions management areas

1. The following pollutant emissions management areas (PEMAs) are listed for the purpose of the present Protocol.

Canada PEMA

2. The PEMA for sulphur for Canada is an area of 1 million square kilometres which includes all the territory of the Provinces of Prince Edward Island, Nova Scotia and New Brunswick, all the territory of the Province of Québec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Québec-Ontario boundary intersects with the James Bay coastline, and all the territory of the Province of Ontario south of a straight line between the point where the Ontario-Québec boundary intersects the James Bay coastline and the Nipigon River near the north shore of Lake Superior.

Russian Federation PEMA

3. The Russian Federation PEMA corresponds to the European territory of the Russian Federation. The European territory of the Russian Federation is a part of the territory of the Russian Federation within the administrative and geographical boundaries of the entities of the Russian Federation located in Eastern Europe bordering the Asian continent in accordance with the conventional borderline that passes from north to south along the Ural Mountains, the border with Kazakhstan to the Caspian Sea, then along the State borders with Azerbaijan and Georgia in the North Caucasus to the Black Sea.

United States of America PEMAs

4. Description of the Geographical Scope of the U.S. Pollutant Emission Management Area (PEMA) For SO_2: The 48 contiguous states and the District of Columbia. This excludes Alaska and Hawaii.

5. Description of the Geographical Scope of the U.S. Pollutant Emission Management Area (PEMA) For NO_x: Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin.

6. Description of the Geographical Scope of the U.S. Pollutant Emission Management Area (PEMA) For VOCs: Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin.

Annex IV
Limit values for emissions of sulphur from stationary sources

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

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

2. For the purpose of this section "emission limit value" (ELV) means the quantity of SO_2 (or sulphur oxides (SO_x) where mentioned as such) 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 SO_2 (SO_x, expressed as SO_2) 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 waste 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, shut-down and maintenance of equipment are excluded.

3. Compliance with ELVs, minimum desulphurization rates, sulphur recovery rates and sulphur content limit values shall be verified

(a) Emissions shall be monitored through measurements or through calculations achieving at least the same accuracy. Compliance with ELVs shall be verified through continuous or discontinuous measurements, type approval, or any other technically sound method including verified calculation methods. In case of continuous measurements, compliance with the ELV is achieved if the validated monthly emission average does not exceed the limit value, unless otherwise specified for the individual source category. In case of discontinuous measurements or other appropriate determination or calculation procedures, compliance with the ELV is achieved if the mean value based on an appropriate number of measurements under representative conditions does not exceed the ELV. The inaccuracy of the measurement methods may be taken into account for verification purposes;

(b) In case of combustion plants applying the minimum rates of desulphurization set out in paragraph 5 (a) (ii), the sulphur content of the fuel shall also be regularly monitored and the competent authorities shall be informed of substantial changes in the type of fuel used. The desulphurization rates shall apply as monthly average values;

(c) Compliance with the minimum sulphur recovery rate shall be verified through regular measurements or any other technically sound method;

(d) Compliance with the sulphur limit values for gas oil shall be verified through regular targeted measurements.

4. Monitoring of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated measuring systems and the reference measurements to calibrate those systems, shall be carried out in accordance with European Committee for Standardization (CEN) standards. If CEN standards are not available, International Organization for Standardization (ISO) standards, national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

5. The following subparagraphs set out special provisions for combustion plants referred to in paragraph 7:

(a) A Party may derogate from the obligation to comply with the emission limit values provided for in paragraph 7 in the following cases:

    (i) For a combustion plant which to this end normally uses low-sulphur fuel, in cases where the operator is unable to comply with those limit values because of an interruption in the supply of low-sulphur fuel resulting from a serious shortage;

(ii) For a combustion plant firing indigenous solid fuel, which cannot comply with the emission limit values provided for in paragraph 7, instead at least the following limit values for the rates of desulphurization have to be met:

a. Existing plants: 50 MW_{th}-100 MW_{th}: 80%;

b. Existing plants: 100 MW_{th}-300 MW_{th}: 90%;

c. Existing plants: > 300 MW_{th}: 95%;

d. New plants: 50 MW_{th}-300 MW_{th}: 93%;

e. New plants: > 300 MW_{th}: 97%;

(iii) For combustion plants normally using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility;

(iv) For existing combustion plants not operated more than 17,500 operating hours, starting from 1 January 2016 and ending no later than 31 December 2023;

(v) For existing combustion plants using solid or liquid fuels not operated more than 1,500 operating hours per year as a rolling average over a period of five years, instead the following ELVs apply:

a. For solid fuels: 800 mg/m^3;

b. For liquid fuels: 850 mg/m^3 for plants with a rated thermal input not exceeding 300 MW_{th} and 400 mg/m^3 for plants with a rated thermal input greater than 300 MW_{th};

(b) Where a combustion plant is extended by at least 50 MW_{th}, the ELV specified in paragraph 7 for new installations shall apply to the extensional part affected by the change. The ELV is calculated as an average weighted by the actual thermal input for both the existing and the new part of the plant;

(c) Parties shall ensure that provisions are made for procedures relating to malfunction or breakdown of the abatement equipment;

(d) In the case of a multi-fuel firing combustion plant involving the simultaneous use of two or more fuels, the ELV shall be determined as the weighted average of the ELVs for the individual fuels, on the basis of the thermal input delivered by each fuel.

6. Parties may apply rules by which combustion plants and process plants within a mineral oil refinery may be exempted from compliance with the individual SO_2 limit values set out in this annex, provided that they are complying with a bubble SO_2 limit value determined on the basis of the best available techniques.

7. Combustion plants with a rated thermal input exceeding 50 MW_{th}:[1]

Table 1
Limit values for SO2 emissions from combustion plants[a]

Fuel type	Thermal input (MW_{th})	ELV for SO2 mg/m^3 [b]
Solid fuels	50–100	New plants: 400 (coal, lignite and other solid fuels) 300 (peat) 200 (biomass)
		Existing plants: 400 (coal, lignite and other solid fuels) 300 (peat) 200 (biomass)
	100–300	New plants: 200 (coal, lignite and other solid fuels) 300 (peat) 200 (biomass)
		Existing plants: 250 (coal, lignite and other solid fuels) 300 (peat) 200 (biomass)
	>300	New plants: 150 (coal, lignite and other solid fuels) (FBC: 200) 150 (peat) (FBC: 200) 150 (biomass)
		Existing plants: 200 (coal, lignite and other solid fuels) 200 (peat) 200 (biomass)
Liquid fuels	50–100	New plants: 350
		Existing plants: 350
	100–300	New plants: 200
		Existing plants: 250
	>300	New plants: 150
		Existing plants: 200
Gaseous fuels in general	>50	New plants: 35
		Existing plants: 35
Liquefied gas	>50	New plants: 5
		Existing plants: 5
Coke oven gas or blast furnace gas	>50	New plants: 200 for blast furnace gas 400 for coke oven gas
		Existing plants: 200 for blast furnace gas 400 for coke oven gas
Gasified refinery residues	> 50	New plants: 35
		Existing plants: 800

Note: FBC = fluidized bed combustion (circulating, pressurized, bubbling).

[a] In particular, the ELVs shall not apply to:

- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials.
- Post-combustion plants designed to purify the waste gases by combustion which are not operated as independent combustion plants.
- 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.
- Recovery boilers within installations for the production of pulp.
- Waste incinerators and
- Plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

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

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[1] The rated thermal input of the combustion plant is calculated as the sum of the input of all units connected to a common stack. Individual units below 15 MW_{th} shall not be considered when calculating the total rated thermal input.

8. Gas oil:

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

	Sulphur content (per cent by weight)
Gas oil	< 0.10

[a] “Gas oil” means any petroleum-derived liquid fuel, excluding marine fuel, falling within CN code 2710 19 25, 2710 19 29, 2710 19 45 or 2710 19 49, or any petroleum-derived liquid fuel, excluding marine fuel, of which less than 65% by volume (including losses) distils at 250°C and of which at least 85% by volume (including losses) distils at 350°C by the ASTM D86 method. Diesel fuels, i.e., gas oils falling within CN code 2710 19 41 and used for self-propelling vehicles, are excluded from this definition. Fuels used in non-road mobile machinery and agricultural tractors are also excluded from this definition.

9. Mineral oil and gas refineries:

Sulphur recovery units: for plants that produce more than 50 Mg of sulphur a day:

Table 3
Limit value expressed as a minimum sulphur recovery rate of sulphur recovery units

Plant type	Minimum sulphur recovery rate[a] (%)
New plant	99.5
Existing plant	98.5

[a] The sulphur recovery rate is the percentage of the imported hydrogen sulphide (H_2S) converted to elemental sulphur as a yearly average.

10. Titanium dioxide production:

Table 4
Limit values for SO_x emissions released from titanium dioxide production (annual average)

Plant type	ELV for SO_x (expressed as SO_2) (kg/t of TiO_2)
Sulphate process, total emission	6
Chloride process, total emission	1.7

B. Canada

11. Limit values for controlling emissions of sulphur oxides will be determined for stationary sources, as appropriate, taking into account information on available control technologies, limit values applied in other jurisdictions, and the documents below:

(a) Order Adding Toxic Substances to Schedule 1 to the Canadian Environmental Act, 1999. SOR/2011-34;

(b) Proposed Regulation, Order Adding Toxic Substances to Schedule 1 to the Canadian Environmental Protection Act, 1999;

(c) New Source Emission Guidelines for Thermal Electricity Generation;

(d) National Emission Guidelines for Stationary Combustion Turbines. PN1072; and

(e) Operating and Emission Guidelines for Municipal Solid Waste Incinerators. PN1085.

C. United States of America

12. Limit values for controlling emissions of sulphur dioxide from stationary sources in the following stationary source categories, and the sources to which they apply, 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 and Subpart Ja;

(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;

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

(l) Stationary Combustion Turbines — 40 C.F.R. Part 60, Subpart KKKK;

(m) Small Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart AAAA;

(n) Commercial and Industrial Solid Waste Combustors — 40 C.F.R. Part 60, Subpart CCCC; and

(o) Other Solid Waste Combustors — 40 C.F.R. Part 60, Subpart EEEE.

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 this section "emission limit value" (ELV) means the quantity of NO_x (sum of NO and NO_2, expressed as NO_2) 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 NO_x 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 waste 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, shut-down and maintenance of equipment are excluded.

3. Emissions shall be monitored in all cases via measurements of NO_x or through calculations or a combination of both achieving at least the same accuracy. Compliance with ELVs shall be verified through continuous or discontinuous measurements, type approval, or any other technically sound method including verified calculation methods. In case of continuous measurements, compliance with the ELVs is achieved if the validated monthly emission average does not exceed the limit values. In case of discontinuous measurements or other appropriate determination or calculation procedures, compliance with the ELVs is achieved if the mean value based on an appropriate number of measurements under representative conditions does not exceed the ELV. The inaccuracy of the measurement methods may be taken into account for verification purposes.

4. Monitoring of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated measuring systems and the reference measurements to calibrate those systems, shall be carried out in accordance with CEN standards. If CEN standards are not available, ISO standards or national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

5. Special provisions for combustion plants referred to in paragraph 6:

(a) A Party may derogate from the obligation to comply with the ELVs provided for in paragraph 6 in the following cases:

- (i) For combustion plants normally using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility;
- (ii) For existing combustion plants not operated more than 17,500 operating hours, starting from 1 January 2016 and ending no later than 31 December 2023; or
- (iii) For existing combustion plants other than onshore gas turbines (covered by paragraph 7) using solid or liquid fuels not operated more than 1,500 operating hours per year as a rolling average over a period of five years, instead the following ELVs apply:
  - a. For solid fuels: 450 mg/m^3;
  - b. For liquid fuels: 450 mg/m^3;

(b) Where a combustion plant is extended by at least 50 MW_{th}, the ELV specified in paragraph 6 for new installations shall apply to the extensional part affected by the change. The ELV is calculated as an average weighted by the actual thermal input for both the existing and the new part of the plant;

(c) Parties shall ensure that provisions are made for procedures relating to malfunction or breakdown of the abatement equipment;

(d) In the case of a multi-fuel firing combustion plant involving the simultaneous use of two or more fuels, the ELV shall be determined as the weighted average of the ELVs for the individual fuels, on the basis of the thermal input delivered by each fuel. Parties may apply rules by which combustion plants and process plants within a mineral oil refinery may be exempted from compliance with the individual NO_x limit values set out in this annex, provided that they are complying with a bubble NO_x limit value determined on the basis of the best available techniques.

