United Nations
Environment
Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/6/6/Rev.1
24 February 1992

ORIGINAL: ENGLISH

Executive Committee of the
Interim Multilateral Fund for the
Implementation of the Montreal Protocol

Sixth Meeting
Montreal, 27-28 February 1992

ECUADOR COUNTRY PROGRAMME

This document consists of:

a) **Evaluation sheet prepared by the Fund Secretariat**

b) **Letter of transmittal from the Government of Ecuador**

c) **Country Programme Cover Sheet**

d) **The Country Programme.**

ECUADOR'S COUNTRY PROGRAMME EVALUATION SHEET

The Fund Secretariat received the Ecuador Country Programme on 21 February 1992 at 8 P.M. Due to the subsequent limited time available before the 27 February 1992 Executive Committee Meeting, the document has only received a cursory review. Therefore, The Fund Secretariat is not in a position to advise The Executive Committee on a course of action regarding this document.

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CCW-C-045-92

Washington, February 21 1992

Mr.Omar El Arini
Chief Officer
Secretariat of the Interim Multilateral Fund for
the Implementation of the Montreal Protocol
Montreal, Quebec
Canada

Dear Mr. El-Arini:

I am now able to remit to you the Ecuadorean Country program once it was sent to me by my capital.

I hope it will get to you on time to make the proper arrangements for the meeting of the Executive Committee.

I should mention that the budget for the Control and Environmental Affairs Unit has finally been established in the sum of $385.000,00, since costs for the training of personnel during the implementation of the program have been considered.

Looking forward to meeting you, I remain.

Sincerely,

Marcel D. Feraud
Commercial Attache
Ecuadorean Embassy

REPUBLICA DEL ECUADOR

MINISTERIO DE INDUSTRIAS COMERCIO INTEGRACION Y PESCA

DESPACHO DEL MINISTRO

Oficio No. DM (. 107 MICIP -i

Quito, february 5 1992

Mr.
OMAR EL ARINI
CHIEF OFFICER
Secretariat of the Interim Multilateral Fund for
the Implementation of the Montreal Protocol
Montreal, Quebec
Canada

Dear Mr. El-Arini:

The Ministry of Industry, in representation of the Government of Ecuador will be pleased to present to the Executive Committee on its february 27 meeting, Ecuador's Country Program to implement the Montreal Protocol. Mr. Marcel Feraud will be presenting the Program. In anticipation of the presentation, attached please find the Country Program Cover Sheet which summarizes the activities to be supported by the Montreal Protocol Interim Multilateral Fund.

As a Party to the Protocol operating under paragraph 1 of Article 5, Ecuador is committed to protecting the stratospheric ozone layer. Ecuador ratified the Montreal Protocol on April 30, 1990. As evidence of its commitment, the Government has prepared a Country Program pledging to phase out controlled substances on an accelerated schedule by the year 2000. The proposed Program covers an eight-year period divided in two four-year phases. Projects to reduce and eliminate about 73% consumption of controlled substances during phase one (1992-1996) have been identified. In addition, a mechanism will be established for transfering resources from the Multilateral Fund to the proposed projects. The budget for this phase is US$3.0 m. This amount is being requested from the Multilateral Fund at this time.

REPUBLICA DEL ECUADOR
MINISTERIO DE INDUSTRIAS COMERCIO INTEGRACION Y PESCA
DESPACHO DEL MINISTRO

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2.

The second four-year phase would include projects to complete the rest of the program. Six such projects have been preliminarily identified so far and will be submitted for approval before 1996.

The Government has designated the Ministry of Industries to execute the Program and monitor compliance with the Protocol. As implementation of the Protocol evolves, new action plans and budgets would be submitted to the Executive Committee for approval.

Sincerely,

JUAN FALCONI PUIG
Minister of Industry

5 Feb 1992

COUNTRY PROGRAM COVER SHEET

Country: Ecuador

Date Received:

Lead National Agency: CONADE, MICIP

Period Covered by the Country Program: 1992-2000[a]

Implementing Agencies: World Bank, UNDP, UNEP

I. Phase-out Schedule

Substances	Current Consumption (tons x ODP) in 1989 (year)	Planned total consumption till phaseout[b] (tons x ODP) Article 5 Schedule	Accelerated Schedule	Planned year of phaseout Article 5 Schedule	Accelerated Schedule
CFC-11	96.0 x 1.0 = 96.0	2,400	900	2010	2000
CFC-12	548.0 x 1.0 = 548.0	14,000	5,100	2010	2000
CFC-114	50.0 x 1.0 = 50.0	1,300	500	2010	2000
Halon 1211	15.0 x 3.0 = 45.0	1,100	400	2010	2000
Carbon Tetrachloride	1.7 x 1.1 = 1.9	50	20	2010	2000
Methyl Chloroform	12.0 x 0.1 = 1.2	30	10	2015	2005
Total	742.1	18,880	6,930		

[a] This country program requests funding for the first four years (1992-96).
[b] Projected at an annual rate of 3.5%

5 FEB 1992

COUNTRY PROGRAM COVER SHEET (Continued)

FIRST PHASE OF ECUADOR'S COUNTRY PROGRAM (Continued)

SUMMARY OF PROJECTS TO BE IMPLEMENTED DURING FIRST PHASE (1992-1996)

Start Year	Type of Project	Project Description	Project Cost (US Dollars)[a]	Participating Agencies	Tons x ODP Phased-out[b]
1992	1) Creation of Control and Environmental Affairs Unit (management support)	Assisting in the implementation of ozone protection program and supporting in the identification of projects. Liaison with implementing agencies and other Latin American countries to promote both technical cooperation and information exchange.	300,000	World Bank	n/a
1992	2) Conversion of 6 large aerosol manufacturing plants from CFC to hydrocarbon propellants and implementation of manufacturing safety training program (investment/training)	Projects involve: (1) converting six large aerosol manufacturing plants from CFC-12 to hydrocarbon propellants, and (2) implementing a manufacturing safety training program.	2,500,000	USEPA World Bank	12,700
1992	3) Reduction of CFC-11 in refrigerator foam insulation produced at three refrigerator manufacturing plants (investment)	Reduction of CFC-11 use in foam at three refrigerator manufacturing plants	100,000	World Bank	400
1992	4) Implementation of CFC refrigerant conservation and material handling training program (training)	Representatives from refrigerant distributors, service shops for industrial and household air conditioners/refrigerants, hotels, supermarkets, restaurants, and refineries will be trained for improved refrigerant conservation and handling.	100,000	UNDP	600
TOTAL			3,000,000		13,700

[a] Project cost is the incremental cost.

[b] This contains the cumulative ODP-weighted metric tons that would be phased out from project implementation date to the Article 5 country phaseout date.

*In accordance to the Mundial Bank Study, the external financing for the first 4 year phase for the creation project of the National Unit, and the Montreal Program to amount to US$689.000.oo; amount that this Ministry aspire to be considere totally.

