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DEVELOPMENT AND TRANSFER OF TECHNOLOGY

WAYS AND MEANS OF LIMITING EMISSIONS OF HYDROFLUOROCARBONS AND PERFLUOROCARBONS

Note by the secretariat

CONTENTS

I. INTRODUCTION

A. Mandate

1. By its decision 13/CP.4, entitled "Relationship between efforts to protect the stratospheric ozone layer and efforts to safeguard the global climate system: issues related to hydrofluorocarbons and perfluorocarbons", the Conference of the Parties (COP) invited Parties, the relevant bodies of the Montreal Protocol, the Intergovernmental Panel on Climate Change (IPCC), intergovernmental organizations and non-governmental organizations to provide information to the secretariat, by 15 July 1999, on available and potential ways and means of limiting emissions of hydrofluorocarbons and perfluorocarbons, including their use as replacements for ozone-depleting substances. In addition, the COP encouraged the convening of a workshop by the IPCC and the Technology and Economic Assessment Panel of the Montreal Protocol (TEAP) in 1999 on the issue. It requested the secretariat to compile the information provided, including, if available, the conclusions of the workshop, for consideration by the Subsidiary Body for Scientific and Technological Advice (SBSTA) at its eleventh session. Furthermore, it requested the SBSTA to report on this information to the COP, at its fifth session, and to seek further guidance from the Conference of the Parties on this matter at that session (FCCC/CP/1998/16/Add.1).

2. The SBSTA, at its tenth session, took note of the information provided by the secretariat on how Parties, international organizations and other organizations may submit information electronically to the secretariat. It encouraged Parties, international organizations and other organizations to make use of the secretariat's web site as a means of providing information on ways and means of limiting emissions of HFCs and PFCs and requested the secretariat to make the information submitted also available on the web site (FCCC/SBSTA/1999/6, para. 70 (c)).

B. Scope of the note

3. This note has been prepared to respond to the above mandate. It contains background information on the issue and an overview of the submissions received from Parties, intergovernmental and non-governmental organizations. It also provides a short summary of the "Joint IPCC/TEAP expert meeting on options for the limitation of emissions of HFCs and PFCs".

4. Submissions from Parties and intergovernmental organizations are provided in document FCCC/SBSTA/1999/MISC.6. The full text of all submissions by Parties, intergovernmental and non-governmental organizations is available on the web site of the UNFCCC secretariat (http://www.unfccc.de/program/wam/). Computer diskettes with all submissions will be available for Parties at the session. A list of all organizations that submitted information is included in annex II.

5. This note contains only an overview of the information submitted to the secretariat. Parties are encouraged to consider the individual submissions from each organization.

C. Possible action by the SBSTA

6. The SBSTA may wish to consider the information provided in this document with a view to determining whether and if so, what future activities relating to the relationship between efforts to protect the stratospheric ozone layer and efforts to safeguard the global climate are necessary. In doing so, it may wish to bear in mind the activities under way in other intergovernmental organizations. It may also wish to consider whether Parties and other organizations should be further encouraged to submit information on ways and means of limiting emissions of HFCs and PFCs. The SBSTA may wish to provide guidance to the secretariat on these matters, including whether it should maintain a database on ways and means of limiting emissions of HFCs and PFCs.

II. BACKGROUND

7. To assist Parties and other organizations to respond to decision 13/CP.4, the secretariat facilitated the submission of information through its web site. An on-line form has been designed for use in submitting information electronically in a common structure and to facilitate the compilation and access to the information. The structure of the form is included in annex I.

8. Sulfur hexafluoride (SF_6) is neither explicitly included in decision 13/CP.4 nor used as a replacement for ozone-depleting substances. However, the secretariat's form provides an opportunity to also provide information on this gas, since HFCs, PFCs and SF_6 are often treated as a group, and in some cases technologies apply to HFCs or PFCs as well as to SF_6. The joint IPCC/TEAP workshop proceeded in the same way.

9. Box 1 provides an overview of fluorinated gases, their ozone depleting potential (ODP) and global warming potential (GWP) as well as their control in international agreements.