6. Combustion plants with a rated thermal input exceeding 50 MW_{th}:[2]

Table 1
Limit values for NO_x emissions released from combustion plants[a]

Fuel type	Thermal input (MW_{th})	ELV for NO_x (mg/m^3)[b]
Solid fuels	50–100	New plants: 300 (coal, lignite and other solid fuels) 450 (pulverized lignite) 250 (biomass, peat) Existing plants: 300 (coal, lignite and other solid fuels) 450 (pulverized lignite) 300 (biomass, peat)
	100–300	New plants: 200 (coal, lignite and other solid fuels) 200 (biomass, peat) Existing plants: 200 (coal, lignite and other solid fuels) 250 (biomass, peat)
	>300	New plants: 150 (coal, lignite and other solid fuels) (general) 150 (biomass, peat) 200 (pulverized lignite)
		Existing plants: 200 (coal, lignite and other solid fuels) 200 (biomass, peat)
Liquid fuels	50–100	New plants: 300
		Existing plants: 450
	100–300	New plants: 150
		Existing plants: 200 (general) Existing plants within refineries and chemical installations: 450 (for firing of distillation and conversion residues from crude oil refining for own consumption in combustion plants and for firing liquid production residue as non-commercial fuel)
	>300	New plants: 100
		Existing plants: 150 (general) Existing plants within refineries and chemical installations: 450 (for firing of distillation and conversion residues from crude oil refining for own consumption in combustion plants and for firing liquid production residue as non-commercial fuel (< 500 MW_{th}))

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[2] The rated thermal input of the combustion plant is calculated as the sum of the input of all units connected to a common stack. Individual units below 15 MW_{th} shall not be considered when calculating the total rated input.

Fuel type	Thermal input (MW_{th})	ELV for NO_x (mg/m^3)[b]
Natural gas	50–300	New plants: 100
		Existing plants: 100
	>300	New plants: 100
		Existing plants: 100
Other gaseous fuels	>50	New plants: 200
		Existing plants: 300

[a] In particular, the ELVs shall not apply to:
- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials.
- Post-combustion plants designed to purify the waste gases by combustion which are not operated as independent combustion plants.
- 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.
- Recovery boilers within installations for the production of pulp.
- Waste incinerators and
- Plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

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

7. Onshore combustion turbines with a rated thermal input exceeding 50 MW_{th}: the NO_x ELVs expressed in mg/m^3 (at a reference O_2 content of 15%) are to be applied to a single turbine. The ELVs in table 2 apply only above 70% load.

Table 2

Limit values for NO_x emissions released from onshore combustion turbines (including Combined Cycle Gas Turbine CCGT)

Fuel type	Thermal input (MW_{th})	ELV for NO_x (mg/m^3)[a]
Liquid fuels (light and medium distillates)	> 50	New plants: 50
		Existing plants: 90 (general) 200 (plants operating less than 1,500 hours a year)
Natural gas[b]	> 50	New plants: 50 (general)[d]
		Existing plants: 50 (general)[c, d] 150 (plants operating less than 1,500 hours per year)
Other gases	> 50	New plants: 50
		Existing plants: 120 (general) 200 (plants operating less than 1,500 hours a year)

[a] Gas turbines for emergency use that operate less than 500 hours per year are not covered.

[b] Natural gas is naturally occurring methane with not more than 20% (by volume) of inert gases and other constituents.

[c] 75 mg/m^3 in the following cases, where the efficiency of the gas turbine is determined at ISO base load conditions:
- Gas turbines, used in combined heat and power systems having an overall efficiency greater than 75%.
- Gas turbines used in combined cycle plants having an annual average overall electrical efficiency greater than 55%.
- Gas turbines for mechanical drives.

[d] For single gas turbines not falling into any of the categories mentioned under footnote c, but having an efficiency greater than 35% — determined at ISO base load conditions — the ELV for NO_x shall be $50 \times \eta / 35$ where η is the gas-turbine efficiency at ISO base load conditions expressed as a percentage.

8. Cement production:

Table 3

Limit values for NO_x emissions released from cement clinker production[a]

Plant type	ELV for NO_x (mg/m^3)
General (existing and new installations)	500
Existing lepol and long rotary kilns in which no waste is coincinerated	800

[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. The O_2 reference content is 10%.

9. Stationary engines:

Table 4
Limit values for NO$_x$ emissions released from new stationary engines

Engine type, power, fuel specification	ELV [a,b,c] (mg/m^3)
Gas engines > 1 MW$_{th}$	
Spark ignited (= Otto) engines	95 (enhanced lean burn)
all gaseous fuels	190 (Standard lean burn or rich burn with catalyst)
Dual fuel engines > 1 MW$_{th}$	
In gas mode (all gaseous fuels)	190
In liquid mode (all liquid fuels)[d]	
1 MW$_{th}$–20 MW$_{th}$	225
>20 MW$_{th}$	225
Diesel engines > 5 MW$_{th}$ (compression ignition)	
Slow (< 300 rpm)/medium (300 rpm–1,200 rpm)/ speed	
5 MW$_{th}$–20 MW$_{th}$	
Heavy Fuel Oil (HFO)	225
and bio-oils	190
Light Fuel Oil (LFO) and Natural Gas (NG)	
>20 MW$_{th}$	190
HFO and bio-oils	190
LFO and NG	190
High speed (>1,200 rpm)	

Note: The reference oxygen content is 15%.[3]

[a] These ELVs do not apply to engines running less than 500 hours a year.

[b] Where Selective Catalytic Reduction (SCR) cannot currently be applied for technical and logistical reasons like on remote islands or where the availability of sufficient amounts of high quality fuel cannot be guaranteed, a transition period of 10 years after the entry into force of the present Protocol for a Party may be applied for diesel engines and dual fuel engines during which the following ELVs apply:
- Dual fuel engines: 1,850 mg/m^3 in liquid mode; 380 mg/m^3 in gas mode.
- Diesel engines — Slow (< 300 rpm) and medium (300 rpm–1,200 rpm)/speed: 1,300 mg/m^3 for engines between 5 MW$_{th}$ and 20 MW$_{th}$ and 1,850 mg/m^3 for engines > 20 MW$_{th}$.
- Diesel engines — High speed (> 1,200 rpm): 750 mg/m^3.

[c] Engines running between 500 and 1,500 operational hours per year may be exempted from compliance with these ELVs in case they are applying primary measures to limit NO$_x$ emissions and meet the ELVs set out in footnote b.

[d] A Party may derogate from the obligation to comply with the emission limit values for combustion plants using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility. The exception time period shall not exceed 10 days except where there it is an overriding need to maintain energy supplies.

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[3] The conversion factor from the limit values in the current Protocol (at 5% oxygen content) is 2,66 (16/6). Thus, the limit value of:
- 190 mg/m^3 at 15 % O$_2$ corresponds to 500 mg/m^3 at 5 % O$_2$.
- 95 mg/m^3 at 15 % O$_2$ corresponds to 250 mg/m^3 at 5 % O$_2$.
- 225 mg/m^3 at 15 % O$_2$ corresponds to 600 mg/m^3 at 5 % O$_2$.

10. Iron ore sinter plants:

Table 5
Limit values for NOx emissions released from iron ore sinter plants[a]

Plant type	ELV[b] for NO_x (mg/m^3)
Sinter plants: New installation	400
Sinter plants: Existing installation	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).

[b] As an exemption to paragraph 3, these ELVs should be considered as averaged over a substantial period of time.

11. Nitric acid production:

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

Type of installations	ELV for NO_x (mg/m^3)
New installations	160
Existing installations	190

B. Canada

12. Limit values for controlling emissions of NO_x will be determined for stationary sources, as appropriate, taking into account information on available control technologies, limit values applied in other jurisdictions, and the documents below:

(a) New Source Emission Guidelines for Thermal Electricity Generation;

(b) National Emission Guidelines for Stationary Combustion Turbines. PN1072;

(c) National Emission Guidelines for Cement Kilns. PN1284;

(d) National Emission Guidelines for Industrial/Commercial Boilers and Heaters. PN1286;

(e) Operating and Emission Guidelines for Municipal Solid Waste Incinerators. PN1085;

(f) Management Plan for Nitrogen Oxides (NO_x) and Volatile Organic Compounds (VOCs) — Phase I. PN1066; and

(g) Operating and Emission Guidelines for Municipal Solid Waste Incinerators. PN1085.

C. United States of America

13. Limit values for controlling emissions of NO_x from stationary sources in the following stationary source categories, and the sources to which they apply, are specified in the following documents:

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

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

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

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

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

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

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

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

(i) Stationary Internal Combustion Engines — Spark Ignition, 40 C.F.R. Part 60, Subpart JJJJ;

(j) Stationary Internal Combustion Engines — Compression Ignition, 40 C.F.R. Part 60, Subpart IIII;

(k) Stationary Combustion Turbines — 40 C.F.R. Part 60, Subpart KKKK;

(l) Small Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart AAAA;

(m) Portland Cement —40 C.F.R. Part 60, Subpart F;

(n) Commercial and Industrial Solid Waste Combustors — 40 C.F.R. Part 60, Subpart CCCC; and

(o) Other Solid Waste Combustors — 40 C.F.R. Part 60, Subpart EEEE.

Annex VI

Limit values for emissions of volatile organic compounds from stationary sources

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

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

2. This section of the present annex covers the stationary sources of VOC emissions listed in paragraphs 8 to 22 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, including vehicle refuelling at service stations;

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

(c) "Wood and plastic lamination" means any activity to adhere together wood and/or plastic to produce laminated products;

(d) "Coating activity" means any activity in which a single or multiple application of a continuous film of coating is laid onto:

  (i) New vehicles defined 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;

  (v) Other metallic and plastic surfaces including those of aeroplanes, ships, trains, etc.;

  (vi) Wooden surfaces;

  (vii) Textile, fabric, film and paper surfaces; and

  (viii) Leather;

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

a. M1 vehicles are those used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat;

b. 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;

c. 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;

d. N1 vehicles are those used for the carriage of goods and having a maximum mass not exceeding 3.5 Mg;

e. N2 vehicles are those used for the carriage of goods and having a maximum mass exceeding 3.5 Mg but not exceeding 12 Mg;

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

(e) "Coil coating" means any activity 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 activity 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 activity 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 subactivities:

(i) Flexography: a printing activity 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 activity 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 activity 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 activity: the adhering of two or more flexible materials to produce laminates; and

(vii) Varnishing: an activity 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 activity of mixing, crushing, blending, calendering, extruding and vulcanization of natural or synthetic rubber and additionally activities for the processing of natural or synthetic rubber to derive an end product;

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

(l) "Standard conditions" means a temperature of 273.15 K and a pressure of 101.3 kPa;

(m) "Organic compound" means any compound containing at least the element carbon and one or more of hydrogen, halogens, oxygen, sulphur, phosphorus, silicon or nitrogen, with the exception of carbon oxides and inorganic carbonates and bicarbonates;

(n) "Volatile organic compound" (VOC) means any organic compound as well as the fraction of creosote, having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular conditions of use;

(o) "Organic solvent" means any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw material, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticizer, or as a preservative;

(p) "Waste gases" means the final gaseous discharge containing VOCs 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;

(q) "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;

(r) "Vehicle refinishing" means any industrial or commercial coating activity and associated degreasing activities performing:

(i) 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 the coating of trailers (including semi-trailers);

(ii) Vehicle refinishing, defined as the coating of road vehicles, or part of them, carried out as part of vehicle repair, conservation or decoration outside manufacturing installations, is not covered by this annex. The products used as part of this activity are considered in annex XI;

(s) “Wood impregnation” means any activity giving a loading of preservative in timber;

(t) “Winding wire coating” means any coating activity of metallic conductors used for winding the coils in transformers and motors, etc.;

(u) “Fugitive emission” means any emission, not in waste gases, of VOCs into air, soil and water as well as, unless otherwise stated, solvents contained in any product; this includes uncaptured emissions of VOCs released to the outside environment via windows, doors, vents and similar openings. Fugitive emissions may be calculated on the basis of a solvent management plan (see appendix I to the present annex);

(v) “Total emission of VOCs” means the sum of fugitive emission of VOCs and emission of VOCs in waste gases;

(w) “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;

(x) “Emission limit value” (ELV) means the maximum quantity of VOC (except methane) emitted from an installation which is not to be exceeded during normal operation. For waste gases, it is expressed in terms of mass of VOC per volume of waste gases (expressed as mg C/m^3 unless specified otherwise), assuming standard conditions for temperature and pressure for dry gas. 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 gases. Emission limit values for waste gases are indicated as ELVc; emission limit values for fugitive emissions are indicated as ELVf;

(y) “Normal operation” means all periods of operation except start-up and shut-down operations and maintenance of equipment;

(z) “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:

(aa) “Footwear manufacture” means any activity of producing complete footwear or part of it;

(bb) “Solvent consumption” means the total input of organic solvents into an installation per calendar year, or any other 12-month period, less any VOCs that are recovered for reuse.

4. The following requirements shall be satisfied

(a) Emissions shall be monitored in all cases via measurements or through calculations[4] achieving at least the same accuracy. Compliance with ELVs shall be verified through continuous or discontinuous measurements, type approval, or any other technically sound method. For the emissions in waste gases, in case of continuous measurements, compliance with the ELVs is achieved if the validated daily emission average does not exceed the ELVs. In case of discontinuous measurements or other appropriate determination procedures, compliance with the ELVs is achieved if the average of all the readings or other procedures within one monitoring exercise does not exceed the limit values. The inaccuracy of the measurement methods may be taken into account for verification purposes. The fugitive and total ELVs apply as annual averages;

(b) The concentrations of air pollutants in gas-carrying ducts shall be measured in a representative way. Monitoring of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated systems and the reference measurements to calibrate those systems, shall be carried out in accordance with CEN standards. If CEN standards are not available, ISO standards, national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

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[4] Methods of calculation will be reflected in the guidance adopted by the Executive Body.