COUNTRY PROGRAM COVER SHEET (Continued)

FIRST PHASE FOR ECUADOR'S COUNTRY PROGRAM (1992-96)

GOVERNMENT ACTION PROGRAM

Year(s)	Description of Action	Sector (if any)	Intended Effect
1992	Define the detailed administrative procedures for allocating import quotas	All	Establish the method to set reference for reductions
1992	Institute a system for tracking imports by importer; explain the operation of the import controls	All	Monitor import reductions; ensure industry's understanding of import controls
1992	Identify an industry CFC task force which can interact with government on behalf of all CFC importers and users	All	Facilitate communication and cooperation with industry
1993-94	Initiate discussions to provide technical assistance to industry for the preparation of projects	All	Provide guidance on eligibility criteria and proposal preparation
1993-94	Oversee preparation of projects for the first phase	Aerosols Refrigeration	Prepare documentation needed for technical approval
1993-94	Work with the financial intermediary to prepare financing proposals	Aerosols Refrigeration	Prepare documentation for funding approval
1993-92	Ensure timely implementation of projects of the first phase	Aerosols Refrigeration	Obtain reductions in controlled substances as scheduled in country program

COUNTRY PROGRAM COVER SHEET (Continued)

SECOND PHASE FOR ECUADOR'S COUNTRY PROGRAM

SUMMARY OF PROJECTS TO BE IMPLEMENTED DURING SECOND PHASE (1996-2000)

Start Year	Type of Project	Project Description	Project Cost (US Dollars)[a]	Participating Agencies	Tons x ODP Phased-out[b]
1996	1) Substitution of HCFC-123 for CFC-11 in Flexible Polyurethane Foams	This project will make conversion from CFC-11, necessitating some minor modifications (i.e., additional ventilation may be required in manufacturing plants).	200,000	World Bank	800
1996	2) Substitution of HCFC-142b or HCFC-142b/HCFC-22 for CFC-11 in Refrigeration Foam Insulation	Plant conversions might include the capital investment cost resulting from the need to incorporate increased ventilation to reduce the flammability risk associated with HCFC-142b. There would be a 10% increase in operating costs in converting a plant to HCFC-142b.	600,000	World Bank	400
1996	3) Implementation of CFC-12 Recycling in MACs	Fifteen to twenty servicing sites will receive recycling machine and training for service technicians.	100,000	World Bank	150
1996	4) Purge/Recycle and Conversion for CFC-11 and CFC-114 Chillers	Selected large CFC-11 chillers will be retrofitted to use HCFC-123. The project will also demonstrate technology for reducing emissions of CFC-11 from the purge devices on centrifugal chillers.	1,000,000	World Bank	700
1996	5) Halon Conservation Training Program	Increased training of personnel working in areas protected by halon systems significantly reduces the amount of halon discharged from the system by 30 percent. Halon-1211 use where it is not essential will be reduced and a network for Halon-1211 recycling will be developed.	150,000	UNDP	350
1996	6) Substitution of Aqueous Cleaning for Methyl Chloroform in Metal Cleaning	This project will consist of small-scale engineering studies, pilot testing, and equipment conversion to eliminate MCF use from metal cleaning operations.	50,000	World Bank	30
		TOTAL	2,100,000		2,430

*** END OF DOCUMENT ***

ECUADOR'S

PROPOSED PROGRAM FOR

IMPLEMENTING THE MONTREAL PROTOCOL

February 20, 1992

Sixth Meeting of the Executive Committee
of the Multilateral Fund under the Montreal Protocol

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ECUADOR'S

PROPOSED PROGRAM FOR

IMPLEMENTING THE MONTREAL PROTOCOL[1]

[1] The following individuals participated in the preparation of this program: Mr. Mario Ruales, Natural Resources and Environment Division, Ms. Irma Suárez, Industry Division, Ecuador's National Development Council (CONADE); Mr. Jorge Chiriboga (CONADE, Guayaquil Regional Office); Ms. Elizabeth Creel, United States Environmental Protection Agency (USEPA); Mr. César A. Plaza, World Bank: and Ms. Valeria Merino Dirani, Mr. Geno Nardini, Mr. Michael Hoffman, Ms. Laura Tlaiye, and Mr. Abyd Karmali (Consultants). The Country Program team appreciates the invaluable leadership and support provided by Dr. Moisés Tacle, Secretary General for Development, CONADE, Mr. Luis Luna, Undersecretary for Industries, Ministry of Industry (MICIP), and Mr. Raúl Paredes, Director General for Rural Development, CONADE. We would also like to thank the many representatives from Ecuador's industry who contributed data and made available their manufacturing facilities for site visits.

EXECUTIVE SUMMARY

1. Ecuador demonstrated its firm commitment to stratospheric ozone layer protection by ratifying the Montreal Protocol on Substances that Deplete the Ozone Layer on April 30, 1990. Since then. Ecuador's National Development Council (CONADE), the United States Environmental Protection Agency (U.S. EPA), and the World Bank agreed to jointly prepare this document which outlines Ecuador's proposed program to implement the Montreal Protocol.

2. The Government of Ecuador, headed by Mr. Rodrigo Borja, has vigorously backed a series of proposals to prevent deterioration of the environment. One of these proposals was Presidential Decree 004 of April 22, 1990, which mandates that all development projects take into account the environmental impact of such projects. In line with this commitment to environmental protection, this program proposes to accelerate the substances controlled under the Montreal Protocol from the year 2010 to the year 2000, thus waiving the 10-year grace period which Ecuador is permitted as a Party operating under Article 5 of the Protocol.

3. This document presents the program of activities to be undertaken over the 8-year period (1992-2000) when consumption of controlled substances will be gradually reduced and eliminated. As Ecuador is eligible for financial and technical assistance from the Interim Multilateral Fund of the Montreal Protocol, this document also presents the request for US$ 3 million to finance the initial four years (1992-96) of the program. In accordance with the guidelines of the Executive Committee for the preparation of Country Programs[2], this document describes Ecuador's consumption of controlled substances and its proposed program to reduce and eliminate their use.

4. Ecuador consumed approximately 720 metric tons of controlled substances in 1990. Ecuador does not produce any of the controlled substances listed in Annex A of the Montreal Protocol. All consumption of trichlorofluoromethane (CFC-11), dichlorodifluoromethane (CFC-12), trichlorotrifluoroethane (CFC-113), dichlorotetrafluoroethane (CFC-114), Halon-1211, methyl chloroform (MCF) and carbon tetrachloride (TET) is met through imports. Exports of these substances are negligible. Ecuador does not import chloropentafluoroethane (CFC-115) and Halon-1301. Ecuadorean industry forecasts indicate that, in the absence of controls, demand for controlled substances for consumption will increase at an annual growth rate of two to five percent.

5. The distribution of consumption of CFC-11 and CFC-12 (644 metric tons in 1990) by industrial end use in Ecuador is as follows: aerosols (72 percent), refrigeration (13 percent), foams (9 percent), cooling and air conditioning (3 percent), and other end-uses (3 percent). Ecuador consumed an estimated 15 metric tons of Halon-1211 in 1990 for use as a fire extinguishing agent. In addition, Ecuador has, on average over the past five years, consumed approximately 7 metric tons of methyl chloroform and 1 metric ton of carbon tetrachloride per year. MCF and TET are used for metal and electronic cleaning applications.

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[2] UNEP (1991), "Procedures for Presentation of Country Programs and Project Proposals to the Executive Committee," November 18-22, 1991.

6. To date, Ecuador has conducted a number of activities to advance its compliance with the Protocol and to contribute to international efforts for strengthening the Protocol.[3] In addition to the preparation of this document with the U.S. EPA and the World Bank, Ecuador is working with the United Nations Development Programme (UNDP) to plan and prepare training seminars for local industries to raise awareness on this issue and to initiate information exchange on substitute technologies. Ecuador is committed to continuing to work with the Fund's implementing agencies (World Bank, UNDP, and UNEP) and bilateral agencies to ensure that the Montreal Protocol is implemented in an efficient manner.

7. The proposed implementation program consists of six important elements: (1) policy framework, (2) institutional framework, (3) legal framework, (4) ozone protection projects, (5) action plan, and (6) budget.