Box 1. Fluorinated gases and their control in international agreements

Group of gases	ODP	Net GWP	International control
CFCs	0.6 to 1	540 to 7100	Montreal Protocol: Industrialized countries phased out in 1996[a] Developing countries phase out by 2010[b]
HCFCs	0.001 to 0.52	20 to 1700	Montreal Protocol: Industrialized countries phase out by 2030[c] Developing countries phase out by 2040[c]
Halons	3 to 10	-85400 to -14100	Montreal Protocol: Industrialized countries phased out in 1994[a] Developing countries phase out by 2010[b]
HFCs	0	140 to 11700	Kyoto Protocol: Included in the group of gases, emissions of which industrialized countries have to limit or reduce in 2008-2012
PFCs	0	6500 to 9200	Kyoto Protocol: Included in the group of gases, emissions of which industrialized countries have to limit or reduce in 2008-2012
SF_6	0	23900	Kyoto Protocol: Included in the group of gases, emissions of which industrialized countries have to limit or reduce in 2008-2012
NF_3	0	10800	Not controlled

[a] With possible exemptions for essential uses; 15 per cent of base level production (1986/89 dependent on gas) allowed to be produced additionally to meet the basic domestic needs of developing countries. Applicable to production and consumption.

[b] With possible exemptions for essential uses; 15 per cent of base level production (average 1995 to 1997) allowed to be produced additionally to meet the basic domestic needs of developing countries. Applicable to production and consumption

[c] Applicable only to consumption.

Explanatory notes:

The chlorine and/or bromine contained in halocarbons (e.g. CFCs, HCFCs and halons) cause ozone depletion. HFCs, PFCs and SF_6 do not contain chlorine or bromine, they do not cause ozone depletion and hence their ozone depleting potential (ODP) is zero. ODP values are taken from the "UNEP handbook on international treaties for the protection of the ozone layer", Fourth Edition, 1996. Parties may wish to consult this reference for complete information on the Vienna Convention and the Montreal Protocol.

In accordance with decision 2/CP.3, the GWPs shown here (except for NF_3) are those provided by the IPCC Second Assessment Report ("1995 IPCC GWP values") based on the effects of the greenhouse gases over a 100-year time horizon. It may be noted that updated and slightly lower GWP values for CFCs, HCFCs and Halons are given in the "Scientific Assessment of Ozone depletion: 1998", WMO, Global Ozone Research and Monitoring Project - Report No. 44.

GWP values for ozone depleting substances (ODS) generally include two effects. Most ODS act directly as greenhouse gases, causing warming, and at the same time deplete ozone, itself a greenhouse gas, inducing indirect cooling. The indirect effects depend upon the abundance of other ozone depleting

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(continued)
substances and cannot be specified independent of past abundances and future scenarios. Net GWPs of CFCs, HCFCs and Halons, taking into account the direct and indirect effects, are provided by the IPCC Second Assessment Report as a range of values for some selected gases for the time frame 1990 to 2090. Values shown here are the lower and upper limits of these ranges. Halons have significantly negative GWPs and induce net cooling due to the negative forcing arising from ozone depletion. Regarding the uncertainty of the given GWPs for ozone depleting substances, the IPCC Second Assessment Report states that the "numbers presented ... should be considered illustrative of the relative values of GWPs among ozone depleting gases, but their absolute magnitudes are presently subject to considerable qualitative uncertainties (at least ±50%)."

The gas NF_3 has been included since its use has been reported in submissions. Its GWP is not given in the IPCC Second Assessment Report. The reference for the GWP of NF_3 is the Scientific Assessment of Ozone Depletion: 1998.

III. SUBMISSIONS

A. General overview

10. As at 18 August 1999, 26 submissions were received, 24 of them electronically. The submissions were from seven Parties (Canada, Finland on behalf of the European Community and its member states, Kenya, New Zealand, Norway, Sudan and United States of America), one intergovernmental organization, 14 non-governmental business organizations, two non-governmental environmental organizations, one organization from academia as well as one submission supported by a group of 30 organizations and individual experts from many different constituencies. A list of all organizations and titles of their submissions is included in annex II.