5. The following ELVs apply for waste gases containing substances harmful to human health:

(a) 20 mg/m^3 (expressed as the mass sum of individual compounds) for discharges of halogenated VOCs, which are assigned the following risk phrases: "suspected of causing cancer" and/or "suspected of causing genetic defects", 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 VOCs, which are assigned the following risk phrases: "may cause cancer", "may cause genetic defects", "may cause cancer by inhalation", "may damage fertility", "may damage the unborn child", 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 22 where it is demonstrated that for an individual installation compliance with the fugitive emission limit value (ELVf) is not technically and economically feasible, a Party may exempt that installation provided that significant risks to human health or the environment are not expected and that the best available techniques are used.

7. The limit values for VOC emissions for the source categories defined in paragraph 3 shall be as specified in paragraphs 8 to 22 below.

8. Storage and distribution of petrol:

(a) Petrol storage installations at terminals, when above the threshold values mentioned in table 1, must be either:

(i) Fixed-roof tanks, which are connected to a vapour recovery unit meeting the ELVs set out in table 1; or

(ii) Designed with a floating roof, either external or internal, equipped with primary and secondary seals meeting the reduction efficiency set out in table 1;

(b) As a derogation from the above-mentioned requirements, fixed-roof tanks, which were in operation prior to 1 January 1996 and which are not connected to a vapour recovery unit, must be equipped with a primary seal which is achieving a reduction efficiency of 90%.

Table 1
Limit values for VOC emissions from the storage and distribution of petrol, excluding the loading of seagoing ships (stage I)

Activity	Threshold value	ELV or reduction efficiency
Loading and unloading of mobile container at terminals	5,000 m^3 petrol throughput annually	10g VOC/m^3 including methane[a]
Storage installations at terminals	Existing terminals or tank farms with a petrol throughput of 10,000 Mg/year or more New terminals (without thresholds except for terminals located in small remote islands with a throughput less than 5,000 Mg/year)	95 wt-%[b]
Service stations	Petrol throughput larger than 100 m^3/year	0.01wt-% of the throughput[c]

[a] 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.

[b] Reduction efficiency expressed in % compared to a comparable fixed-roof tank with no vapour-containment controls, i.e., with only a vacuum/pressure relief valve.

[c] Vapours displaced by the delivery of petrol into storage installations at service stations and in fixed-roof tanks used for the intermediate storage of vapours must be returned through a vapour-tight connection line to the mobile container delivering the petrol. Loading operations may not take place unless the arrangements are in place and properly functioning. Under these conditions, no additional monitoring of the compliance with the limit value is required.

Table 2
Limit values for VOC emissions for car refuelling at service station (stage II)

Threshold values	Minimum vapour capture efficiency wt-% [a]
New service station if its actual or intended throughput is greater than 500 m^3 per annum Existing service station if its actual or intended throughput is greater than 3,000 m^3 per annum as of 2019 Existing service station if its actual or intended throughput is greater than 500 m^3 per annum and which undergoes a major refurbishment	Equal to or greater than 85 wt-% with a vapour/petrol ratio equal to or greater than 0.95 but less than or equal to 1.05 (v/v)

[a] The capture efficiency of the systems has to be certified by the manufacturer in accordance with relevant technical standards or type approval procedures.

9. Adhesive coating:

Table 3
Limit values for adhesive coating

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Footwear manufacture (solvent consumption > 5 Mg/year)	25[a] g VOC / pair of shoes
Other adhesive coating (solvent consumption 5 Mg/year–15 Mg/year)	ELVc = 50 mg[b] C/m^3 ELVf = 25 wt-% or less of the solvent input *Or* total ELV of 1.2 kg or less of VOC/kg of solid input
Other adhesive coating (solvent consumption 15 Mg/year–200 Mg/year)	ELVc = 50 mg[b] C/m^3 ELVf = 20 wt-% or less of the solvent input *Or* total ELV of 1 kg or less of VOC/kg of solid input
Other adhesive coating (solvent consumption > 200 Mg/year)	ELVc = 50 mg[c] C/m^3 ELVf = 15 wt-% or less of the solvent input *Or* total ELV of 0.8 kg or less of VOC/kg of solid input

[a] Total ELVs are expressed in grams of solvent emitted per pair of complete footwear produced.
[b] If techniques are used which allow reuse of recovered solvent, the limit value shall be 150 mg C/m^3.
[c] If techniques are used which allow reuse of recovered solvent, the limit value shall be 100 mg C/m^3.

10. Wood and plastic lamination:

Table 4
Limit values for wood and plastic lamination

Activity and threshold	ELV for VOC (yearly)
Wood and plastic laminating (solvent consumption > 5 Mg/year)	Total ELV of 30 g VOC/m^2 of final product

11. Coating activities (vehicle coating industry):

Table 5
Limit values for coating activities in the vehicle industry

Activity and threshold	ELV for VOC[a] (yearly for total ELV)
Manufacture of cars (M1, M2) (solvent consumption > 15 Mg/year and ≤ 5,000 coated items a year or > 3,500 chassis built)	90 g VOC/m^2 or 1.5 kg/ body + 70 g/m^2
Manufacture of cars (M1, M2) (solvent consumption 15 Mg/year –200 Mg/year and > 5,000 coated items a year)	*Existing installations*: 60g VOC/m^2 or 1.9 kg/ body + 41 g/m^2 *New installations*: 45 g VOC/m^2 or 1.3 kg/body + 33 g/m^2
Manufacture of cars (M1, M2) (solvent consumption > 200 Mg/year and > 5,000 coated items a year)	35 g VOC/m^2 or 1 kg/body + 26 g/m^2[b]
Manufacture of truck cabins (N1, N2, N3) (solvent consumption > 15 Mg/year and ≤ 5,000 coated items/year)	*Existing installations*: 85 g VOC/m^2 *New installations*: 65 g VOC/m^2
Manufacture of truck cabins (N1, N2, N3) (solvent consumption 15 Mg/year–200 Mg/year and > 5,000 coated items a year)	*Existing installations*: 75 g VOC/m^2 *New installations*: 55 g VOC/m^2
Manufacture of truck cabins (N1, N2, N3) (solvent consumption > 200 Mg/year and > 5,000 coated items a year)	55 g VOC/m^2
Manufacture of trucks and vans (solvent consumption > 15 Mg/year and ≤ 2,500 coated items a year)	*Existing installations*: 120 g VOC/m^2 *New installations*: 90 g VOC/m^2
Manufacture of trucks and vans (solvent consumption 15 Mg/year–200 Mg/year and > 2,500 coated items a year)	*Existing installations*: 90 g VOC/m^2 *New installations*: 70 g VOC/m^2
Manufacture of trucks and vans (solvent consumption > 200 Mg/year and > 2,500 coated items a year)	50 g VOC/m^2
Manufacture of buses (solvent consumption > 15 Mg/year and ≤ 2,000 coated items a year)	*Existing installations*: 290 g VOC/m^2 *New installations*: 210 g VOC/m^2
Manufacture of buses (solvent consumption 15 Mg/year–200 Mg/year and > 2,000 coated items a year)	*Existing installations*: 225 g VOC/m^2 *New installations*: 150 g VOC/m^2
Manufacture of buses (solvent consumption > 200 Mg/year and > 2,000 coated items a year)	150 g VOC/m^2

[a] The total limit values are expressed in terms of mass of organic 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). The total ELVs defined in the table above refer to all process stages carried out at the same installation from electrophoretic coating, or any other kind of coating process through the final wax and polish of top-coating inclusive, as well as solvent used in cleaning of process equipment, including spray booths and other fixed equipment, both during and outside of production time.

[b] For existing plants achieving these levels may entail cross-media effects, high capital costs and long payback periods. Major step decreases in VOC emissions necessitate changing the type of paint system and/or the paint application system and/or the drying system and this usually involves either a new installation or a complete refurbishment of a paint shop and requires significant capital investment.

12. Coating activities (metal, textile, fabric, film, plastic, paper and wooden surfaces coating):

Table 6
Limit values for coating activities in various industrial sectors

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Wood coating (solvent consumption 15 Mg/year–25 Mg/year)	ELVc = 100[a] mg C/m^3 ELVf = 25 wt-% or less of the solvent input *Or* total ELV of 1.6 kg or less of VOC/kg of solid input
Wood coating (solvent consumption 25 Mg/year–200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating ELVf = 20 wt-% or less of the solvent input *Or* total ELV of 1 kg or less of VOC/kg of solid input
Wood coating (solvent consumption > 200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating ELVf = 15 wt-% or less of the solvent input *Or* total ELV of 0.75 kg or less of VOC/kg of solid input
Coating of metal and plastics (solvent consumption 5 Mg/year–15 Mg/year)	ELVc = 100[a, b] mg C/m^3 ELVf = 25[b] wt-% or less of the solvent input *Or* total ELV of 0.6 kg or less of VOC/kg of solid input
Other coating, including textile, fabric film and paper (excluding web screen printing for textiles, see printing) (solvent consumption 5 Mg/year–15 Mg/year)	ELVc = 100[a,b] mg C/m^3 ELVf = 25[b] wt-% or less of the solvent input Or total ELV of 1.6 kg or less of VOC/kg of solid input
Textile, fabric, film and paper coating (excluding web screen printing for textiles, see printing) (solvent consumption > 15 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating[b, c] ELVf = 20[b] wt-% or less of the solvent input *Or* total ELV of 1 kg or less of VOC/kg of solid input
Coating of plastic workpieces (solvent consumption 15 Mg/year–200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating[b] ELVf = 20[b] wt-% or less of the solvent input *Or* total ELV of 0.375 kg or less of VOC/kg of solid input
Coating of plastic workpieces (solvent consumption > 200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating[b] ELVf = 20[b] wt-% or less of the solvent input *Or* total ELV of 0.35 kg or less of VOC/kg of solid input
Coating of metal surfaces (solvent consumption 15 Mg/year–200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating[b] ELVf = 20[b] wt-% or less of the solvent input *Or* total ELV of 0.375 kg or less of VOC/kg of solid input Exception for coatings in contact with food: Total ELV of 0.5825 kg or less of VOC/kg of solid input
Coating of metal surfaces (solvent consumption >200 Mg/year)	ELVc = 50 mg C/m^3 for drying and 75 mg C/m^3 for coating[b] ELVf = 20[b] wt-% or less of the solvent input *Or* total ELV of 0.33 kg or less of VOC/kg of solid input Exception for coatings in contact with food: Total ELV of 0.5825 kg or less of VOC/kg of solid input

[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 is then to be used, unless this option is not technically and economically feasible. In this case, the best available technique is used.

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

13. Coating activities (leather and winding wire coating):

Table 7
Limit values for leather and winding wire coating

Activity and threshold	ELV for VOC (yearly for total ELV)
Leather coating in furnishing and particular leather goods used as small consumer goods like bags, belts, wallets, etc. (solvent consumption > 10 Mg/year)	Total ELV of 150 g/m^2
Other leather coating (solvent consumption 10 Mg/year–25 Mg/year)	Total ELV of 85 g/m^2
Other leather coating (solvent consumption > 25 Mg/year)	Total ELV of 75 g/m^2
Winding wire coating (solvent consumption > 5 Mg/year)	Total ELV of 10 g/kg applies for installations where average diameter of wire ≤ 0,1 mm Total ELV of 5 g/kg applies for all other installations

14. Coating activities (coil coating):

Table 8
Limit values for coil coating

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Existing installation (solvent consumption 25 Mg/year–200 Mg/year)	ELVc = 50 mg[a] C/m^3 ELVf = 10 wt-% or less of the solvent input Or total ELV of 0.45 kg or less of VOC/kg of solid input
Existing installation (solvent consumption > 200 Mg/year)	ELVc = 50 mg[a] C/m^3 ELVf = 10 wt-% or less of the solvent input ***Or*** total ELV of 0.45 kg or less of VOC/kg of solid input
New installation (solvent consumption 25 Mg/year–200 Mg/year)	ELVc = 50 mg C/m^3 [a] ELVf = 5 wt-% or less of the solvent input ***Or*** total ELV of 0.3 kg or less of VOC/kg of solid input
New installation (solvent consumption > 200 Mg/year)	ELVc = 50 mg[a] C/m^3 ELVf = 5 wt-% or less of the solvent input ***Or*** total ELV of 0.3 kg or less of VOC/kg of solid input

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

15. Dry cleaning:

Table 9
Limit values for dry cleaning

Activity	ELV for VOC[a,b] (yearly for total ELV)
New and existing installations	Total ELV of 20 g VOC/kg

[a] Limit value for total emissions of VOCs calculated as mass of emitted VOC per mass of cleaned and dried product.

[b] This emission level can be achieved by using at least type IV machines or more efficient ones.