8. The Government is currently designing a policy framework for phasing out controlled substances. Although Ecuador is permitted to use the 10 year grace period allowed to Article 5 Parties, an accelerated phaseout is proposed because the country is committed to taking immediate action to stop further deterioration of the ozone layer. Exhibit ES-1 presents the proposed phaseout date for each of the controlled substances. By adhering to these phaseout dates, the country would be avoiding approximately 12,000 ODP-weighted tons of controlled substances that would have been emitted by the year 2010. In addition, an accelerated phaseout is believed to be desirable and feasible because: (1) eliminating CFC use in the aerosols sector, the largest end-use sector, is technically feasible, cost-effective, and can be implemented in the short term once a supply of substitute propellants is made available, (2) the use of available recycling technology can result in significant reductions of unnecessary emissions of controlled substances, and (3) introducing substitute refrigerants in the production of new refrigeration equipment as soon as technologies become available would reduce and eventually eliminate future demand for refrigerants in equipment servicing. In sum, there are strong environmental and economic reasons for supporting an accelerated elimination of controlled substances in Ecuador.

9. A policy for ensuring a phaseout of CFCs and halons by the year 2000 and methyl chloroform by 2005 in Ecuador requires two components: (1) reduction of imports according to the proposed phaseout schedule, and (2) provision of incentives for technology substitution. Given the specific and concentrated nature of the activities to be controlled under the Protocol in Ecuador, guidelines for industry should be clear and simple, thus achieving a cost-effective and expeditious implementation of the country's ozone protection strategy.

10. The proposed framework for reducing imports of controlled substances by 2000 will be based on limiting the amount of controlled substances that each importer can introduce into Ecuador. It is proposed that the distribution of import quotas be based on historic import levels for each importer. Quotas would be reassigned every year according to the country's phaseout schedule. During early 1992, the Government would work to set up a system for allocating import quotas throughout the phaseout period.

[3] Ecuador has submitted consumption reports to the Ozone Secretariat and is pursuing ratification of the June 1990 amendments to the Protocol.

11. In line with the spirit and guidelines of the Interim Multilateral Fund of the Montreal Protocol, incentives for technology substitution through technical assistance, training, and financing of industrial projects would be a second integral component of the policy framework. These incentives would lead to a reduction of demand for the controlled substances which contributes to the overall goal of accelerating a phaseout of controlled substances.

12. Furthermore, the aforementioned policy components - import controls and incentives for technology substitution - would expedite compliance with the Protocol while minimizing the economic impact on Ecuadorean consumers. The incentive system for this country program will target the selection and adoption of alternative technologies with adequate financial support so that the need to pass on price increases to consumers is minimized. Hence, the economic incentive brought about by price increases (resulting from substance scarcity combined with technical and financial assistance to industry) would be more effective than a purely regulatory or normative approach.

13. Based on an analysis to determine the most appropriate institutional framework to implement the program, the Government has decided to delegate this function to the Ministry of Industries, Trade, Integration, and Fisheries (MICIP) and to designate MICIP as the lead agency in charge of Protocol implementation. For this purpose, MICIP would establish inter-ministerial and inter-institutional coordination mechanisms. Given its experience with industrial development, import controls, and the existence of qualified technical and administrative staff, MICIP will be an adequate institution for assuming responsibility for this program. Coordination among various ministries and government bodies will be essential for a number of activities, most importantly, import controls (which involve current functions of the Central Bank), and the financing of industrial projects (which would require a financial intermediary, possibly the Corporación Financiera Nacional).

14. To address environmental issues affecting industry, including implementation of the Protocol, MICIP is creating a National Office of Environmental Affairs (NOEA). Two full-time staff within one of the three units within NOEA (the Control and Environmental Affairs Unit) will be responsible for managing all aspects of the program.

15. To support implementation of the proposed policy and to establish the required institutional framework, two legal instruments will be enacted: a Presidential Decree and Ministerial Agreements. The Presidential Decree would stipulate the following:

- Ecuador's base year and phaseout schedule (i.e., interim targets for import reductions and complete elimination by the year 2000);
- a ban on production of controlled substances in Ecuador and a ban of exports to countries that have not ratified the Protocol;
- designate MICIP as the lead agency in charge of program implementation;
- designate a inter-ministerial and inter-institutional coordination mechanism;
- designate MICIP as responsible for defining the policy for import controls and incentives for technology substitution; and
- designate a financial intermediary as responsible for working with MICIP to articulate a financing mechanism for eligible industrial projects.

16. The Ministerial Agreements would establish within MICIP the unit that would be in charge of the program and would delineate roles for other ministries. They would outline the policy for implementing import controls and for incentive measures, and articulate coordination mechanisms with other ministries.

17. Ecuador's action plan to implement this program's first 4-year phase would follow a two-pronged approach. Step one would involve the execution of all actions to establish the legal, institutional, and policy frameworks. Step two would implement projects in the two sectors, aerosols and refrigeration, which account for about 85% of CFC-11 and CFC-12 usage. The main activities would include substituting hydrocarbon propellants in about six aerosol manufacturing plants and reducing CFC-11 use in the manufacture of insulation for domestic refrigerators. It would also include training people in the conservation of refrigerants. Exhibit ES-2 presents a summary of specific actions and projects to be undertaken during the first phase.

18. It is estimated that implementation of the projects during the first phase would decrease consumption by 540 ODP-weighted metric tons per year. Over a period of 18 years, total reduction would be 13,700 ODP-weighted metric tons.

19. The second 4-year phase would include implementation of numerous projects, six of which have been identified so far in the areas of flexible foams, chillers, halons, mobile air conditioning, and solvents. It is estimated that about 130 ODP-weighted metric tons per year would be reduced upon completion of these projects, or 2,430 ODP-weighted metric tons if projected from 1992 to 2010. A summary of the projects identified so far for the second phase are presented in Exhibit ES-3. In 1996, more projects will be identified and submitted for approval for this second phase.

20. As shown in Exhibit ES-2, the budget for the first phase (1992-96) is US$3,085,000, of which approximately US$2,500,000 is proposed for plant conversions in the aerosols sector; US$200,000 for projects in the refrigeration sector; and US$385,000 for the operation of the ozone protection unit within MICIP. These are the funds being requested from the Multilateral Fund at this time.

21. As shown in Exhibit ES-3, the preliminary budget for the second phase is US$2,100,000. In 1996, the Government will assess the progress made in implementing the proposed action plan during the first phase and will consider the need to request further financing for projects in the second phase to eliminate consumption of controlled substances.

22. The remainder of this report is divided into four chapters. The first three chapters provide the context and background for the program and the last chapter represents the substantive content of the proposed program for implementing the Protocol in Ecuador. In summary,

> Chapter I describes the role of controlled substances in stratospheric ozone depletion.
>
> Chapter II presents background on the Montreal Protocol and its subsequent amendments and outlines the opportunities available to Ecuador through the Interim Multilateral Fund of the Montreal Protocol.

Chapter III details the consumption pattern of controlled substances in Ecuador and summarizes the practices, technologies, and substitute chemicals and products that can be used to substitute the use of such substances.

Chapter IV presents the proposed implementation program:

> Section A introduces the country program by stating Ecuador's commitment to protection of the stratospheric ozone layer and describing the key elements of the program.
>
> Section B presents two key elements of a policy framework for achieving the program targets: import controls and incentives for technology substitution.
>
> Section D presents the proposed institutional framework.
>
> Section E presents the proposed legal framework.
>
> Section F describes the proposed projects to reduce and/or eliminate consumption of controlled substances.
>
> Section G outlines the Government's proposed action plan.
>
> Section H presents the proposed implementation schedule and budget for the actions listed in the preceding chapter.