11. Fourteen submissions used the form provided by the secretariat. Some submissions included additional supplementary information, such as previously prepared studies. The submissions included 45 individual ways and means of limiting emissions. The total amount of information submitted is about 300 pages, excluding hard copies of sixteen publications, one video and one database.

12. The IPCC is currently preparing information on HFCs and PFCs in several reports. In the Third Assessment Report (TAR), due early 2001, Working Group I will include these gases in the analysis of global radiative forcing. Working Group III will include information on HFCs and PFCs in Chapter 2 (Mitigation Scenarios), Chapter 3 (Options to Mitigate Emissions), Chapter 5 (Barriers) and Chapter 6 (Policies and Measures). Some information on options to mitigate emissions will be provided in an Appendix. In addition, the IPCC special report on emission scenarios (SRES), due in March 2000, includes long term projections of HFC / PFC emissions.

13. The Technology and Economic Advisory Panel of the Montreal Protocol (TEAP) has formed an HFC/PFC task force which will provide a report on the implications to the Montreal Protocol of the inclusion of HFCs and PFCs in the Kyoto Protocol, to the eleventh Meeting of the Parties to the Montreal Protocol in Beijing, from 29 November to 3 December 1999. The

TEAP task force has submitted a bibliography, a list of relevant web sites, hard copies of 16 publications and a database on refrigerant literature.

B. Refrigeration

14. HFCs and PFCs are used as refrigerants in refrigerators and air conditioners, replacing CFCs and HCFCs. The largest number of submissions, 23 of the 45 individual ways and means, were relevant to refrigeration. It may be noted that different views were expressed regarding this category.

15. *Policies and measures.* Parties reported measures in place such as prohibiting venting of refrigerants, mandatory recovery and recycling / destruction of refrigerant, limiting the use of certain substitutes for ozone-depleting substances, registration of companies before refrigerants can be purchased or equipment serviced, regular mandatory leakage tests, eco-labelling and research. Industry reported on voluntary agreements between industry and governments, a register of refrigerant handlers, a code of practice for the minimisation of refrigerant emissions and a registered technicians programme.

16. *Technological options.* Four submissions contained a full review of the refrigeration and air-conditioning sector, seven submissions described different options to limit emissions, two submissions listed examples of application of alternative technologies and three provided information on one specific refrigeration technology. Some submissions focussed on limitation of refrigerant emissions while others included energy efficiency.

C. Foams

17. HFCs are used as foam blowing agents, replacing CFCs and HCFCs. Apart from general studies on HFCs, PFCs and SF_6, one Party reported on measures such as eco-labelling and voluntary agreements as well as technological options to reduce emissions.

D. Fire extinguishers

18. HFCs and PFCs are used as fire extinguishing gases, replacing halons. Parties reported measures in place to limit the use of certain substitutes for ozone-depleting substances, a ban of HFCs and PFCs in fire extinguishers, regular mandatory leak tests, annual mandatory reporting to regional authorities and voluntary agreements. One Party commented on technological options and an industry association representing the European fire industry provided a submission.

E. Aerosols

19. HFCs are used as propellants in aerosols, replacing CFCs and HCFCs. One Party reported technological options. An industry association, representing pharmaceutical companies, provided a submission on metred dose inhalers (MDIs).

F. Solvents

20. HFCs and PFCs are used as solvents, replacing CFCs and HCFCs. Parties reported measures in place to limit the use of certain substitutes for ozone-depleting substances and a ban of HFCs as solvents.

G. Production of halocarbons and SF_6

21. Emissions of HFCs, PFCs and SF_6 from chemical production can occur through inadvertent by-production or fugitive emissions. Parties reported measures in place such as pollution control statutes and technological options to reduce the emissions. One company described a capture and recycling system.