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

Table 10
Limit values form manufacturing of coatings, varnishes, inks and adhesives

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
New and existing installations with solvent consumption between 100 Mg/year–1,000 Mg/year	ELVc = 150 mg C/m^3 ELVfa = 5 wt-% or less of the solvent input Or total ELV of 5 wt-% or less of the solvent input
New and existing installations with solvent consumption > 1,000 Mg/year	ELVc = 150 mg C/m^3 ELVf[a] = 3 wt-% or less of the solvent input Or total ELV of 3 wt-% or less of the solvent input

[a] The fugitive limit value does not include solvents sold as part of a preparation in a sealed container.

17. Printing activities (flexography, heat-set web offset, publication rotogravure, etc.):

Table 11
Limit values for printing activities

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Heat-set offset (solvent consumption 15 Mg/year–25 Mg/year)	ELVc = 100 mg C/m^3 ELVf = 30 wt-% or less of the solvent input[a]
Heat-set offset (solvent consumption 25 Mg/year–200 Mg/year)	New and existing installations ELVc = 20 mg C/m^3 ELVf = 30 wt-% or less of the solvent input[a]
Heat-set offset (solvent consumption >200 Mg/year)	For new and upgraded presses Total ELV = 10 wt-% or less of the ink consumption[a]
	For existing presses Total ELV = 15 wt-% or less of the ink consumption[a]
Publication gravure (solvent consumption 25 Mg/year–200 Mg/year)	For new installations ELVc = 75 mg C/m^3 ELVf = 10 wt-% or less of the solvent input Or total ELV of 0.6 kg or less of VOC/kg of solid input
	For existing installations ELVc = 75 mg C/m^3 ELVf = 15 wt-% or less of the solvent input Or total ELV of 0.8 kg or less of VOC/kg of solid input
Publication gravure (solvent consumption > 200 Mg/year)	For new installations Total ELV = 5 wt-% or less of the solvent input
	For existing installations Total ELV = 7 wt-% or less of the solvent input
Packaging rotogravure and flexography (solvent consumption 15 Mg/year–25 Mg/year)	ELVc = 100 mg C/m^3 ELVf = 25 wt-% or less of the solvent input Or total ELV of 1.2 kg or less of VOC/kg of solid input

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Packaging rotogravure and flexography (solvent consumption 25 Mg/year–200 Mg/year) and rotary screen printing (solvent consumption > 30 Mg/year)	ELVc = 100 mg C/m^3 ELVf = 20 wt-% or less of the solvent input Or total ELV of 1.0 kg or less of VOC/kg of solid input
Packaging rotogravure and flexography (solvent consumption > 200 Mg/year)	For plants with all machines connected to oxidation: Total ELV = 0.5 kg VOC/kg of solid input For plants with all machines connected to carbon adsorption: Total ELV = 0.6 kg VOC/kg of solid input For existing mixed plants where some existing machines may not be attached to an incinerator or solvent recovery: Emissions from the machines connected to oxidizers or carbon adsorption are below the emission limits of 0.5 or 0.6 kg VOC/kg of solid input respectively. For machines not connected to gas treatment: use of low solvent or solvent free products, connection to waste gas treatment when there is spare capacity and preferentially run high solvent content work on machines connected to waste gas treatment. Total emissions below 1.0 kg VOC/kg of solid input

[a] Residual solvent in the finished product is not taken into account in the calculation of the fugitive emission.

18. Manufacturing of pharmaceutical products:

Table 12
Limit values for manufacturing of pharmaceutical products

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
New installations (solvent consumption > 50 Mg/year)	ELVc = 20 mg C/m$^{3\ a,b}$ ELVf = 5 wt-% or less of the solvent input[b]
Existing installations (solvent consumption > 50 Mg/year)	ELVc = 20 mg C/m$^{3\ a,c}$ ELVf = 15 wt-% or less of the solvent input[c]

[a] If techniques are used which allow reuse of recovered solvents, the limit value shall be 150 mg C/m^3.
[b] A total limit value of 5% of solvent input may be applied instead of applying ELVc and ELVf.
[c] A total limit value of 15% of solvent input may be applied instead of applying ELVc and ELVf.

19. Conversion of natural or synthetic rubber:

Table 13
Limit values for conversion of natural or synthetic rubber

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
New and existing installations: conversion of natural or synthetic rubber (solvent consumption > 15 Mg/year)	ELVc = 20 mgC/m$^{3\ a}$ ELVf = 25 wt-% of the solvent input[b] *Or* total ELV = 25wt-% of solvent input

[a] If techniques are used which allow reuse of recovered solvent, the limit value shall be 150 mg C/m^3.
[b] The fugitive limit does not include solvents sold as part of a preparation in a sealed container.

20. Surface cleaning:

Table 14
Limit values for surface cleaning

Activity and threshold	Threshold value for solvent consumption (Mg/year)	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)	
Surface cleaning using substances mentioned in paragraph 3 (z) (i) of this annex	1–5	ELVc = 20 mg expressed as the mass sum of individual compounds/m^3	ELVf = 15wt-% of solvent input
	> 5	ELVc = 20 mg expressed as the mass sum of individual compounds/m^3	ELVf = 10wt-% of solvent input
Other surface cleaning	2–10	ELVc = 75 mg C/m^3 [a]	ELVf = 20wt-%[a] of solvent input
	> 10	ELVc = 75 mg C/m^3 [a]	ELVf = 15wt-%[a] of solvent input

[a] Installations for which the average organic solvent content of all cleaning material used does not exceed 30 wt-% are exempt from applying these values.

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

Table 15
Limit values for extraction of vegetable and animal fat and refining of vegetable oil

Activity and threshold	ELV for VOC (yearly for total ELV)	
New and existing installations (solvent consumption > 10 Mg/year)	Total ELV (kg VOC/Mg product)	
	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, excluding degumming:[b]	1.5
	Degumming:	4.0

[a] Limit values for total emissions of VOCs from installations treating single batches of seeds or other vegetable material shall be set case by case by a Party on the basis of the best available techniques.
[b] The removal of gum from the oil.

22. Impregnation of wood:

Table 16
Limit values for impregnation of wood

Activity and threshold	ELV for VOC (daily for ELVc and yearly for ELVf and total ELV)
Wood impregnation (solvent consumption 25 Mg/year–200 Mg/year)	ELVc = 100[a] mg C/m^3 ELVf = 45 wt-% or less of the solvent input *Or* 11 kg or less of VOC/m^3
Wood impregnation (solvent consumption > 200 Mg/year)	ELVc = 100[a] mg C/m^3 ELVf = 35 wt-% or less of the solvent input *Or* 9 kg or less of VOC/m^3

[a] Does not apply to impregnation with creosote.

B. Canada

23. Limit values for controlling emissions of VOCs will be determined for stationary sources, as appropriate, taking into account information on available control technologies, limit values applied in other jurisdictions, and the documents below:

(a) VOC Concentration Limits for Architectural Coatings Regulations. SOR/2009–264;

(b) VOC Concentration Limits for Automotive Refinishing roducts. SOR/2009–197;

(c) Proposed regulations for VOC Concentrations Limits for Certain Products;

(d) Guidelines for the Reduction of Ethylene Oxide Releases from Sterilization Applications;

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

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

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

(h) A Plan to Reduce VOC Emissions by 20 Percent from Consumer Surface Coatings. PN1114;

(i) Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks. PN1180;

(j) Environmental Code of Practice for Vapour Recovery during Vehicle Refueling at Service Stations and Other Gasoline Dispersing Facilities. PN1184;

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

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

(m) Environmental Guideline for the Reduction of Volatile Organic Compound Emissions from the Plastics Processing Industry. PN1276;

(n) National Action Plan for the Environmental Control of Ozone-Depleting Substances (ODS) and Their Halocarbon Alternatives. PN1291;

(o) Management Plan for Nitrogen Oxides (NO_x) and Volatile Organic Compounds (VOCs) — Phase I. PN1066;

(p) Environmental Code of Practice for the Reduction of Volatile Organic Compound Emissions from the Commercial/Industrial Printing Industry. PN1301;

(q) Recommended CCME[5] Standards and Guidelines for the Reduction of VOC Emissions from Canadian Industrial Maintenance Coatings. PN1320; and

(r) Guidelines for the Reduction of VOC Emissions in the Wood Furniture Manufacturing Sector. PN1338.

C. United States of America

24. Limit values for controlling emissions of VOCs from stationary sources in the following stationary source categories, and the sources to which they apply, 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;

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

(u) Stationary Internal Combustion Engines — Spark Ignition, 40 C.F.R. Part 60, Subpart JJJJ;

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[5] Canadian Council of Ministers of the Environment.

(v) Stationary Internal Combustion Engines — Compression Ignition, 40 C.F.R. Part 60, Subpart IIII and

(w) New and in-use portable fuel containers — 40 C.F.R. Part 59, Subpart F.

25. Limit values for controlling emissions of VOC from sources subject to National Emission Standards for Hazardous Air Pollutants (HAPs) are specified in the following documents:

(a) Organic HAPs from the Synthetic Organic Chemical Manufacturing Industry — 40 C.F.R. Part 63, Subpart F;

(b) Organic HAPs from the Synthetic Organic Chemical Manufacturing Industry: Process Vents, Storage Vessels, Transfer Operations, and Wastewater — 40 C.F.R. Part 63, Subpart G;

(c) Organic HAPs: Equipment Leaks — 40 C.F.R. Part 63, Subpart H;

(d) Commercial ethylene oxide sterilizers — 40 C.F.R. Part 63, Subpart O;

(e) Bulk gasoline terminals and pipeline breakout stations — 40 C.F.R. Part 63, Subpart R;

(f) Halogenated solvent degreasers — 40 C.F.R. Part 63, Subpart T;

(g) Polymers and resins (Group I) — 40 C.F.R. Part 63, Subpart U;

(h) Polymers and resins (Group II) — 40 C.F.R. Part 63, Subpart W;

(i) Secondary lead smelters — 40 C.F.R. Part 63, Subpart X;

(j) Marine tank vessel loading — 40 C.F.R. Part 63, Subpart Y;

(k) Petroleum refineries — 40 C.F.R. Part 63, Subpart CC;

(l) Offsite waste and recovery operations — 40 C.F.R. Part 63, Subpart DD;

(m) Magnetic tape manufacturing — 40 C.F.R. Part 63, Subpart EE;

(n) Aerospace manufacturing — 40 C.F.R. Part 63, Subpart GG;

(o) Oil and natural gas production — 40 C.F.R. Part 63, Subpart HH;

(p) Ship building and ship repair — 40 C.F.R. Part 63, Subpart II;

(q) Wood furniture — 40 C.F.R. Part 63, Subpart JJ;

(r) Printing and publishing — 40 C.F.R. Part 63, Subpart KK;

(s) Pulp and paper II (combustion) — C.F.R. Part 63, Subpart MM;

(t) Storage tanks — 40 C.F.R. Part 63, Subpart OO;

(u) Containers — 40 C.F.R. Part 63, Subpart PP;

(v) Surface impoundments — 40 C.F.R. Part 63, Subpart QQ;

(w) Individual drain systems — 40 C.F.R. Part 63, Subpart RR;

(x) Closed vent systems — 40 C.F.R. Part 63, Subpart SS;

(y) Equipment leaks: control level 1 — 40 C.F.R. Part 63, Subpart TT;

(z) Equipment leaks: control level 2 — 40 C.F.R. Part 63, Subpart UU;

(aa) Oil-Water Separators and Organic-Water Separators — 40 C.F.R. Part 63, Subpart VV;

(bb) Storage Vessels (Tanks): Control Level 2 — 40 C.F.R. Part 63, Subpart WW;

(cc) Ethylene Manufacturing Process Units — 40 C.F.R. Part 63, Subpart XX;

(dd) Generic Maximum Achievable Control Technology Standards for several categories — 40 C.F.R. Part 63, Subpart YY;

(ee) Hazardous waste combustors — 40 C.F.R. Part 63, Subpart EEE;

(ff) Pharmaceutical manufacturing — 40 C.F.R. Part 63, Subpart GGG;

(gg) Natural Gas Transmission and Storage — 40 C.F.R. Part 63, Subpart HHH;

(hh) Flexible Polyurethane Foam Production — 40 C.F.R. Part 63, Subpart III;

(ii) Polymers and Resins: group IV — 40 C.F.R. Part 63, Subpart JJJ;

(jj) Portland cement manufacturing — 40 C.F.R. Part 63, Subpart LLL;

(kk) Pesticide active ingredient production –— 40 C.F.R. Part 63, Subpart MMM;

(ll) Polymers and resins: group III — 40 C.F.R. Part 63, Subpart OOO;

(mm) Polyether polyols — 40 C.F.R. Part 63, Subpart PPP;

(nn) Secondary aluminum production — 40 C.F.R. Part 63, Subpart RRR;

(oo) Petroleum refineries — 40 C.F.R. Part 63, Subpart UUU;

(pp) Publicly owned treatment works — 40 C.F.R. Part 63, Subpart VVV;

(qq) Nutritional Yeast Manufacturing — 40 C.F.R. Part 63, Subpart CCCC;

(rr) Organic liquids distribution (non-gasoline) — 40 C.F.R. Part 63, Subpart EEEE;

(ss) Miscellaneous organic chemical manufacturing — 40 C.F.R. Part 63, Subpart FFFF;

(tt) Solvent Extraction for Vegetable Oil Production — 40 C.F.R. Part 63, Subpart GGGG;