EXHIBIT ES-1
PLANNED PHASEOUT DATES

Substances	Current Consumption (tons x ODP) in 1989 (year)	Planned total consumption till phaseout[b] (tons x ODP)		Planned year of phaseout	
		Article 5 Schedule	Accelerated Schedule	Article 5 Schedule	Accelerated Schedule
CFC-11	96.0 x 1.0 = 96.0	2,400	900	2010	2000
CFC-12	548.0 x 1.0 = 548.0	14,000	5,100	2010	2000
CFC-114	50.0 x 1.0 = 50.0	1,300	500	2010	2000
Halon 1211	15.0 x 3.0 = 45.0	1,100	400	2010	2000
Carbon Tetrachloride	1.7 x 1.1 = 1.9	50	20	2010	2000
Methyl Chloroform	12.0 x 0.1 = 1.2	30	10	2015	2005
Total	742.1	18,880	6,930		

[a] This country program requests funding for the first four years (1992-96).
[b] Projected at an annual rate of 3.5%

EXHIBIT ES-2
FIRST PHASE FOR ECUADOR'S COUNTRY PROGRAM (1992-96)

GOVERNMENT ACTION PROGRAM

Year(s)	Description of Action	Sector (if any)	Intended Effect
1992	Define the detailed administrative procedures for allocating import quotas	All	Establish the method to set reference for reductions
1992	Institute a system for tracking imports by importer; explain the operation of the import controls	All	Monitor import reductions; ensure industry's understanding of import controls
1992	Identify an industry CFC task force which can interact with government on behalf of all CFC importers and users	All	Facilitate communication and cooperation with industry
1993-94	Initiate discussions to provide technical assistance to industry for the preparation of projects	All	Provide guidance on eligibility criteria and proposal preparation
1993-94	Oversee preparation of projects for the first phase	Aerosols Refrigeration	Prepare documentation needed for technical approval
1993-94	Work with the financial intermediary to prepare financing proposals	Aerosols Refrigeration	Prepare documentation for funding approval
1993-92	Ensure timely implementation of projects of the first phase	Aerosols Refrigeration	Obtain reductions in controlled substances as scheduled in country program

EXHIB' 3-2 (Continued)
FIRST PHASE OF ECUADOR'S COUNTRY PROGRAM

SUMMARY OF PROJECTS TO BE IMPLEMENTED DURING FIRST PHASE (1992-1996)

Start Year	Type of Project	Project Description	Project Cost (US Dollars)[a]	Participating Agencies	Tons x ODP Phased-out[b]
1992	1) Creation of the Montreal Protocol unit within the Environmental Affairs Office at MICIP (management support)	Assisting in the implementation of ozone protection program and supporting in the identification of projects. Liaison with implementing agencies and other Latin American countries to promote both technical cooperation and information exchange.	385,000[c]	World Bank	n/a
1992	2) Conversion of 6 large aerosol manufacturing plants from CFC to hydrocarbon propellants and implementation of manufacturing safety training program (investment/training)	Projects involve: (1) converting six large aerosol manufacturing plants from CFC-12 to hydrocarbon propellants, and (2) implementing a manufacturing safety training program.	2,500,000	USEPA World Bank	12,700
1992	3) Reduction of CFC-11 in refrigerator foam insulation produced at three refrigerator manufacturing plants (investment)	Reduction of CFC-11 use in foam at three refrigerator manufacturing plants	100,000	World Bank USEPA	400
1992	4) Implementation of CFC refrigerant conservation and material handling training program (training)	Representatives from refrigerant distributors, service shops for industrial and household air conditioners/refrigerants, hotels, supermarkets, restaurants, and refineries will be trained for improved refrigerant conservation and handling.	100,000	UNDP	600
		TOTAL	3,085,000		13,700

[a] Project cost is the incremental cost.
[b] This contains the cumulative ODP-weighted metric tons that would be phased out from project implementation date to the Article 5 country phaseout date.
[c] This amount represents the incremental cost to the Government of establishing and operating the Montreal Protocol unit and is independent of the resources designated for MICIP's Environmental Affairs Office.

EXHIBIT ES-3
SECOND PHASE FOR ECUADOR'S COUNTRY PROGRAM

SUMMARY OF PROJECTS TO BE IMPLEMENTED DURING SECOND PHASE (1996-2000)

Start Year	Type of Project	Project Description	Project Cost (US Dollars)[a]	Participating Agencies	Tons x ODP Phased -out[b]
1996	1) Substitution of HCFC-123 for CFC-11 in Flexible Polyurethane Foams	This project will make conversion from CFC-11, necessitating some minor modifications (i.e., additional ventilation may be required in manufacturing plants).	200,000	World Bank	800
1996	2) Substitution of HCFC-142b or HCFC-142b/HCFC-22 for CFC-11 in Refrigeration Foam Insulation	Plant conversions might include the capital investment cost resulting from the need to incorporate increased ventilation to reduce the flammability risk associated with HCFC-142b. There would be a 10% increase in operating costs in converting a plant to HCFC-142b.	600,000	World Bank	400
1996	3) Implementation of CFC-12 Recycling in MACs	Fifteen to twenty servicing sites will receive recycling machine and training for service technicians.	100,000	World Bank	150
1996	4) Purge/Recycle and Conversion for CFC-11 and CFC-114 Chillers	Selected large CFC-11 chillers will be retrofitted to use HCFC-123. The project will also demonstrate technology for reducing emissions of CFC-11 from the purge devices on centrifugal chillers.	1,000,000	World Bank	700
1996	5) Halon Conservation Training Program	Increased training of personnel working in areas protected by halon systems significantly reduces the amount of halon discharged from the system by 30 percent. Halon-1211 use where it is not essential will be reduced and a network for Halon-1211 recycling will be developed.	150,000	UNDP	350
1996	6) Substitution of Aqueous Cleaning for Methyl Chloroform (MCF) in Metal Cleaning	This project will consist of small-scale engineering studies, pilot testing, and equipment conversion to eliminate MCF use from metal cleaning operations.	50,000	World Bank	30
		TOTAL	2,100,000		2,430

I. STRATOSPHERIC OZONE DEPLETION

23.Stratospheric ozone shields the earth from harmful ultraviolet (UV) radiation. Increasing concentrations of human-made chemicals including chlorofluorocarbons (CFCs), halons, methyl chloroform, carbon tetrachloride, and HCFCs destroy stratospheric ozone. A significant reduction in stratospheric ozone could increase the incidence of skin cancer and cataracts, suppress the human immune system, and damage crops, aquatic organisms and natural ecosystems. Increased ultraviolet radiation also contributes to increased ground-level ozone (smog). Finally, as well as being ozone depletors, almost all of the controlled substances are suspected of acting as greenhouse gases and, therefore, may contribute to higher temperatures, changes in climate, and a global rise in sea levels that could damage coastal areas.

24. CFCs, and particularly halons, are potent ozone depletors. CFCs consist of chlorine, fluorine, and carbon. They were first developed in the 1930s as efficient, safe refrigerants for home use. The physical properties of CFCs made them ideal for a wide variety of applications--they are nonflammable, efficient, inexpensive and low in toxicity. These properties helped increase demand for CFCs and led to their use as foam-blowing agents, cleaners for electrical and metallic parts, aerosol propellants, and in other applications. Halons, containing bromine, are used as fire-extinguishing agents. They are preferred in many applications due to their excellent flame-extinguishing properties, low toxicity, lack of electrical conductivity, and lack of corrosivity and residue.