H. Metal production

22. PFCs are an inadvertent by-product of primary aluminium smelting, SF_6 is used in magnesium production and processing as an inert cover gas to prevent molten magnesium from re-oxidising. Parties reported measures in place such as pollution control statutes and voluntary agreements. An association of aluminium producers submitted the results of measures taken by its member companies. A company described a capture and recycling system.

I. Semiconductor manufacturing

23. HFCs, PFCs, SF_6 and NF_3 are used by the semiconductor manufacturers in plasma etching and chemical vapour deposition processes. Parties reported measures in place such as voluntary agreements. A global association of semiconductor manufacturers reported on its activities. A company described a capture and recycling system.

J. Electrical insulation

24. SF_6 is used in circuit breakers, gas-insulated substations, and switchgear as insulating gas. Parties reported measures in place such as voluntary agreements. Industry described a capture and recycling system, a reuse concept and a life-cycle assessment.

H. Other uses

25. Miscellaneous applications of HFCs, PFCs and SF_6 include their use in thermal and acoustic insulation, in inflatable products, as cosmetics, as cooling and heating fluid, in medical appliances, as testers and tracers and in nuclear fuel processing. Parties reported on ongoing efforts to reduce SF_6 in sound absorbing windows.

IV. REPORT ON THE JOINT IPCC/TEAP EXPERT MEETING ON OPTIONS FOR THE LIMITATION OF EMISSIONS OF HFCS AND PFCS

26. As invited by the COP (decision 13/CP.4) and subsequently by the Conference of the Parties to the Montreal Protocol (decision X/16, UNEP/OzL.Pro.10/9), the IPCC and TEAP organized a joint workshop on ways and means of limiting emissions of HFCs and PFCs.

27. Two documents emerged from that workshop, the first of which contains a summary of the results of the workshop. This document will be made available by the IPCC and TEAP at the eleventh session of the SBSTA. The second document is a compilation of the papers presented at the workshop and is available upon request from the IPCC and TEAP.

28. The following paragraphs 29 to 43 were provided by IPCC and TEAP as part of the workshop report and are reproduced here without formal editing by the UNFCCC secretariat.

29. *The IPCC/TEAP Joint Expert Meeting was the first opportunity for representatives of governments, international agencies, environmental organisations and the private sector to meet and explore co-ordinated actions that might be taken to address the atmospheric problems of stratospheric ozone depletion and climate change. It also provided the first opportunity for experts working on the climate problem through IPCC and those working on ozone depletion through TEAP to discuss their common and separate issues in the same forum. The meeting was held in Petten, the Netherlands, 26-28 May 1999, and was attended by over 100 participants from 24 nations.*

30. Within the framework of the Montreal Protocol it has been recognised that substitutes for ozone depleting substances (ODSs) should be compatible with the goals of climate protection. Technical assessments have also utilised measures such as the Total Equivalent Warming Impact (TEWI) factor to study the implications for global warming of energy associated CO_2 emissions. However, the actual implementation of the Montreal Protocol cannot mandate climate change considerations since it only controls listed substances directly involved in ozone depletion. The Kyoto Protocol has created a more immediate need to further examine the relationship between the climate and ozone treaty regimes. It includes the hydrofluorocarbons (HFCs) among the gases that are to be controlled for climate protection, and these are the principal substances chosen as substitutes for ODSs under the Montreal Protocol.

31. The widely different replacement strategies for ODSs among countries demonstrate the need for more explicit international co-ordination of actions taken to address ozone depletion and climate protection simultaneously. The future choices of ODS substitutes are important for maintaining environmental quality and a sound economy, encouraging technological innovation, and for assuring developing countries an improved quality of life. These concerns formed the background, as well as a very important part for all discussions at the Joint Expert Meeting. Furthermore, the Meeting also provided an opportunity for specialists to examine the implications for both the global environment and the global economy of the Kyoto greenhouse gases which contribute to global warming, but which do not affect the ozone layer directly, such as CO_2, SF_6, and the perfluorocarbons (PFCs).