(uu) Auto and Light Duty Truck Coatings — 40 C.F.R. Part 63, Subpart IIII;

(vv) Paper and Other Web Coating — 40 C.F.R. Part 63, Subpart JJJJ;

(ww) Surface Coatings for Metal Cans — 40 C.F.R. Part 63, Subpart KKKK;

(xx) Miscellaneous Metal Parts and Products Coatings — 40 C.F.R. Part 63, Subpart MMMM;

(yy) Surface Coatings for Large Appliances — 40 C.F.R. Part 63, Subpart NNNN;

(zz) Printing, Coating and Dyeing of Fabric — 40 C.F.R. Part 63, Subpart OOOO;

(aaa) Surface Coating of Plastic Parts and Products — 40 C.F.R. Part 63, Subpart PPPP;

(bbb) Surface Coating of Wood Building Products — 40 C.F.R. Part 63, Subpart QQQQ;

(ccc) Metal Furniture Surface Coating — 40 C.F.R. Part 63, Subpart RRRR;

(ddd) Surface coating for metal coil — 40 C.F.R. Part 63, Subpart SSSS;

(eee) Leather finishing operations — 40 C.F.R. Part 63, Subpart TTTT;

(fff) Cellulose products manufacturing — 40 C.F.R. Part 63, Subpart UUUU;

(ggg) Boat manufacturing — 40 C.F.R. Part 63, Subpart VVVV;

(hhh) Reinforced Plastics and Composites Production — 40 C.F.R. Part 63, Subpart WWWW;

(iii) Rubber tire manufacturing — 40 C.F.R. Part 63, Subpart XXXX;

(jjj) Stationary Combustion Engines — 40 C.F.R. Part 63, Subpart YYYY;

(kkk) Stationary Reciprocating Internal Combustion Engines: Compression Ignition — 40 C.F.R. Part 63, Subpart ZZZZ;

(lll) Semiconductor manufacturing — 40 C.F.R. Part 63, Subpart BBBBB;

(mmm) Iron and steel foundries — 40 C.F.R. Part 63, Subpart EEEEE;

(nnn) Integrated iron and steel manufacturing — 40 C.F.R. Part 63, Subpart FFFFF;

(ooo) Asphalt Processing and Roofing anufacturing — 40 C.F.R. Part 63, Subpart LLLLL;

(ppp) Flexible Polyurethane Foam Fabrication — 40 C.F.R. Part 63, Subpart MMMMM;

(qqq) Engine test cells/stands — 40 C.F.R. Part 63, Subpart PPPPP;

(rrr) Friction products manufacturing — 40 C.F.R. Part 63, Subpart QQQQQ;

(sss) Refractory products manufacturing — 40 C.F.R. Part 63, Subpart SSSSS;

(ttt) Hospital ethylene oxide sterilizers — 40 C.F.R. Part 63, Subpart WWWWW;

(uuu) Gasoline Distribution Bulk Terminals, Bulk Plants, and Pipeline Facilities — 40 C.F.R. Part 63, Subpart BBBBBB;

(vvv) Gasoline Dispensing Facilities — 40 C.F.R. Part 63, Subpart CCCCCC;

(www) Paint Stripping and Miscellaneous Surface Coating Operations at Area Sources — 40 C.F.R. Part 63, Subpart HHHHHH;

(xxx) Acrylic Fibers/Modacrylic Fibers Production (Area Sources) — 40 C.F.R. Part 63, Subpart LLLLLL;

(yyy) Carbon Black Production (Area Sources) — 40 C.F.R. Part 63, Subpart MMMMMM;

(zzz) Chemical Manufacturing Area Sources: Chromium Compounds — 40 C.F.R. Part 63, Subpart NNNNNN;

(aaaa) Chemical Manufacturing for Area Sources — 40 C.F.R. Part 63, Subpart VVVVVV;

(bbbb) Asphalt Processing and Roofing Manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart AAAAAAA; and

(cccc) Paints and Allied Products Manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart CCCCCCC.

Appendix

Solvent management plan

I. Introduction

1. This appendix to the annex on limit values for emissions of VOCs 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).

II. 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.

III. Definitions

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

    (a) Inputs of organic solvents:

    (i) 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;

    (ii) 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:

    (i) O1. Emission of VOCs in waste gases;

    (ii) O2. Organic solvents lost in water, if appropriate taking into account wastewater treatment when calculating O5;

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

    (iv) 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;

    (v) 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 wastewater, or captured, e.g., by adsorption, as long as they are not counted under O6, O7 or O8);

    (vi) O6. Organic solvents contained in collected waste;

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

(viii) 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;

(ix) O9. Organic solvents released in other ways.

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

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

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

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

$$C = I1 - O8$$

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

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

$$E = F + O1$$

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

(b) Determination of fugitive emission of VOCs for comparison with fugitive emission values in the annex:

(i) Methodology: The fugitive emission of VOC 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 VOCs can be determined by a short but comprehensive set of measurements. This need not to be done again until the equipment is modified.

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, one year after the date of entry into force of the present Protocol for the Party in question or 31 December 2020, whichever is the later.

2. The timescales for the application of the limit values for fuels and new mobile sources referred to in article 3, paragraph 5, shall be the date of entry into force of the present Protocol for the Party in question or the dates associated with the measures specified in annex VIII, whichever is the later.

3. The timescales for the application of the limit values for VOCs in products referred to in article 3, paragraph 7, shall be one year after the date of entry into force of the present Protocol for the Party in question.

4. Notwithstanding paragraphs 1, 2 and 3, but subject to paragraph 5, a Party to the Convention that becomes a Party to the present Protocol between 1 January 2013 and 31 December 2019 may declare upon ratification, acceptance, approval of, or accession to, the present Protocol that it will extend any or all of the timescales for application of the limit values referred to in article 3, paragraphs 2, 3, 5 and 7, as follows:

(a) For existing stationary sources, up to 15 years after the date of entry into force of the present Protocol for the Party in question;

(b) For fuels and new mobile sources, up to 5 years after the date of entry into force of the present Protocol for the Party in question; and

(c) For VOCs in products, up to 5 years after the date of entry into force of the present Protocol for the Party in question.

5. A Party that has made an election pursuant to article 3 bis of the present Protocol with respect to annex VI and/or VIII may not also make a declaration pursuant to paragraph 4 applicable to the same annex.

Annex VIII

Limit values for fuels and new mobile sources

I. 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. This annex specifies emission limit values for NO_x, expressed as nitrogen dioxide (NO_2) equivalents, for hydrocarbons, most of which are volatile organic compounds, for carbon monoxide (CO) and for particulate matter as well as environmental specifications for marketed fuels for vehicles.

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

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

Passenger cars and light-duty vehicles

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

Heavy-duty vehicles

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

Compression-ignition (CI) and spark-ignition (SI) non-road vehicles and machines

6. Limit values for agricultural and forestry tractors and other non-road vehicle/ machine engines are listed in tables 4 to 6.

7. Limit values for locomotives and railcars are listed in tables 7 and 8.

8. Limit values for inland waterway vessels are listed in table 9.

9. Limit values for recreational crafts are listed in table 10.

Motorcycles and mopeds

10. Limit values for motorcycles and mopeds are given in tables 11 and 12.

Fuel quality

11. Environmental quality specifications for petrol and diesel are given in tables 13 and 14.

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

			Limit values[a]													
Category	Class, application date*	Reference mass (RW) (kg)	Carbon monoxide L1 (g/km)		Total Hydrocarbons (HC) L2 (g/km)		Non-methane volatile organic compound (NMVOC) L3 (g/km)		Nitrogen oxides L4 (g/km)		Hydrocarbons and nitrogen oxides combined L2 + L4 (g/km)		Particulate matter L5 (g/km)		Number of particles[a] (P) L6(#/km)	
			Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel
Euro 5																
M[b]	1.1. 2014	All	1.0	0.50	0.10	–	0.068	–	0.06	0.18	–	0.23	0.0050	0.0050	–	6.0x1011
N_1[c]	I, 1.1.2014	RW 1305	1.0	0.50	0.10	–	0.068	–	0.06	0.18	–	0.23	0.0050	0.0050	–	6.0x1011
	II, 1.1.2014	1305 < RW≤ 1760	1.81	0.63	0.13	–	0.090	–	0.075	0.235	–	0.295	0.0050	0.0050	–	6.0x1011
	III, 1.1.2014	1760 < RW	2.27	0.74	0.16	–	0.108	–	0.082	0.28	–	0.35	0.0050	0.0050	–	6.0x1011
N_2	1.1.2014		2.27	0.74	0.16	–	0.108	–	0.082	0.28	–	0.35	0.0050	0.0050	–	6.0x1011
Euro 6																
M[b]	1.9.2015	All	1.0	0.50	0.10		0.068	–	0.06	0.08	–	0.17	0.0045	0.0045	6.0x1011	6.0x1011
N_1[c]	I, 1.9.2015	RW ≤1305	1.0	0.50	0.10	–	0.068	–	0.06	0.08	–	0.17	0.0045	0.0045	6.0x1011	6.0x1011
	II, 1.9.2016	1305 < RW≤ 1760	1.81	0.63	0.13	–	0.090	–	0.075	0.105	–	0.195	0.0045	0.0045	6.0x1011	6.0x1011
	III, 1.9.2016	1760 < RW	2.27	0.74	0.16	–	0.108	–	0.082	0.125	–	0.215	0.0045	0.0045	6.0x1011	6.0x1011
N_2	1.9.2016		2.27	0.74	0.16	–	0.108	–	0.082	0.125	–	0.215	0.0045	0.0045	6.0x1011	6.0x1011

* The registration, sale and entry into service of new vehicles that fail to comply with the respective limit values shall be refused as from the dates given in the column.

[a] Test cycle specified by NEDC

[b] Except vehicles whose maximum mass exceeds 2,500 kg.

[c] And those category M vehicles specified in note b.

Table 2
Limit values for heavy-duty vehicles steady-state cycle load-response tests

	Application date	Carbon monoxide (g/kWh)	Hydro-carbons (g/kWh)	Total hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)	Smoke (m^{-1})
B2 (“EURO V”)[a]	1.10.2009	1.5	0.46	–	2.0	0.02	0.5
“EURO VI”[b]	31.12.2013	1.5	–	0.13	0.40	0.010	–

[a] Test cycle specified by the European steady-state cycle (ESC) and the European load-response (ELR) tests.
[b] Test cycle specified by the world heavy duty steady state cycle (WHSC).

Table 3
Limit values for heavy-duty vehicles — transient cycle tests

	Application date*	Carbon monoxide (g/kWh)	Total hydro-carbons (g/kWh)	Non-methane hydrocarbons (g/kWh)	Methane[a] (g/kWh)	Nitrogen oxides (g/kWh)	Particulates (g/kWh)[b]
B2 “EURO V”[c]	1.10.2009	4.0	–	0.55	1.1	2.0	0.030
“EURO VI” (CI)[d]	31.12.2013	4.0	0.160	–	–	0.46	0.010
“EURO VI” (PI)[d]	31.12.2013	4.0	–	0.160	0.50	0.46	0.010

Note: PI = Positive ignition, CI = Compression ignition.
* The registration, sale and entry into service of new vehicles that fail to comply with the respective limit values shall be refused as from the dates given in the column.
[a] For natural gas engines only.
[b] Not applicable to gas-fuelled engines at stage B2.
[c] Test cycle specified by the European transient cycle (ETC) test.
[d] Test cycle specified by the world heavy duty transient cycle (WHTC).

Table 4
Limit values for diesel engines for non-road mobile machines, agricultural and forestry tractors (stage IIIB)

Net power (P) (kW)	Application date*	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
$130 \leq P \leq 560$	31.12.2010	3.5	0.19	2.0	0.025
$75 \leq P < 130$	31.12.2011	5.0	0.19	3.3	0.025
$56 \leq P < 75$	31.12.2011	5.0	0.19	3.3	0.025
$37 \leq P < 56$	31.12.2012	5.0	4.7[a]	4.7[a]	0.025

* 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.
[a] Editor’s note: This figure represents the sum of hydrocarbons and nitrogen oxides and was reflected in the final approved text by a single figure in a merged cell in the table. As this text does not include tables with dividing lines, the figure is repeated in each column for clarity.

Table 5
Limit values for diesel engines for non-road mobile machines, agricultural and forestry tractors (stage IV)

Net power (P) (kW)	Application date*	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
130 ≤ P ≤ 560	31.12.2013	3.5	0.19	0.4	0.025
56 ≤ P < 130	31.12.2014	5.0	0.19	0.4	0.025

* 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.

Table 6
Limit values for spark-ignition engines for non-road mobile machines

Hand-held engines		
Displacement (cm^3)	*Carbon monoxide (g/kWh)*	*Sum of hydrocarbons and oxides of nitrogen (g/kWh)*[a]
Disp < 20	805	50
20 ≤ disp. < 50	805	50
Disp ≥ 50	603	72
Non-hand-held engines		
Displacement(cm^3)	*Carbon monoxide (g/kWh)*	*Sum of hydrocarbons and oxides of nitrogen (g/kWh)*
Disp < 66	610	50
66 ≤ disp. < 100	610	40
100 ≤ disp. < 225	610	16.1
Disp ≥ 225	610	12.1

Note: 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.