25. Because CFCs and halons are chemically inert, they are virtually unreactive in the lower atmosphere. As a result, CFCs and halons slowly migrate to the upper atmosphere where higher energy radiation strikes them, releasing chlorine and bromine atoms. Once released, the chlorine and bromine acts as a catalyst, repeatedly combining with and breaking apart stratospheric ozone molecules. A single chlorine atom can destroy over 100,000 ozone molecules.

26. Factors governing the relative efficiency of these compounds to destroy ozone include: (1) rate of release of the compound into the atmosphere; (2) rate of removal of the compound in the troposphere and its persistence in the stratosphere; and (3) efficiency of the compound in destroying ozone in the stratosphere. One commonly used measure of a compound's efficiency in destroying ozone is the "ozone depleting potential", or ODP. This term provides a useful metric for estimating the ozone destruction potential of various chemicals relative to CFC-11 which is considered to have an ODP of 1.0.

II. THE MONTREAL PROTOCOL

27. In September 1987, 24 nations, including the United States, Japan, the Soviet Union, and members of the European Community negotiated and signed the Montreal Protocol on Substances that Deplete the Ozone Layer. As of January 1, 1992, 74 nations, including Ecuador, have ratified the Protocol. These countries represent over 90 percent of the world's production of CFCs and halons. The Montreal Protocol entered into force on January 1, 1989. This international environmental agreement limited production of specified CFCs to 50 percent of 1986 levels by the year 1998 and called for a freeze in production of specified halons at 1986 levels starting in 1992.

The London Agreement

28. Shortly after the 1987 Protocol was negotiated, new scientific evidence showed that more depletion had occurred than previously expected (e.g., reports of the Ozone Trends Panel). Consequently, several countries called for further actions to protect the ozone layer by expanding the provisions of the 1987 Montreal Protocol. In June 1990, the Parties to the Montreal Protocol met in London and agreed to Protocol amendments calling for more stringent controls on the CFCs and halons in the original agreement as well as additional controls on other important substances such as carbon tetrachloride and methyl chloroform (MCF). The amendments limit production of specified CFCs to 50 percent of 1986 levels by the year 1995 and to 15 percent by the year 1997. Under the new international agreement, CFCs, halons, and carbon tetrachloride are to be phased out by the year 2000, and MCF is to be phased out by the year 2005. A non-binding resolution by the Parties called for a phaseout of hydrochlorofluorocarbons (HCFCs) by the year 2020 if feasible and no later than 2040. The Protocol allows developing countries (listed in Article V, paragraph 1 of the agreement) a ten year grace period. A summary of key provisions of the Protocol is presented in Appendix B.

The November 1992 Meeting

29. Recent scientific data on ozone depletion over the past decade suggest that depletion has been occurring at a rate twice as fast as originally observed. For example, at latitudes where 2 percent depletion had been observed over the last decade, this new study, based on satellite data, shows that actual depletion is 4 to 5 percent. This information will be considered by the Parties to the Protocol in November, 1992, and could well lead to accelerated phaseout dates for CFCs and halons, as well as more stringent interim reduction deadlines for all controlled substances.

Opportunities Available through the Interim Multilateral Fund to Assist Developing Countries in Technology Transfer

30. In addition to setting a regulatory timetable to phase out controlled substances, at the June 1990 Meeting of the Parties in London, the Parties established by decision a US$200 million (US$240 million if India ratifies the Protocol) Interim Multilateral Fund ("Fund") to finance the incremental costs to developing countries that are Party to the Protocol of eliminating their use of controlled substances. The Fund was established in January 1991. It is managed by an Executive Committee of fourteen Parties including seven developing and seven industrialized countries. The

Fund's implementing agencies are the World Bank, the United Nations Environment Program, and the United Nations Development Program. Financial and technical assistance from the Fund are available only to Parties operating under Article V, paragraph 1 of the Montreal Protocol. These countries are listed below in Exhibit II-1.

EXHIBIT II-1

DEVELOPING COUNTRIES CURRENTLY ELIGIBLE FOR ASSISTANCE UNDER THE INTERIM MULTILATERAL FUND

1. Argentina
2. Bangladesh
3. Botswana
4. Brazil
5. Burkina Faso
6. Cameroon
7. Chile
8. Costa Rica
9. **Ecuador**
10. Egypt
11. Fiji
12. The Gambia
13. Ghana
14. Guatemala
15. Iran
16. Jordan
17. Kenya
18. Libya
19. Malawi
20. Malaysia
21. Maldives
22. Mexico
23. Nigeria
24. Panama
25. People's Republic of China
26. Philippines
27. Sri Lanka
28. Syrian Arab Republic
29. Thailand
30. Togo
31. Trinidad and Tobago
32. Tunisia
33. Turkey
34. Uganda
35. Uruguay
36. Venezuela
37. Yugoslavia
38. Zambia

Notes:

1. Poland, Hungary, Bulgaria and Czechoslovakia are Parties to the Protocol but are not considered "developing countries" and, therefore, do not qualify for funding under the Multilateral Fund. However, since they are Parties to the Protocol and have per capita income under $4,000, they qualify for funding for stratospheric ozone related projects under the Global Environmental Facility.

Eligibility Criteria for Funding under the Interim Multilateral Fund

31. This Fund finances projects in Article V countries that achieve a reduction in the production, consumption, or emission of controlled substances. Such funding is available only to projects in countries such as Ecuador which are Party to the Montreal Protocol and satisfy the project eligibility and funding criteria outlined below. These criteria were determined by the Executive Committee of the Fund. Section III of the Draft Report of the Third Meeting of the Executive Committee for the Interim Multilateral Fund Under the Montreal Protocol contains the latest draft of the project eligibility criteria. These criteria are summarized as follows:

- Financial and technical assistance from the Fund shall be available only to Parties operating under Article 5, paragraph 1 of the Montreal Protocol.
- All projects (e.g., training, technical assistance, pre-investment studies, country program preparation, technology development, or manufacturing facility related) must receive approval of the requesting country's government.
- Financial assistance for capital investment projects shall be available for the following categories of incremental costs:[4]
  - Supply of substitutes (i.e., costs of conversion, costs arising from premature retirement of equipment, costs of new production for alternative facilities, net operational costs, and costs of importing substitutes).
  - Use in manufacturing as an intermediate good (i.e., cost of conversion, patents, capital, retraining, research and development, and net operational costs).
  - End use (i.e., cost of premature replacement of equipment, cost of recovering and recycling controlled substances, and costs of providing technical assistance to reduce consumption of controlled substances).
- Assistance for other categories of incremental costs associated with capital investment projects requires approval by the Executive Committee.
- Projects other than capital investment projects shall also qualify for assistance under the Fund (e.g., technical assistance and clearinghouse functions).
- Financial and technical assistance shall be available for projects that are cost-effective and based upon environmentally sound alternative technologies or substitutes.

[4] Draft Report of the Third Meeting of the Executive Committee for the Interim Multilateral Fund Under the Montreal Protocol, Appendix I, "Indicative List of Categories of Incremental Cost", Montreal April 15-19, 1991.

III. ECUADOR'S CONSUMPTION OF CONTROLLED SUBSTANCES AND SUBSTITUTION POSSIBILITIES

A. Consumption of Controlled Substances

32. **Sources.** Ecuador meets its consumption of controlled substances through importation; exports are negligible. The majority of Ecuador's consumption of controlled substances consists of CFC-11 and CFC-12, with some consumption of carbon tetrachloride (TET), methyl chloroform (MCF), and halons. According to data collected from Ecuador's Central Bank[5], amounts of controlled substances consumed have varied considerably over the past five years (1986-1990). The average quantity of annual consumption over the past five years for each substance is as follows:

Substance	Average Consumption in Metric Tons (1986-90)
CFC-11 and CFC-12	653.6[6]
CFC-114	50
MCF	6.8
TET	0.9
Halons	15

33. The 1990 consumption estimates are as follows (figures are also shown in Exhibit III-1):

Substance	Estimated 1990 Consumption in Metric Tons[7]
CFC-11	96
CFC-12	548
CFC-114	50
MCF	12
TET	2
Halons	15

[5] Data from Ecuador's Central Bank is classified according to the Ecuadorean tariff schedule of 1986-1990 (i.e., not harmonized with international tariffs). The tariff schedule data does not distinguish between CFC-11 and CFC-12.