32. The Joint Expert Meeting consisted of a one day plenary followed by working sessions organised by end-use application. The sectors projected to consume the largest amount of HFCs, are the refrigeration, mobile and stationary air conditioning industry, followed by insulating foam manufacturing, solvent and fire extinguishants, aerosol applications and medical devices. Use of PFCs and SF_6 is more specifically confined to narrowly defined sub-sectors such as chemical and metals manufacturing, electronics and specialty products. At the Meeting, each working group identified numerous technical options and management techniques for limiting emissions from specific applications. Particularly for HFC substitutes for CFCs, the working groups developed unprioritised lists of available and emerging options.

33. The experts concluded that while alternatives may not yet be technically and economically feasible for some current uses, there are technologies for other uses that can further reduce of ODSs and global warming gases in the near future. Plenary presentations also made clear that different governments were pursuing alternative strategies for replacing CFCs, especially in the refrigeration and air conditioning sectors. While several European governments such as Denmark and Sweden are considering regulations to limit the use of HFCs and are encouraging hydrocarbon and ammonia refrigerants, the United States is encouraging the use of HFCs together with containment and recycling. Japan is following a focused strategy to encourage low GWP substitutes for specific applications, while developing countries and countries with economies in transition are choosing various alternatives for CFCs depending upon commercial ties and their own industrial capacities.

34. The expert groups identified four distinct categories of options to reduce the emissions of HFCs, PFCs and SF_6:

*(a) **Alternative Substances and Technologies**. When available, alternatives eliminate the specified gas emissions entirely. A few participants in the Joint Expert Meeting believed that such alternative substances are available and that these should be explored as the primary option. However, most of the participants cautioned that the reduction of direct global warming from the elimination of a gas might be outweighed by increased indirect global warming from carbon dioxide if energy efficiency is lowered.*

*(b) **Containment.** Though there has been substantial technical progress in the containment and recycling of HFCs and PFCs as refrigerants, blowing agents or fire extinguishants, these procedures have not been applied to all markets; further improvements are expected to be feasible. In some cases, containment is driven by national regulations, but several voluntary industry initiatives have also been significant. While improved containment can substantially reduce releases, it cannot be 100% effective in practice.*

*(c) **Improved System or Process Design.** Altering the process or system design can substantially reduce emissions as has occurred with PFC releases in aluminium smelting and from electronics manufacturing; it has substantially reduced emissions of HFCs and N_2O associated with chemical manufacturing. Redesign of products can also permit the use of reduced chemical charge or use.*

(d) ***End of Product Life Recovery for Recycling or Destruction.*** *Technology for recycling HFC refrigerants is fully commercialised, but so far employed only when mandated by regulation (e.g., USA), or when voluntary industry association or corporate programs are in place (e.g. Australia, Japan and France). Recovery for destruction is generally not economical, although destruction facilities exist in several locations. Destruction at end-of-life appears to have technical potential for major reductions in HFC releases from the foams sector, but it may not be cost effective. The procedures for promoting recycling or destruction may also differ.*

35. For process related releases of HFCs and N_2O in chemical manufacturing, or PFCs from aluminium smelting, recovery of inadvertent by-products should be a first requirement. In a second instance, optimising the chemical and smelting production efficiency and redesigning production processes will minimise the generation of inadvertent by-products thereby substantially reducing these incidental releases. Most efforts to date have been voluntary, but these practices can be disseminated to all manufacturers. The other alternative is end-of-the-pipe capture with disposal or recycling.

36. At the Joint Expert Meeting, the relationship between the global warming impact of HFC emissions and energy efficiency gains or losses, which may result from the use of non-HFC technologies, was discussed at great length. The insulation foam working-group considered energy efficiency as the most important element influencing the possible use of HFCs, while the refrigeration and air conditioning group was divided on the importance of considering energy efficiency. A small number of participants believed energy efficiency to be beyond the mandate of the Joint Expert Meeting whereas the majority of participants were of the opinion that it must be considered. Considering the full, life cycle global warming contribution when making choices of gases, technologies and processes under both the Montreal and Kyoto Protocols can help to meet both sets of treaty goals sooner and more cost effectively. Furthermore, the Meeting also noted that there is a need for standardised equipment testing procedures among technologies and countries.