[a] The NO_x emissions for all engine classes must not exceed 10 g/kWh.

Table 7
Limit values for engines used for propulsion of locomotives

Net power (P) (kW)	Carbon monoxide (g/kWh)	Hydrocarbons (g/kWh)	Nitrogen oxides (g/kWh)	Particulate matter (g/kWh)
130 < P	3.5	0.19	2.0	0.025

Note: 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.

Table 8
Limit values for engines used for propulsion of railcars

Net power (P) (kW)	Carbon monoxide (g/kWh)	Sum of hydrocarbons and oxides of nitrogen (g/kWh)	Particulate matter (g/kWh)
130 < P	3.5	4.0	0.025

Table 9
Limit values for engines for propulsion of inland waterways vessels

Displacement (litres per cylinder/kW)	Carbon monoxide (g/kWh)	Sum of hydrocarbons and oxides of nitrogen (g/kWh)	Particulate matter (g/kWh)
Disp. < 0.9 Power ≥ 37 kW	5.0	7.5	0.4
0.9 ≤ disp. < 1.2	5.0	7.2	0.3
1.2 ≤ disp. < 2.5	5.0	7.2	0.2
2.5 ≤ disp. < 5.0	5.0	7.2	0.2
5.0 ≤ disp. < 15	5.0	7.8	0.27
15 ≤ disp. < 20 Power < 3300 kW	5.0	8.7	0.5
15 ≤ disp. < 20 Power > 3300 kW	5.0	9.8	0.5
20 ≤ disp. < 25	5.0	9.8	0.5
25 ≤ disp. < 30	5.0	11.0	0.5

Note: 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.

Table 10
Limit values for engines in recreational crafts

Engine type	CO (g/kWh) CO = A +B/P^n_N			Hydrocarbons (HC) (g/kWh) HC = A +B/P $^n{}_N{}^a$			NO_x g/kWh	PM g/kWh
	A	B	n	A	B	n		
2-stroke	150	600	1	30	100	0.75	10	Not Appl.
4-stroke	150	600	1	6	50	0.75	15	Not Appl.
CI	5	0	0	1.5	2	0.5	9.8	1

Abbreviations: Not Appl. = Not Applicable.
Note: 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 the placing on the market of new engines, whether or not installed in machinery, only if they meet the respective limit values set out in the table.

[a] Where A, B and n are constants and P_N is the rate engine power in kW and the emissions are measured in accordance with the harmonized standards.

Table 11
Limit values for motorcycles (> 50 cm^3; > 45 km/h)

Engine size	Limit values
Motorcycle < 150 cc	Hydrocarbons (HC) = 0.8 g/km NO_x = 0.15 g/km
Motorcycle > 150 cc	HC = 0.3 g/km NO_x = 0.15 g/km

Note: With the exception of vehicles intended for export to countries that are not Parties to the present Protocol, Parties shall permit the registration, where applicable, and the placing on the market only if they meet the respective limit values set out in the table.

Table 12
Limit values for mopeds (<50 cm^3; < 45 km/h)

CO (g/km)	Hydrocarbons (HC) + NO_x (g/km)
1.0[a]	1.2

Note: With the exception of vehicles intended for export to countries that are not Parties to the present Protocol, Parties shall permit the registration, where applicable, and the placing on the market only if they meet the respective limit values set out in the table.

[a] For 3- and 4-wheelers, 3.5 g/km.

Table 13
Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines

Type: Petrol

Parameter	Unit	Limits	
		Minimum	Maximum
Research octane number	–	95	–
Motor octane number	–	85	–
Reid vapour pressure, summer period[a]	kPa	–	60
Distillation:			
Evaporated at 100°C	% v/v	46	–
Evaporated at 150°C	% v/v	75	–
Hydrocarbon analysis:			
Olefins	% v/v	–	18.0[b]
Aromatics	–	–	35
Benzene	–	–	1
Oxygen content	% m/m	–	3.7
Oxygenates:			
Methanol, stabilizing agents must be added	% v/v	–	3
Ethanol, stabilizing agents may be necessary	% v/v	–	10

Parameter	Unit	Limits	
		Minimum	Maximum
Parameter:			
Iso-propyl alcohol	% v/v	–	12
Tert-butyl alcohol	% v/v	–	15
Iso-butyl alcohol	% v/v	–	15
Ethers containing 5 or more carbon atoms per molecule	% v/v	–	22
Other oxygenates[c]	% v/v	–	15
Sulphur content	mg/kg	–	10

[a] The summer period shall begin no later than 1 May and shall not end before 30 September. For Parties with arctic conditions the summer period shall begin no later than 1 June and not end before 31 August and the Reid Vapour Pressure (RVP) is limited to 70 kPa.

[b] 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 Party of another unleaded petrol with lower octane numbers than set out here.

[c] 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.

Table 14
Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines

Type: Diesel fuel

Parameter	Unit	Limits	
		Minimum	Maximum
Cetane number	–	51	–
Density at 15°C	kg/m^3	–	845
Distillation point: 95%	°C	–	360
Polycyclic aromatic hydrocarbons	% m/m	–	8
Sulphur content	mg/kg	–	10

B. Canada

12. Limit values for controlling emissions from fuels and mobile sources will be determined, as appropriate, taking into account information on available control technologies, limit values applied in other jurisdictions, and the documents below:

(a) Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations. SOR/2010–201;

(b) Marine Spark-Ignition Engine, Vessel and Off-road Recreational Vehicle Emission Regulations. SOR/2011–10;

(c) Renewable Fuels Regulations. SOR/2010–189;

(d) Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals. SOR/2007–86;

(e) Off-road Compression-Ignition Engine Emission Regulations. SOR/2005–32;

(f) On-Road Vehicle and Engine Emission Regulations. SOR/2003–2;

(g) Off-Road Small Spark-Ignition Engine Emission Regulations. SOR/2003–355;

(h) Sulphur in Diesel Fuel Regulations. SOR/2002–254;

(i) Gasoline and Gasoline Blend Dispensing Flow Rate Regulations. SOR/2000–43;

(j) Sulphur in Gasoline Regulations. SOR/99–236;

(k) Benzene in Gasoline Regulations. SOR/97–493;

(l) Gasoline Regulations. SOR/90–247;

(m) Federal Mobile PCB Treatment and Destruction Regulations. SOR/90–5;

(n) Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products;

(o) Canada-Wide Standards for Benzene, Phase 2;

(p) Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks. PN 1180;

(q) Environmental Code of Practice for Vapour Recovery in Gasoline Distribution Networks. PN 1057;

(r) Environmental Code of Practice for Light Duty Motor Vehicle Emission Inspection and Maintenance Programs — 2nd Edition. PN 1293;

(s) Joint Initial Actions to Reduce Pollutant Emissions that Contribute to Particulate Matter and Ground-level Ozone; and

(t) Operating and Emission Guidelines for Municipal Solid Waste Incinerators. PN 1085.

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) Registration of fuels and fuel additives — 40 C.F.R Part 79;

(b) Regulation of fuels and fuel additives — 40 C.F.R Part 80, including: Subpart A — general provisions; Subpart B — controls and prohibitions; Subpart D — reformulated gasoline; Subpart H — gasoline sulphur standards; Subpart I — motor vehicle diesel fuel; non-road, locomotive, and marine diesel fuel; and ECA marine fuel; Subpart L — gasoline benzene; and

(c) Control of emissions from new and in-use highway vehicles and engines — 40 C.F.R Part 85 and Part 86.

14. Standards for non-road engines and vehicles are specified in the ollowing documents:

(a) Fuel sulphur standards for non-road diesel engines — 40 C.F.R Part 80, Subpart I;

(b) Aircraft engines — 40 C.F.R Part 87;

(c) Exhaust emission standards for non-road diesel engines — Tier 2 and 3; 40 C.F.R Part 89;

(d) Non-road compression-ignition engines — 40 C.F.R Part 89 and Part 1039;

(e) Non-road and marine spark-ignition engines — 40 C.F.R Part 90, Part 91, Part 1045, and Part 1054;

(f) Locomotives — 40 C.F.R Part 92 and Part 1033;

(g) Marine compression-ignition engines — 40 C.F.R Part 94 and Part 1042;

(h) New large non-road spark-ignition engines — 40 C.F.R Part 1048;

(i) Recreational engines and vehicles — 40 C.F.R Part 1051;

(j) Control of evaporative emissions from new and in-use non-road and stationary equipment — 40 C.F.R. Part 1060;

(k) Engine testing procedures — 40 C.F.R Part 1065; and

(l) General compliance provisions for non-road programs — 40 C.F.R Part 1068.

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.

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. [6]

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. [6]

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.[6] Applicability may be limited for animal welfare reasons, for instance in straw-based systems for pigs and aviary and free-range systems for poultry.

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[6] 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).

Annex X
Limit values for emissions of particulate matter 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. In this section only, "dust" and "total suspended particulate matter" (TSP) means the mass of particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions.

3. For the purpose of this section, "emission limit value" (ELV) means the quantity of dust and/or TSP 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 waste 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, shut-down and maintenance of equipment are excluded.

4. Emissions shall be monitored in all cases via measurements or through calculations achieving at least the same accuracy. Compliance with limit values shall be verified through continuous or discontinuous measurements, type approval, or any other technically sound method including verified calculation methods. In case of continuous measurements, compliance with the limit value is achieved if the validated monthly emission average does not exceed the ELV. In case of discontinuous measurements or other appropriate determination or calculation procedures, compliance with the ELVs 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. The inaccuracy of measurement methods may be taken into account for verification purposes.

5. Monitoring of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated measuring systems and the reference measurements to calibrate those systems, shall be carried out in accordance with CEN standards. If CEN standards are not available, ISO standards, national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

6. Special provisions for combustion plants referred to in paragraph 7:

(a) A Party may derogate from the obligation to comply with the ELVs provided for in paragraph 7 in the following cases:

(i) For combustion plants normally using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility;

(ii) For existing combustion plants not operated more than 17,500 operating hours, starting from 1 January 2016 and ending no later than 31 December 2023;

(b) Where a combustion plant is extended by at least 50 MW$_{th}$, the ELV specified in paragraph 7 for new installations shall apply to the extensional part affected by the change. The ELV is calculated as an average weighted by the actual thermal input for both the existing and the new part of the plant;

(c) Parties shall ensure that provisions are made for procedures relating to malfunction or breakdown of the abatement equipment;

(d) In the case of a multi-fuel firing combustion plant involving the simultaneous use of two or more fuels, the ELV shall be determined as the weighted average of the ELVs for the individual fuels, on the basis of the thermal input delivered by each fuel.

7. Combustion plants with a rated thermal input exceeding 50 MW_{th}:[7]

Table 1
Limit values for dust emissions from combustion plants[a]

Fuel type	Thermal input (MW_{th})	ELV for dust (mg/m^3)[b]
Solid fuels	50–100	New plants: 20 (coal, lignite and other solid fuels) 20 (biomass, peat)
		Existing plants: 30 (coal, lignite and other solid fuels) 30 (biomass, peat)
	100–300	New plants: 20 (coal, lignite and other solid fuels) 20 (biomass, peat)
		Existing plants: 25 (coal, lignite and other solid fuels) 20 (biomass, peat)
	>300	New plants: 10 (coal, lignite and other solid fuels) 20 (biomass, peat)
		Existing plants: 20 (coal, lignite and other solid fuels) 20 (biomass, peat)
Liquid fuels	50–100	New plants: 20
		Existing plants: 30 (in general) 50 (for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants)
Liquid fuels	100–300	New plants: 20
		Existing plants: 25 (in general) 50 (for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants)
	>300	New plants: 10
		Existing plants: 20 (in general) 50 (for the firing of distillation and conversion residues within refineries from the refining of crude oil for own consumption in combustion plants)

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[7] The rated thermal input of the combustion plant is calculated as the sum of the input of all units connected to a common stack. Individual units below 15 MW_{th} shall not be considered when calculating the total rated thermal input.

Fuel type	Thermal input (MW_{th})	ELV for dust (mg/m^3)[b]
Natural gas	> 50	5
Other gases	> 50	10 30 (for gases produced by the steel industry which can be used elsewhere)

[a] In particular, the ELVs shall not apply to:
- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials.
- Post-combustion plants designed to purify the waste gases by combustion which are not operated as independent combustion plants.
- 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.
- Recovery boilers within installations for the production of pulp.
- Waste incinerators and
- Plants powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

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

8. Mineral oil and gas refineries:

Table 2
Limit values for dust emissions released from mineral oil and gas refinerie

Emission source	ELV for dust (mg/m^3)
FCC regenerators	50

9. Cement clinker production:

Table 3
Limit values for dust emissions released from cement production[a]

Emission source	ELV for dust (mg/m^3)
Cement installations, kilns, mills and clinker coolers	20

[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. The reference oxygen content is 10%.