[6] In addition, this figure excludes 1988, when the imposition of a tax on CFCs in the United States contributed to an unusually high amount of 2,669 metric tons being consumed.

[7] CFC-11 and CFC-12 data have been separated based on industry estimates of consumption of controlled substances in each end use.

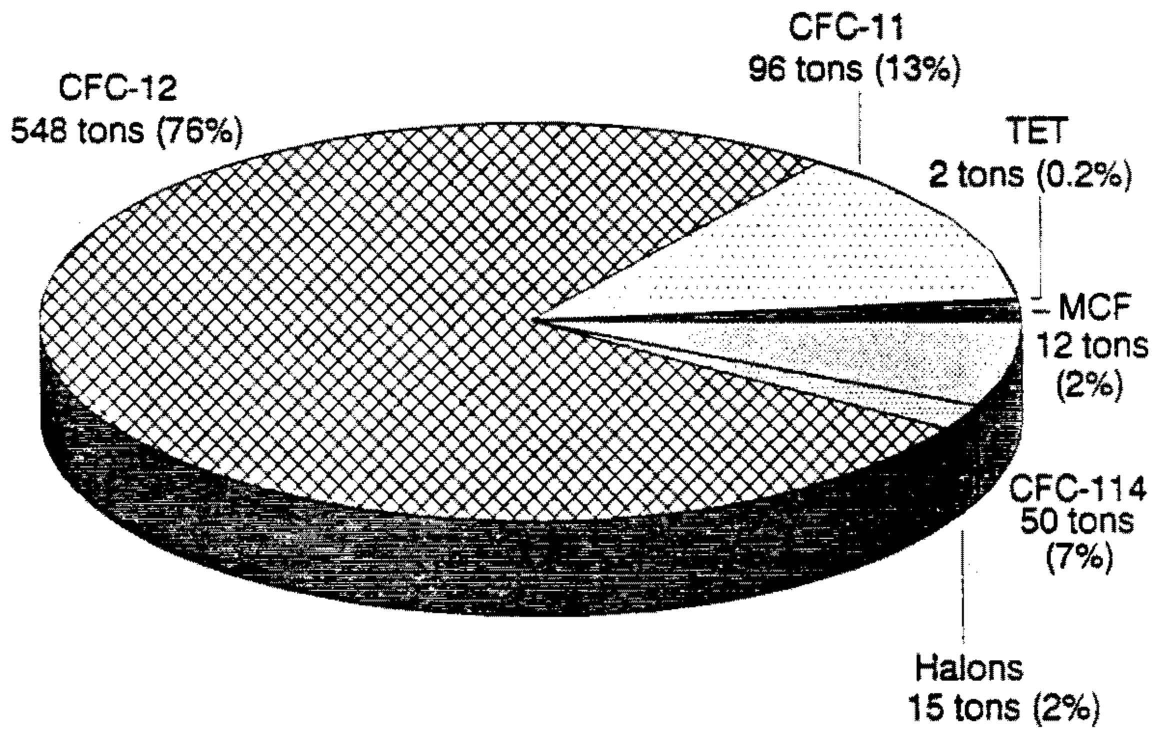
34. Ecuador obtains its supply of CFC-11 and CFC-12 from Germany, the Netherlands, Spain, the United Kingdom, the United States, and as of 1990, Belgium, Brazil, Colombia, and Mexico. As shown in Exhibit III-2, the United Kingdom, Brazil, and the United States accounted for the largest shares of imports. Only the United States, Germany, and the United Kingdom exported MCF and TET to Ecuador from 1986 to 1990. Exhibits III-2 and III-3 show the countries of origin for 1990 consumption of CFC-11 and CFC-12, TET, and MCF.

Exhibit III-1

Consumption of Controlled Substances by Type

(Estimates Based on Actual Metric Tons Imported in 1990)

Ecuador, 1990



Total Consumption: 723 Metric Tons

Source: World Bank 1991.

Note: Figures are not weighted by the ozone depletion potential of each substance.

Exhibit III-2

Consumption of CFC-11 & CFC-12 by Country of Origin
Ecuador, 1990

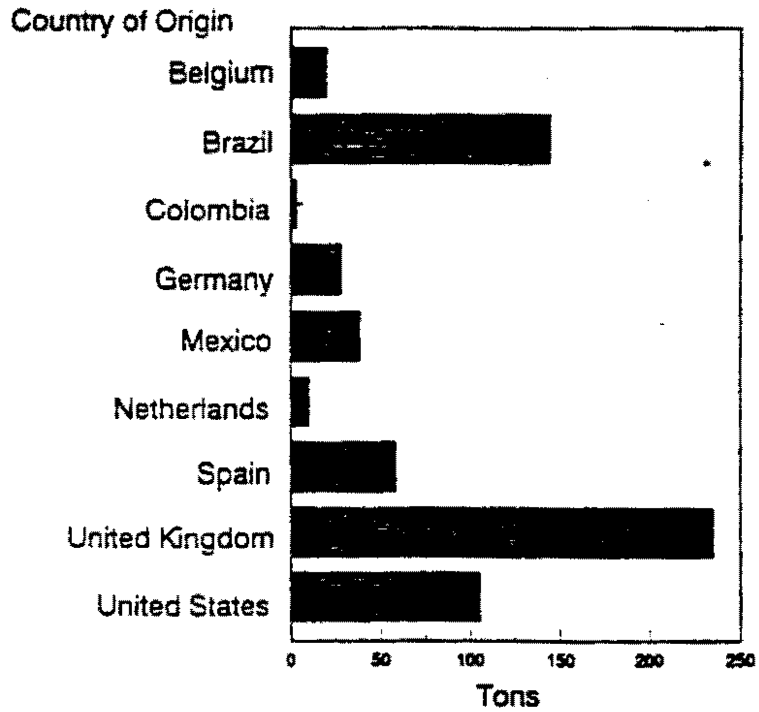
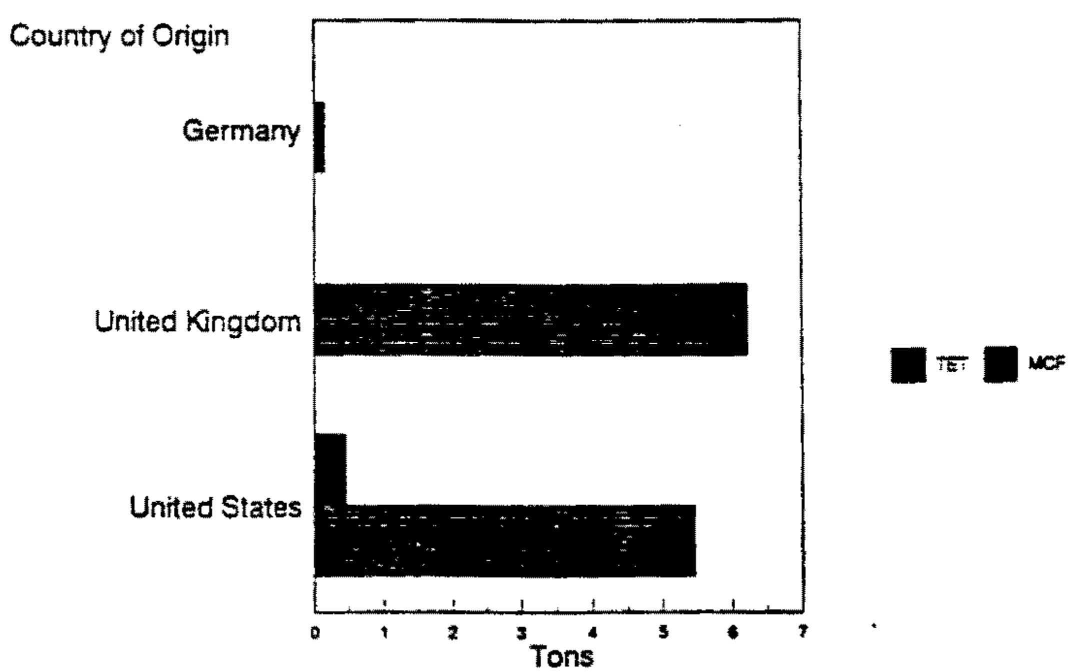