37. One government representative explicitly emphasised that despite the global warming reductions from the elimination of CFCs, there continues to be a need to limit the emissions of HFCs and PFCs by prohibiting their use, while also doing more to increase energy efficiency of buildings and appliances.

38. There was a strong plea to assist developing countries and countries with economies in transition in simultaneously improving the energy efficiency of appliances and systems while assisting them in shifting away from CFCs in refrigeration, air conditioning, foams and other applications. While not required to eliminate CFCs until 2010, many developing countries have already proceeded in the transition process away from ODSs. The Meeting requested that more synergistic projects be financed jointly by the Multilateral Fund and the Global Environmental Facility, and that a simple, dual-goal application process be devised. An overcomplicated project application system on the other hand would discourage such efforts.

39. Developing countries expressed concern that some developed countries may try to impose their own choice of technology on developing countries. Such efforts could undermine

trust and mutual respect under the Protocol and would be counterproductive if developing countries would begin to question the advice given within the Montreal Protocol framework. Specifically, concerns were expressed that uncertainty on possible controls to address climate change may adversely affect compliance with Montreal Protocol obligations particularly for the refrigeration, air conditioning and foams sector. This could undermine credibility of future global environmental treaties. It is also essential that technologies chosen to address climate change and ozone protection meet the sustainable development goals of developing countries.

40. Data presented at the Expert Meeting clearly demonstrated that consumption of CFCs and halons reached its peak in terms of their contribution to ozone depletion and global warming in the year 1988. In the ten years since, the actions taken under the Montreal Protocol have reduced the ODP weighted emissions of these substances and their HCFC substitutes by approximately 80% (with almost 18% due to continued CFC and halon consumption in some countries). These actions have also decreased the direct global warming impact of all the fluorocarbons by approximately two-thirds. The rate of reduction has, however, slowed between 1995 and 1997. Projecting into the future proved more difficult since it depends critically upon assumptions about technical feasibility of alternatives, and future demand for the services provided by these types of substances.

41. Several sector working-groups quantified the range of technically feasible emission reduction options available in the near term. More detailed analysis is still needed for the many sub-sectors of refrigeration, air conditioning and heat pumps. More information is also needed to derive global estimates of future emissions of HFCs under different system tightness and replacement scenarios, and alternative assumptions concerning different emission projections, life cycle analysis, cost performance ratios etc. In addition, more work is needed to quantify carbon dioxide emissions reductions that could be achieved at various costs through energy efficiency improvements in the refrigeration, air conditioning and heat pump sector and in building related insulation foam. Even for the EU where data is the most detailed, scenarios differed by more than a factor of two (1.7% to 4% of CO2 equivalents) for the level of HFC use in the EU by 2010. Substantial increases in HFC use are anticipated in the refrigeration and air conditioning, insulating foam, medical and aerosol sectors, while major reductions will occur from lowered releases of HFCs in HCFC manufacturing.

42. While the precise HFC growth was uncertain, it appears that the use of HFCs will be substantially less in amount and in terms of contribution to global warming than the CFCs and HCFCs they replace. PFC use and release is expected to remain small because of its limited applicability, and also due to the high price of these chemicals. Because of the early stage of substitution and numerous uncertainties regarding the development of HFC end user markets, it was concluded that an accurate emission forecast for the first Kyoto Commitment Period (i.e., 2008-2012) is virtually impossible to make at this time.

43. Presentations and discussions at the Joint Expert Meeting highlighted the complexity of the links between ozone depletion and climate change mitigation activities, the multiplicity of solutions required to address these two global change issues simultaneously, and the need for solutions tailored to regional or national needs. The different perspectives of the experts on the

possible future emissions and current and future availability and feasibility of alternatives to HFCs, PFCs and SF6 in each sector demonstrates the need for substantial additional research and analysis to provide a valid and consistent, qualitative and quantitative picture of potential options. Despite uncertainty and differing opinions expressed at the Joint Expert Meeting, many practical options for reducing emissions of these gases were identified.