10. Lime production:

Table 4
Limit values for dust emissions released from lime production[a]

Emission source	ELV for dust (mg/m^3)
Lime kiln firing	20[b]

[a] Installations for the production of lime with a capacity of 50 Mg/day or more. This includes lime kilns integrated in other industrial processes, with the exception of the pulp industry (see table 9). The reference oxygen content is 11%.

[b] Where the resistivity of the dust is high, the ELV may be higher, up to 30 mg/m^3.

11. Production and processing of metals:

Table 5
Limit values for dust emissions released from primary iron and steel production

Activity and capacity threshold	ELV for dust (mg/m^3)
Sinter plant	50
Pelletization plant	20 for crushing, grinding and drying 15 for all other process steps
Blast furnace: Hot stoves (>2.5 t/hour)	10
Basic oxygen steelmaking and casting (>2.5 t/hour)	30
Electric steelmaking and casting (>2.5 t/hour)	15 (existing) 5 (new)

Table 6
Limit values for dust emissions released from iron foundries

Activity and capacity threshold	ELV for dust (mg/m^3)
Iron foundries (>20 t/day): all furnaces (cupola, induction, rotary) all mouldings (lost, permanent)	20
Hot and cold rolling	20 50 where a bag filter cannot be applied due to the presence of wet fumes

Table 7
Limit values for dust emissions released from non-ferrous metals production and processing

	ELV for dust (mg/m^3) (daily)
Non-ferrous metal processing	20

12. Glass production:

Table 8
Limit values for dust emissions released from glass production[a]

	ELV for dust (mg/m^3)
New installations	20
Existing installations	30

[a] Installations for the production of glass or glass fibres with a capacity of 20 Mg/day or more. Concentrations refer to dry waste gases at 8% oxygen by volume (continuous melting), 13% oxygen by volume (discontinuous melting).

13. Pulp production:

Table 9
Limit values for dust emissions released from pulp production

	ELV for dust (mg/m^3) (annual averages)
Auxiliary boiler	40 when firing liquid fuels (at 3% oxygen content) 30 when firing solid fuels (at 6% oxygen content)
Recovery boiler and lime kiln	50

14. Waste incineration:

Table 10
Limit values for dust emissions released from waste incineration

	ELV for dust (mg/m^3)
Municipal waste incineration plants (> 3 Mg/hour)	10
Hazardous and medical waste incineration (> 1 Mg/hour)	10

Note: Oxygen reference: dry basis, 11%.

15. Titanium dioxide production:

Table 11
Limit values for dust emissions released from titanium dioxide production

	ELV for dust (mg/m^3)
Sulphate process, total emission	50
Chloride process, total emission	50

Note: For minor emission sources within an installation, an ELV of 150 mg/m^3 may be applied.

16. Combustion installations with a rated thermal input < 50 MW$_{th}$:

This paragraph is recommendatory in character and describes the measures that can be taken insofar as a Party considers them to be technically and economically feasible for the control of particulate matter:

(a) Residential combustion installations with a rated thermal input < 500 kW$_{th}$:

(i) Emissions from new residential combustion stoves and boilers with a rated thermal input < 500 kW$_{th}$ can be reduced by the application of:

a. Product standards as described in CEN standards (e.g., EN 303–5) and equivalent product standards in the United States and Canada. Countries applying such product standards may define additional national requirements taking into account, in particular, the contribution of emissions of condensable organic compounds to the formation of ambient PM; or

b. Ecolabels specifying performance criteria that are typically stricter than the minimum efficiency requirements of the EN product standards or national regulations;

Table 12

Recommended limit values for dust emissions released from new solid fuel combustion installations with a rated thermal input < 500 kW_{th} to be used with product standards

	Dust (mg/m^3)
Open/closed fireplaces and stoves using wood	75
Log wood boilers (with heat storage tank)	40
Pellet stoves and boilers	50
Stoves and boilers using other solid fuels than wood	50
Automatic combustion installations	50

Note: O_2 reference content: 13%.

(ii) Emissions from existing residential combustion stoves and boilers can be reduced by the following primary measures:

a. Public information information and awareness-raising programmes regarding:

i. The proper operation of stoves and boilers;

ii. The use of untreated wood only;

iii. The correct seasoning of wood for moisture content.

b. Establishing a programme to promote the replacement of the oldest existing boilers and stoves by modern appliances; or

c. Establishing an obligation to exchange or retrofit old appliances.

(b) Non-residential combustion installations with a rated thermal input 100 kW_{th}–1 MW_{th}:

Table 13

Recommended limit values for dust emissions released from boilers and process heaters with a rated thermal input of 100 kW_{th}–1 MW_{th}

		Dust (mg/m^3)
Solid fuels 100 kW_{th}–500 kW_{th}	New installations	50
	Existing installations	150
Solid fuels 500 kW_{th}–1 MW_{th}	New installations	50
	Existing installations	150

Note: O_2 reference content: wood, other solid biomass and peat: 13%; coal, lignite and other fossil solid fuels: 6%.

(c) Combustion installations with a rated thermal input > 1 MW_{th}–50 MW_{th}:

Table 14
Recommended limit values for dust emissions released from boilers and process heaters with a rated thermal input of 1 MW_{th}–50 MW_{th}

		Dust (mg/m^3)
Solid fuels > 1 MW_{th}–5 MW_{th}	New installations	20
	Existing installations	50
Solid fuels > 5 MW_{th}–50 MW_{th}	New installations	20
	Existing installations	30
Liquid fuels > 1 MW_{th}–5 MW_{th}	New installations	20
	Existing installations	50
Liquid fuels >5 MW_{th}–50 MW_{th}	New installations	20
	Existing installations	30

Note: O_2 reference content: wood, other solid biomass and peat: 11%; coal, lignite and other fossil solid fuels: 6%; liquid fuels, including liquid biofuels: 3%.

B. Canada

17. Limit values for controlling emissions of PM will be determined for stationary sources, as appropriate, taking into account information on available control technologies, limit values applied in other jurisdictions and the documents listed in subparagraphs (a) to (h) below. Limit values may be expressed in terms of PM or TPM. TPM in this context means any PM with an aerodynamic diameter of less than 100 µm:

(a) Secondary Lead Smelter Release Regulation. SOR/91-155;

(b) Environmental Code of Practice for Base Metals Smelters and Refineries;

(c) New Source Emission Guidelines for Thermal Electricity Generation;

(d) Environmental Code of Practice for Integrated Steel Mills (EPS 1/MM/7);

(e) Environmental Code of Practice for Non-Integrated Steel Mills (EPS 1/MM/8);

(f) Emission Guidelines for Cement Kilns. PN 1284;

(g) Joint Initial Actions to Reduce Pollutant Emissions that Contribute to Particulate Matter and Ground-level Ozone; and

(h) Performance testing of solid-fuel-burning heating appliances, Canadian Standards Association. B415. 1-10.

C. United States of America

18. Limit values for controlling emissions of PM from stationary sources in the following stationary source categories, and the sources to which they apply, are specified in the following documents:

(a) Steel Plants: Electric Arc Furnaces — 40 C.F.R. Part 60, Subpart AA and Subpart AAa;

(b) Small Municipal Waste Combustors — 40 C.F.R. Part 60, Subpart AAAA;

(c) Kraft Pulp Mills — 40 C.F.R. Part 60, Subpart BB;

(d) Glass Manufacturing — 40 C.F.R. Part 60, Subpart CC;

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

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

(g) Grain Elevators — 40 C.F.R. Part 60, Subpart DD;

(h) Municipal Waste Incinerators — 40 C.F.R. Part 60, Subpart E, Subpart Ea and Subpart Eb;

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

(j) Portland Cement — 40 C.F.R. Part 60, Subpart F;

(k) Lime Manufacturing — 40 C.F.R. Part 60, Subpart HH;

(l) Hot Mix Asphalt Facilities — 40 C.F.R. Part 60, Subpart I;

(m) Stationary Internal Combustion Engines: Compression Ignition — 40 C.F.R. Part 60, Subpart IIII;

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

(o) Secondary Lead Smelters — 40 C.F.R. Part 60, Subpart L;

(p) Metallic Minerals Processing — 40 C.F.R. Part 60, Subpart LL;

(q) Secondary Brass and Bronze — 40 C.F.R. Part 60, Subpart M;

(r) Basic Oxygen Process Furnaces — 40 C.F.R. Part 60, Subpart N;

(s) Basic Process Steelmaking Facilities — 40 C.F.R. Part 60, Subpart Na;

(t) Phosphate Rock Processing — 40 C.F.R. Part 60, Subpart NN;

(u) Sewage Treatment Plant Incineration — 40 C.F.R. Part 60, Subpart O;

(v) Nonmetallic Minerals Processing Plants — 40 C.F.R. Part 60, Subpart OOO;

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

(x) Ammonium Sulfate Manufacturing — 40 C.F.R. Part 60, Subpart PP;

(y) Wool Fiberglass Insulation — 40 C.F.R. Part 60, Subpart PPP;

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

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

(bb) Primary Aluminum reduction plants — 40 C.F.R. Part 60, Subpart S;

(cc) Phosphate Fertilizer Production — 40 C.F.R. Part 60, Subparts T, U, V, W, X;

(dd) Asphalt Processing and Asphalt Roofing anufacturing — 40 C.F.R. Part 60, Subpart UU;

(ee) Calciners and Dryers in Mineral Industries — 40 C.F.R. Part 60, Subpart UUU;

(ff) Coal Preparation Plants — 40 C.F.R. Part 60, Subpart Y;

(gg) Ferroalloy Production Facilities — 40 C.F.R. Part 60, Subpart Z;

(hh) Residential Wood Heaters — 40 C.F.R. Part 60, Subpart AAA;

(ii) Small Municipal Waste Combustors (after 11/30/1999) — 40 C.F.R. Part 60, Subpart AAAA;

(jj) Small Municipal Waste Combustors (before 11/30/1999) — 40 C.F.R. Part 60, Subpart BBBB;

(kk) Other Solid Waste Incineration Units (after 12/9/2004) — 40 C.F.R. Part 60, Subpart EEEE;

(ll) Other Solid Waste Incineration Units (before 12/9/2004) — 40 C.F.R. Part 60, Subpart FFFF;

(mm) Stationary Compression Ignition Internal Combustion Engines — 40 C.F.R. Part 60, Subpart IIII; and

(nn) Lead Acid BatteryManufacturing Plants — 40 C.F.R. Part 60, Subpart KK.

19. Limit values for controlling emissions of PM from sources subject to National Emission Standards for Hazardous Air Pollutants:

(a) Coke oven batteries — 40 C.F.R. Part 63, Subpart L;

(b) Chrome Electroplating (major and Area sources) – 40 C.F.R. Part 63, Subpart N;

(c) Secondary lead smelters — 40 C.F.R. Part 63, Subpart X;

(d) Phosphoric Acid Manufacturing Plants — 40 C.F.R. Part 63, Subpart AA;

(e) Phosphate Fertilizers Production Plants — 40 C.F.R. Part 63, Subpart BB;

(f) Magnetic Tape Manufacturing — 40 C.F.R. Part 63, Subpart EE;

(g) Primary Aluminum— 40 C.F.R. Part 63, Subpart L;

(h) Pulp and paper II (combustion) — 40 C.F.R. Part 63, Subpart MM;

(i) Mineral wool manufacturing — 40 C.F.R. Part 63, Subpart DDD;

(j) Hazardous waste combustors — 40 C.F.R. Part 63, Subpart EEE;

(k) Portland cement manufacturing — 40 C.F.R. Part 63, Subpart LLL;

(l) Wool fiberglass manufacturing — 40 C.F.R. Part 63, Subpart NNN;

(m) Primary copper — 40 C.F.R. Part 63, Subpart QQQ;

(n) Secondary aluminum — 40 C.F.R. Part 63, Subpart RRR;

(o) Primary lead smelting — 40 C.F.R. Part 63, Subpart TTT;

(p) Petroleum refineries — 40 C.F.R. Part 63, Subpart UUU;

(q) Ferroalloys production — 40 C.F.R. Part 63, Subpart XXX;

(r) Lime manufacturing — 40 C.F.R. Part 63, Subpart AAAAA;

(s) Coke Ovens: Pushing, Quenching, and Battery Stacks — 40 C.F.R. Part 63, Subpart CCCCC;

(t) Iron and steel foundries — 40 C.F.R. Part 63, Subpart EEEEE;

(u) Integrated iron and steel manufacturing — 40 C.F.R. Part 63, Subpart FFFFF;

(v) Site remediation — 40 C.F.R. Part 63, Subpart GGGGG;

(w) Miscellaneous coating manufacturing — 40 C.F.R. Part 63, Subpart HHHHH;

(x) Asphalt Processing and Roofing Manufacturing — 40 C.F.R. Part 63, Subpart LLLLL;

(y) Taconite Iron Ore Processing — 40 C.F.R. Part 63, Subpart RRRRR;

(z) Refractory products manufacturing — 40 C.F.R. Part 63, Subpart SSSSS;

(aa) Primary magnesium refining — 40 C.F.R. Part 63, Subpart TTTTT;

(bb) Electric Arc Furnace Steelmaking Facilities — 40 C.F.R. Part 63, Subpart YYYYY;

(cc) Iron and steel foundries — 40 C.F.R. Part 63, Subpart ZZZZZ;

(dd) Primary Copper Smelting Area Sources — 40 C.F.R. Part 63, Subpart EEEEEE;

(ee) Secondary Copper Smelting Area Sources — 40 C.F.R. Part 63, Subpart FFFFFF;

(ff) Primary Nonferrous Metals Area Sources: Zinc, Cadmium, and Beryllium — 40 C.F.R. Part 63, Subpart GGGGGG;

(gg) Lead Acid Battery Manufacturing (Area sources) — 40 C.F.R. Part 63, Subpart PPPPPP;

(hh) Glass manufacturing (area sources) — 40 C.F.R. Part 63, Subpart SSSSSS;

(ii) Secondary Nonferrous Metal Smelter (Area Sources) — 40 C.F.R. Part 63, Subpart TTTTTT;

(jj) Chemical Manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart VVVVVV;

(kk) Plating and Polishing Operations (Area sources) — 40 C.F.R. Part 63, Subpart WWWWWW;

(ll) Area Source Standards for Nine Metal Fabrication and Finishing Source Categories — 40 C.F.R.Part 63, Subpart XXXXXX;

(mm) Ferroalloys Production (Area Sources) — 40 C.F.R. Part 63, Subpart YYYYYY;

(nn) Aluminum, Copper, and Nonferrous Foundries (Area Sources) — 40 C.F.R. Part 63, Subpart ZZZZZZ;

(oo) Asphalt Processing and Roofing Manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart AAAAAAA;

(pp) Chemical Preparation (Area Sources) — 40 C.F.R. Part 63, Subpart BBBBBBB;

(qq) Paints and Allied Products Manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart CCCCCCC;

(rr) Prepared animal feeds manufacturing (Area Sources) — 40 C.F.R. Part 63, Subpart DDDDDDD; and

(ss) Gold Mine Ore Processing and Production (Area Sources) — 40 C.F.R. Part 63, Subpart EEEEEEE.