Exhibit III-3

Consumption of TET & MCF by Country of Origin
Ecuador, 1990



Source: World Bank 1991

B. Prices, Import Tariffs and Other Regulations

35. A 5 percent import tariff was imposed on all categories of controlled substances that were imported into Ecuador in 1990. Using the exchange rate information provided in Exhibit III-4, and the tariff schedule provided in Exhibit III-5, the approximate 1990 price per kilogram (with import tariff included) for CFC-11 and CFC-12 was US$2.34/kg (1818.60 Sucres/kg), while the price for TET and MCF was US$8.61/kg (6691.52 Sucres/kg) and US$0.99/kg (769.41 Sucres/kg) respectively (see Exhibit III-6). No special import permits are required. As can be seen from Exhibit III-6, the price for TET has varied considerably and maintains little consistency with the international price for this substance. For the most part, this is due to a large fee imposed by the Ecuadorean Government on TET as part of its efforts to discourage its use in manufacturing narcotics.

Exhibit III-4
Exchange Rate of Sucres/USD
Ecuador, 1990

Year	Sucres / USD
1986	124.98
1987	193.80
1988	343.27
1989	543.09
1990	777.18

Exhibit III-5
Tariff Schedule for Controlled Substances
Ecuador, 1990

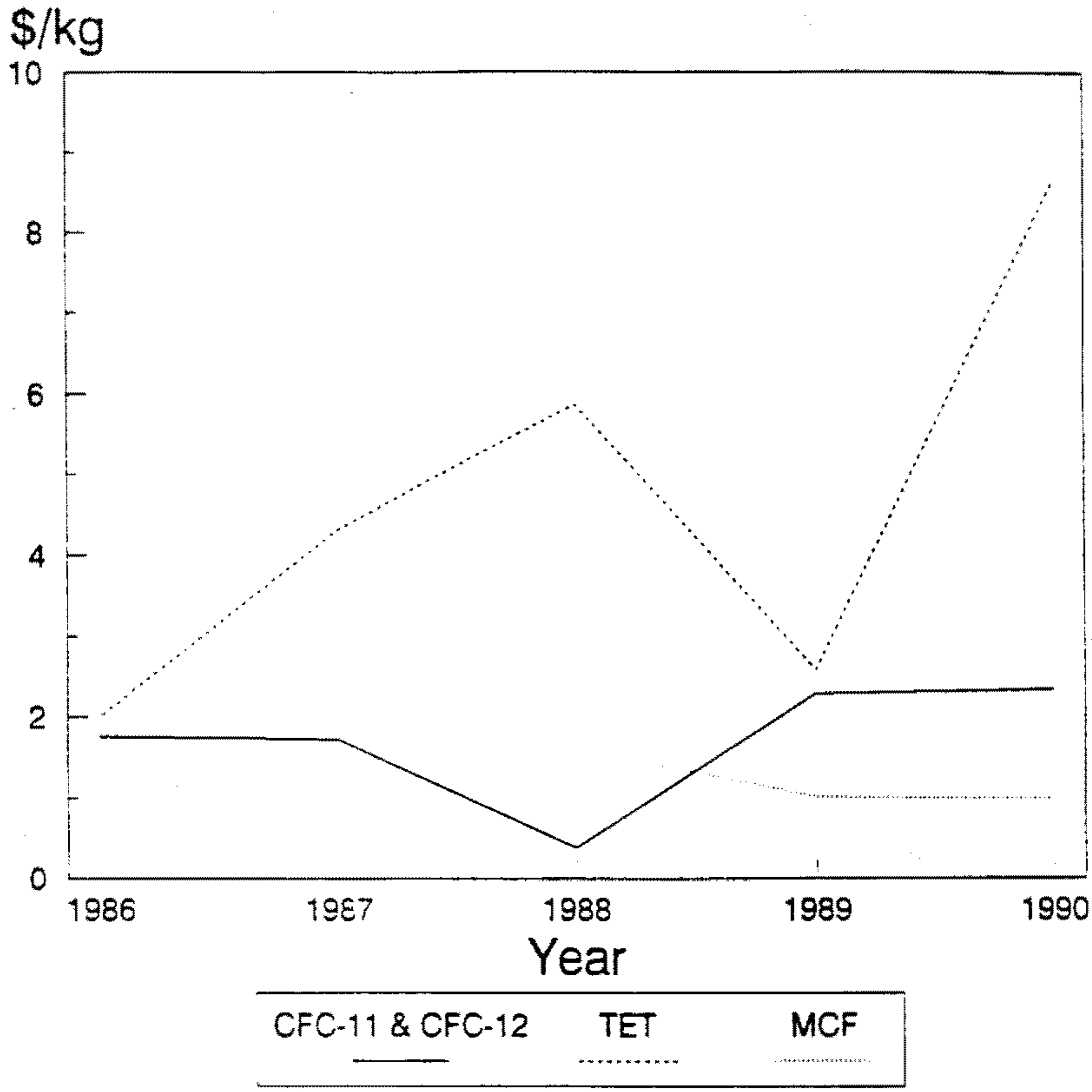
Tariff Schedule	Product	Tariff
29.02.02.06 (a) 2903.40.10.00 (b)	CFC-11 & CFC-12	5%
29.02.01.11 (a) 2903.14.00.00 (b)	TET	5%
29.02.01.13 (a) 2903.19.10.00 (b)	MCF	5%
29.02.01.99 (a) 2903.19.90.00 (b)	Others	5%

(a) 1986-1989 Tariff Schedule
(b) 1990 Tariff Schedule (Harmonized)