Annex I

STRUCTURE OF THE FORM FOR SUBMITTING INFORMATION ON HFCS, PFCS AND SF_6

Organization:
[ ]Party's submission
[ ]United Nations
[ ]Intergovernmental organization
[ ]Non-governmental organization

Contact person: Ms./Mr.
First name:
Last name:
Street (1):
Street (2):
Postal code:
City:
State:
Country:
Telephone:
Fax:
E-mail:
WWW:
Date of submission: dd/mm/yyyy

Title:
Type (select from below):
Category (select from below):
Gases affected (select from below):
General description:
Impacts on ozone depletion:
Impacts on global warming:
Other environmental impacts:
Economic impact (cost):
Timing issues:
Examples of application:
Regional availability or applicability:
Other remarks:
Sources of additional information (what and where):
Link to more information:

Types:
Technology, leakage reduction in existing equipment
Technology, recovery / recycling
Technology, destruction
Technology, improved system design
Technology, substitution of gas in existing equipment
Technology, substitution of gas and equipment
Technology, other
Policy and measure, regulation
Policy and measure, tax
Policy and measure, government subsidy
Policy and measure, voluntary agreement
Policy and measure, public education
Policy and measure, specialist training
Policy and measure, other

Categories:
Aluminium production
Magnesium production
Feedstock
By-product emissions
Fugitive emissions
Refrigeration, domestic
Refrigeration, commercial
Refrigeration, cold storage and food processing
Refrigeration, industrial
Refrigeration, air conditioning and heat pumps (air cooled systems)
Refrigeration, air conditioning (water chillers)
Refrigeration, transport
Refrigeration, mobile air conditioning
Refrigeration, heat pumps (heating only and heat recovery)
Refrigeration, other
Foam, polyurethane, rigid, domestic refrigerators and freezers
Foam, polyurethane, rigid, other appliances
Foam, polyurethane, rigid, boardstock/flexible faced lamination
Foam, polyurethane, rigid, sandwich panels
Foam, polyurethane, rigid, spray
Foam, polyurethane, rigid, slabstock
Foam, polyurethane, rigid, pipe
Foam, polyurethane, rigid, one component
Foam, polyurethane, flexible, slabstock and boxfoam
Foam, polyurethane, moulded
Foam, polyurethane, integral skin
Foam, polyurethane, miscellaneous
Foam, phenolic
Foam, extruded polystyrene, sheet
Foam, extruded polystyrene, boardstock
Foam, extruded polystyrene, polyolefin
Foam, other
Fire extinguishers, fixed systems
Fire extinguishers, portable extinguishers
Aerosols, metred dose inhalers

Categories (*continued*)

Aerosols, personal care
Aerosols, household
Aerosols, industrial
Aerosols, other
Solvents, precision cleaning
Solvents, electronics cleaning
Solvents, metal cleaning
Solvents, deposition applications
Solvents, other
Semiconductors manufacturing
Electrical insulation
Thermal / acoustic insulation
Inflatable products
Cosmetics
Cooling and heat transfer fluid
Medical
Testing and tracers
Nuclear
Other

Gases:
HFC-23
HFC-32
HFC-41
HFC-125
HFC-134
HFC-134a
HFC-152a
HFC-143
HFC-143a
HFC-227ea
HFC-236fa
HFC-245ca
HFC-43-10mee
Other HFCs
CF_4
C_2F_6
C_3F_8
C_4F_{10}
c-C_4F_8
C_5F_{12}
C_6F_{14}
Other PFCs
SF_6

Annex II

LIST OF PARTIES, INTERGOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS THAT SUBMITTED INFORMATION[1]