Annex XI
Limit values for volatile organic compounds content of products

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 concerns the limitation of emissions of volatile organic compounds (VOCs) due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products.

3. For the purpose of section A of the present annex, the following general definitions shall apply:

(a) "Substances" means any chemical element and its compounds, as they occur in the natural state or as produced by industry, whether in solid or liquid or gaseous form;

(b) "Mixture" means mixtures or solutions composed of two or more substances;

(c) "Organic compound" means any compound containing at least the element carbon and one or more of hydrogen, oxygen, sulphur, phosphorus, silicon, nitrogen, or a halogen, with the exception of carbon oxides and inorganic carbonates and bicarbonates;

(d) "Volatile organic compound (VOC)" means any organic compound having an initial boiling point less than or equal to 250°C measured at a standard pressure of 101.3 kPa;

(e) "VOC content" means the mass of VOCs, expressed in grams/litre (g/l), in the formulation of the product in its ready to use condition. The mass of VOCs in a given product which react chemically during drying to form part of the coating shall not be considered part of the VOC content;

(f) "Organic solvent" means any VOC which is used alone or in combination with other agents to dissolve or dilute raw materials, products, or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or as a plasticizer, or as a preservative;

(g) "Coating" means any mixture, including all the organic solvents or mixtures containing organic solvents necessary for its proper application, which is used to provide a film with decorative, protective or other functional effect on a surface;

(h) "Film" means a continuous layer resulting from the application of one or more coats to a substrate;

(i) "Water-borne coatings (WB)" means coatings the viscosity of which is adjusted by the use of water;

(j) "Solvent-borne coatings (SB)" means coatings the viscosity of which is adjusted by the use of organic solvent;

(k) "Placing on the market" means making available to third parties, whether in exchange for payment or not. Importation into the Parties customs territory shall be deemed to be placing on the market for the purposes of this annex.

4. “Paints and varnishes” means products listed in the subcategories below, excluding aerosols. They are coatings applied to buildings, their trim and fittings, and associated structures for decorative, functional and protective purpose:

(a) “Matt coatings for interior walls and ceilings” means coatings designed for application to indoor walls and ceilings with a gloss ≤ 25 @ 60 degrees;

(b) “Glossy coatings for interior walls and ceilings” means coatings designed for application to indoor walls and ceilings with a gloss > 25 @ 60 degrees;

(c) “Coatings for exterior walls of mineral substrate” means coatings designed for application to outdoor walls of masonry, brick or stucco;

(d) “Interior/exterior trim and cladding paints for wood, metal or plastic” means coatings designed for application to trim and cladding which produce an opaque film. These coatings are designed for either a wood, metal or a plastic substrate. This subcategory includes undercoats and intermediate coatings;

(e) “Interior/exterior trim varnishes and wood stains” means coatings designed for application to trim which produce a transparent or semi-transparent film for decoration and protection of wood, metal and plastics. This subcategory includes opaque wood stains. Opaque wood stains means coatings producing an opaque film for the decoration and protection of wood, against weathering, as defined in EN 927-1, within the semi-stable category;

(f) “Minimal build wood stains” means wood stains which, in accordance with EN 927-1:1996, have a mean thickness of less than 5µm when tested according to ISO 2808: 1997, method 5A;

(g) “Primers” means coatings with sealing and/or blocking properties designed for use on wood or walls and ceilings;

(h) “Binding primers” means coatings designed to stabilize loose substrate particles or impart hydrophobic properties and/or to protect wood against blue stain;

(i) “One-pack performance coatings” means performance coatings based on film-forming material. They are designed for applications requiring a special performance, such as primer and topcoats for plastics, primer coat for ferrous substrates, primer coat for reactive metals such as zinc and aluminium, anticorrosion finishes, floor coatings, including for wood and cement floors, graffiti resistance, flame retardant, and hygiene standards in the food or drink industry or health services;

(j) “Two-pack performance coatings” means coatings with the same use as one-performance coatings, but with a second component (e.g., tertiary amines) added prior to application;

(k) “Multicoloured coatings” means coatings designed to give a two-tone or multiple-colour effect, directly from the primary application;

(l) “Decorative effect coatings” means coatings designed to give special aesthetic effects over specially prepared pre-painted substrates or base coats and subsequently treated with various tools during the drying period.

5. “Vehicle refinishing products” means products listed in the subcategories below. They are used for the coating of road vehicles, or part of them, carried out as part of vehicle repair, conservation or decoration outside of manufacturing installations. In this respect, “road vehicle” means any motor vehicle intended for use on the road, being complete or incomplete, having at least four wheels and a maximum design speed exceeding 25 km/h, and its trailers, with the exception of vehicles which run on rails and of agricultural and forestry tractors and all mobile machinery:

(a) “Preparatory and cleaning” means products designed to remove old coatings and rust, either mechanically or chemically, or to provide a key for new coatings:

- (i) Preparatory products include gunwash (a product designed for cleaning spray-guns and other equipment), paint strippers, degreasers (including anti-static types for plastic) and silicone removers;
- (ii) “Pre-cleaner” means a cleaning product designed for the removal of surface contamination during preparation for and prior to the application of coating materials;

(b) “Bodyfiller/stopper” means heavy-bodied compounds designed to be applied to fill deep surface imperfections prior to the application of the surfacer/filler;

(c) “Primer” means any coating that is designed for application to bare metal or existing finishes to provide corrosion protection prior to application of a primer surfacer:

- (i) “Surfacer/filler” means a coating designed for application immediately prior to the application of topcoat for the purpose of corrosion resistance, to ensure adhesion of the topcoat, and to promote the formation of a uniform surface finish by filling in minor surface imperfections;
- (ii) “General metal primer” means a coating designed for application as primers, such as adhesion promoters, sealers, surfacers, undercoats, plastic primers, wet-on-wet, non-sand fillers and spray fillers
- (iii) “Wash primer” means coatings containing at least 0.5% by weight of phosphoric acid designed to be applied directly to bare metal surfaces to provide corrosion resistance and adhesion; coatings used as weldable primers; and mordant solutions for galvanized and zinc surfaces;

(d) “Topcoat” means any pigmented coating that is designed to be applied either as a single-layer or as a multiple-layer base to provide gloss and durability. It includes all products involved such as base coatings and clear coatings:

- (i) “Base coatings” means pigmented coatings designed to provide colour and any desired optical effects, but not the gloss or surface resistance of the coating system;
- (ii) “Clear coating” means a transparent coating designed to provide the final gloss and resistance properties of the coating system;

(e) “Special finishes” means coatings designed for application as topcoats requiring special properties, such as metallic or pearl effect, in a single layer, high-performance solid-colour and clear coats, (e.g., anti-scratch and fluorinated clear coat), reflective base coat, texture finishes (e.g., hammer), anti-slip, under-body sealers, anti-chip coatings, interior finishes; and aerosols.

6. Parties shall ensure that the products covered by this annex which are placed on the market within their territory comply with the maximum VOC content as specified in tables 1 and 2. For the purposes of restoration and maintenance of buildings and vintage vehicles designated by competent authorities as being of particular historical and cultural value, Parties may grant individual licences for the sale and purchase in strictly limited quantities of products which do not meet the VOC limit values laid down in this annex. Parties may also exempt from compliance with the above requirements products sold for exclusive use in an activity covered by annex VI and carried out in a registered or authorized installation complying with that annex.

Table 1
Maximum VOC content for paints and varnishes

Product subcategory	Type	(g/l)[*]
Interior matt wall and ceilings (Gloss ≤ 25@60°)	WB	30
	SB	30
Interior glossy walls and ceilings (Gloss > 25@60°)	WB	100
	SB	100
Exterior walls of mineral substrate	WB	40
	SB	430
Interior/exterior trim and cladding paints for wood and metal	WB	130
	SB	300
Interior/exterior trim varnishes and wood stains, including opaque wood stains	WB	130
	SB	400
Interior and exterior minimal build wood stains	WB	130
	SB	700
Primers	WB	30
	SB	350
Binding primers	WB	30
	SB	750
One pack performance coatings	WB	140
	SB	500
Two-pack reactive performance coatings for specific end-use	WB	140
	SB	500
Multi-coloured coatings	WB	100
	SB	100
Decorative effects coatings	WB	200
	SB	200

[*] g/l ready to use.

Table 2
Maximum VOC content for vehicle refinishing products

Product subcategory	Coatings	VOC (g/l)[*]
Preparatory and cleaning	Preparatory	850
	Pre-cleaner	200
Bodyfiller/stopper	All types	250
Primer	Surfacer/filler and general (metal) primer	540
	Wash primer	780
Topcoat	All types	420
Special finishes	All types	840

[*] g/l of ready-for-use product. Except for "preparatory and cleaning", any water content of the product ready for use should be discounted.

B. Canada

7. Limit values for controlling emissions of VOCs from the use of consumer and commercial products will be determined, as appropriate, taking into account information on available control technologies, techniques and measures, limit values applied in other jurisdictions, and the documents below:

(a) VOC Concentration Limits for Architectural Coatings Regulations. SOR/2009-264;

(b) VOC Concentration Limits for Automotive Refinishing Products. SOR/2009-197;

(c) Regulations Amending the Prohibition of Certain Toxic Substances Regulations, 2005 (2-Methoxyethanol, Pentachlorobenzene and Tetrachlorobenzenes). SOR/2006-279;

(d) Federal Halocarbon Regulations. SOR/2003-289;

(e) Prohibition of Certain Toxic Substances Regulations. SOR/2003-99;

(f) Solvent Degreasing Regulations. SOR/2003-283;

(g) Tetrachloroethylene (Use in Dry Cleaning and Reporting Requirements) Regulations. SOR/2003-79;

(h) Order Adding Toxic Substances to Schedule 1 to the Canadian Environmental Protection Act, 1999;

(i) Notice with Respect to Certain Substances on the Domestic Substances List (DSL);

(j) Order Amending Schedule 1 to the Canadian Environmental Protection Act, 1999 (Miscellaneous Program);

(k) Ozone-depleting Substances Regulations. SOR/99-7;

(l) Proposed regulations for VOC Concentrations Limits for Certain Products;

(m) Proposed notice requiring the preparation and implementation of pollution prevention plans in respect of specified substances on Schedule 1 of the Canadian Environmental Protection Act, 1999, related to the resin and synthetic rubber manufacturing sector;

(n) Proposed notice requiring the preparation and implementation of pollution prevention plans in respect of specified substances on Schedule 1 of the Canadian Environmental Protection Act, 1999, implicated in the polyurethane and other foam sector (except polystyrene);

(o) Notice with Respect to Certain Hydrochlorofluorocarbons;

(p) Notice with Respect to Certain Substances on the Domestic Substances List (DSL); and

(q) Environmental Code of Practice for the Reduction of Solvent Emissions from Dry Cleaning Facilities. PN 1053.

C. United States of America

8. Limit values for controlling emissions of VOCs from sources subject to National Volatile Organic Compound Emission Standards for Consumer and Commercial Products are specified in the following documents:

(a) Automobile refinish coatings — 40 C.F.R. Part 59, Subpart B;

(b) Consumer products — 40 C.F.R. Part 59, Subpart C;

(c) Architectural coatings — 40 C.F.R. Part 59, Subpart D; and

(d) Aerosol coatings — 40 C.F.R. Part 59, Subpart E.