Parties	**Titles of submission**
Canada	Ways and means of limiting emissions of HFCs and PFCs
Finland on behalf of the European Community and its member States	Available and potential ways and means of limiting HFC, PFC and SF6 emissions
	Refrigerant conservation
	Refrigerant alternatives
	Refrigerant charge size reduction
	Alternative refrigeration technologies
	Refrigerant recovery and disposal
	Alternative foam blowing agents
	Not-in-kind insulation materials
	Emissions reduction options for HFC-blown foams
	Reduction of HFC emissions from aerosols
	Reduction of HFC emissions from solvents
	Reduction of HFC and PFC emissions from fire fighting
	Reducing HFC-23 emissions from manufacturing of HCFC-22
	Reducing PFC emissions from primary aluminium smelting
	Reducing PFC, HFC and SF6 emissions from semiconductors manufacturing
Kenya	Potential ways and means of limiting emissions of hydrofluorocarbons and perfluorocarbons
New Zealand	Relationship between efforts to protect the stratospheric ozone layer and efforts to safeguard the global climate system: issues related to hydrfluorocarbons and perfluorocarbons
Norway	Ways and means to limit emissions of HFCs
Sudan	Available and potential ways and means of limiting emissions of HFCs and PFCs, including their use as replacements for ODSs
USA	Available and potential ways and means of limiting emissions of hydrofluorocarbons and perfluorocarbons
	Voluntary Aluminum Industrial Partnership (VAIP)
	SF6 Emissions Reduction Partnership for Electric Power Systems
	SF6 Emission Reduction Partnership for the Magnesium Industry

[1] As at 18 August 1999.

	U.S. Voluntary PFC Emission Reduction Partnership for Semiconductors
	HFC-23 Emission Reduction From HCFC-22 Manufacture
	U.S. Environmental Protection Agency, Clean Air Act, Title VI, sections 608 and 609 Recycling and Emissions Reductions Programs
	U.S. Environmental Protection Agency, Clean Air Act Title VI, section 612 Significant New Alternatives Policy (SNAP) program

Intergovernmental organizations	**Titles of submission**
Technology and Economic Assessment Panel (TEAP)	Activities of the TEAP Task Force on HFCs and PFCs

Non-governmental organizations	**Titles of submission**
The Air Conditioning and Refrigeration Industry Board (ACRIB)	Declaration of intent on the use of HFCs
The Air Conditioning and Refrigeration Industry Board (ACRIB)	Register of Refrigerant Handlers
American Air Liquide	SF_6/PFC Capture and Recycling System
Association Francaise du Froid	Document submitted by Association Francaise du Froid
Calor Gas Ltd. Joint expert submission	Use of non-HFC technology
Climate Action Lanka	Refrigerant substitution
ECOFYS	Reduction of the emissions of HFC's, PFC's and SF_6 in the European Union
EUROFEU	The Need for Fluorocarbons in Fire Protection
Greenpeace	How to limit HFC emissions? Eliminate them.
Greenpeace	Cool Technologies: Working without HFCs, Video
ICI Klea	Reducing emissions from domestic appliances
ICI Klea	HFCs - Facts not Emotions
Institute of Refrigeration	Code of Practice for the Minimization of Refrigerant Emissions
International Institute for Applied Systems Analysis (IIASA)	A model for estimating future emissions of sulfur hexafluoride and perfluorocarbons
International Institute of Refrigeration	Reduction of emissions of HFCs. Various aspects to be taken into account
International Pharmaceutical Aerosol Consortium (IPAC)	Documents submitted by IPAC
International Primary Aluminium Institute	PFC Surveys form International Primary Aluminium Institute
Solvay Flour und Derivate	Life-cycle assessment 'Electricity supply using SF_6 technology'
Solvay Flour und Derivate	Primary and secondary recycling of fluorinated refrigerants
Solvay Flour und Derivate	SF_6 ReUse concept

Vehicle Air Conditioning Specialists Australia	Refrigerant recovery from written off vehicles
Vehicle Air Conditioning Specialists Australia	Registered Technicians Programme
Vehicool	Adiabatic Air Conditioning (AAC)
World Semiconductor Council	World Semiconductor Council Activities in Support of Limiting Emissions of HFC's, PFC's and SF_6

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