Source: Dept. of Monetary Policy of CONADE

Exhibit III-6

Prices per kg for Imported Controlled Substances Ecuador, 1990

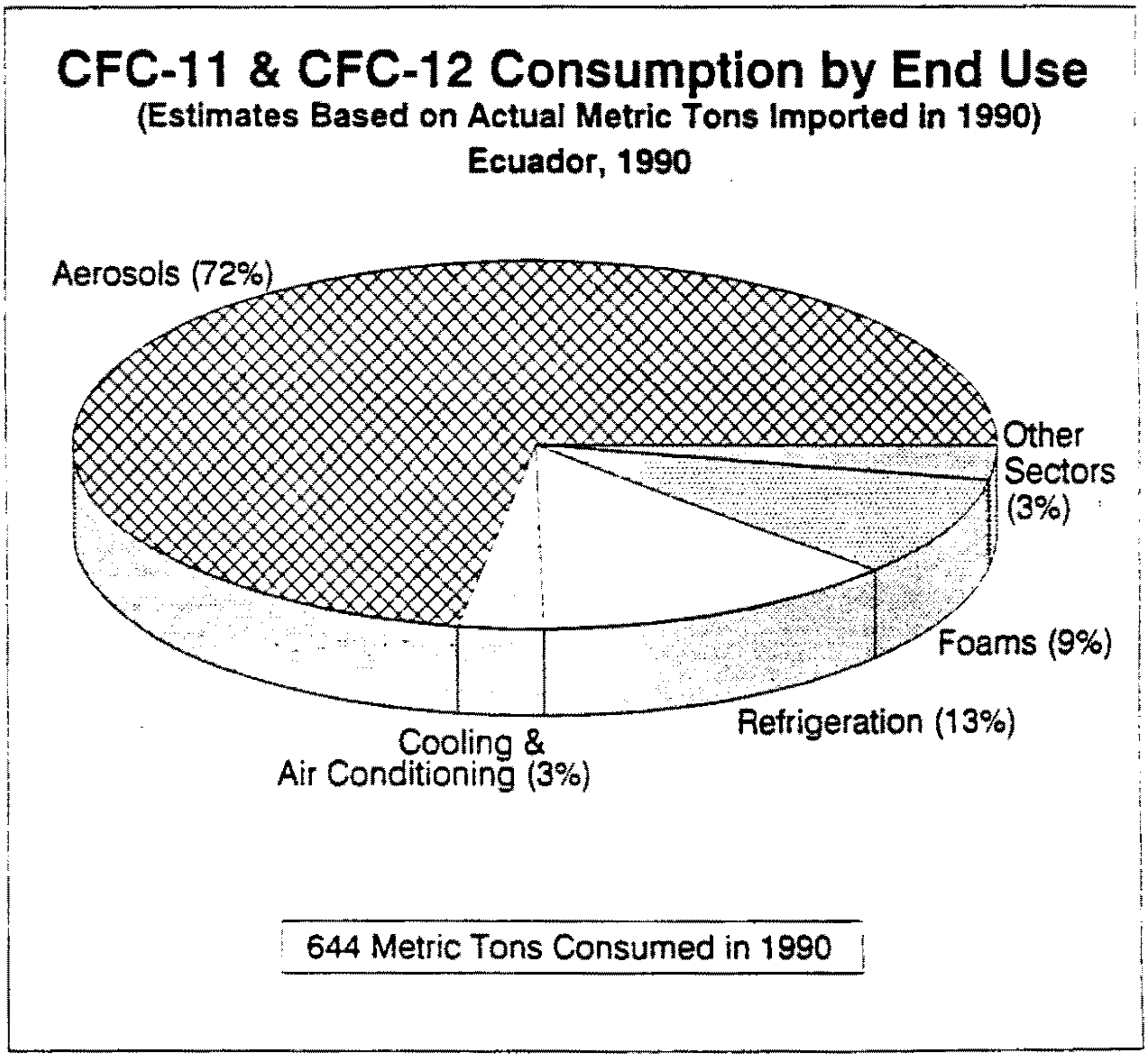


Source: Central Bank of Ecuador
Note: Import tariff included in price; price is in USD

C. Current Consumption Technology and Equipment Characteristics by End Use

36. Exhibit III-7 shows CFC-11 and CFC-12 consumption by end use in Ecuador in 1990. Aerosols represented the greatest use of these controlled substances with 72 percent of 644 total metric tons consumed in 1990. Aerosols were followed by refrigeration with 13 percent, foams with 9 percent, cooling and air conditioning with 3 percent, and miscellaneous uses accounted for 3 percent. Growth in the demand for controlled substances in Ecuador is estimated by various Ecuadorean industry sources to be between two and five percent per year.

Exhibit III-7



Source: World Bank 1991

37. There was no data available for consumption by end use for TET and MCF in 1990. However, it is believed that most of the TET and MCF are used for metal and electronic cleaning applications. Halons are used as fire-extinguishing agents although no data is available on the specific halon end-uses (e.g. portable units, stationary systems, etc.).

38. Most of MCF consumption is used for cleaning operations, with the rest being used for adhesive applications. Specific uses of solvents in the electronics industry include those related to cleaning automotive electrical systems, military electronics, and printed circuit boards and components.

Aerosols

39. Exhibit III-8 shows the distribution of aerosol units produced in Ecuador in 1990 by product type. Deodorants account for the largest share of production, followed by insecticides and household products, hair sprays, and other products. The Ecuadorean aerosol industry is presently experiencing a two to five percent growth rate. In recent years, Ecuador's domestic production has been between 5 to 6 million cans per year, with approximately 6.2 million units produced in 1990.

40. There is no present data on imports; however, a review of shelf space in two supermarkets revealed the presence of aerosol products manufactured in the U.S. Thus, these imports are likely to use hydrocarbon propellants. Moreover, Ecuador's exports of aerosol products are negligible.

41. Currently, the predominant propellant used in 98 percent of aerosol products is CFC-12, with approximately 500 tons of CFC-12 used per year. There is growing awareness and increasing concern among domestic manufacturers about finding a safe and cost-effective substitute for CFCs. In light of this, many manufacturers are evaluating CO_2 as a substitute propellant for CFCs. However, CO_2 has not received acceptance in industrialized nations due to poor performance characteristics related to variable spray quality. Thus, other alternatives, such as hydrocarbons, may be better long-term solutions. Presently, however, hydrocarbons such as isobutane, propane, and butane of "aerosol grade" purity are not available in Ecuador. One of the projects described in this program will ensure adequate supply of hydrocarbon propellants.

42. The Ecuadorean market for aerosol products is fairly concentrated. These manufacturers account for over 70 percent of the market. In total, there are six large and several small manufacturers. Most of the large plants have one or two lines with in-line equipment of up to 100 cans/min. However, most of those manufacturers are currently operating below capacity due weak consumer demand for these products.

Refrigeration

43. CFC-12 consumption in the refrigeration sector has been noticeably decreasing, with HCFC-22 and CFC-502 as the replacement refrigerants of choice. Both of these replacements have much lower ODPs than CFC-12. However, both can be considered only interim solutions. Data gathered on the consumption of CFCs by type of cooling system indicates that CFCs are used in both commercial and residential refrigeration. Residential refrigeration includes home refrigerators, freezers, and other small refrigerated appliances such as ice machines and dehumidifiers. CFCs are used as refrigerants in the following types of commercial systems in Ecuador:

- Retail food storage, used to refrigerate food and beverages in grocery and convenience stores;
- Chillers, air conditioning systems in large commercial and industrial buildings, including office buildings, hospitals, schools, and factories;
- Cold storage, refrigerated spaces such as warehouses that are used to store meat, produce dairy products, and other perishable goods;
- Industrial process refrigeration, used in large-scale engineering applications, chemical processing, petrochemical and refinery applications, and large-scale ice manufacture; and
- Refrigerated transport, including refrigerated trucks, trailers, and rail cars.

44. The major user of CFC-12 for retail refrigeration and cold storage in 1990 was a large supermarket chain with 0.91 metric tons consumed. However, this firm is in the process of phasing out CFC-12 and replacing it with CFC-502.

45. CFCs are released from commercial refrigeration systems and air conditioners during: (1) manufacturing - including CFC used for leak testing, and CFC emission from reworked units; (2) installation; (3) use and servicing on-site; and (4) product disposal. CFC emissions during use, servicing, and disposal far exceed those resulting from manufacturing and installation.

Foams

46. In the foams sector, CFC-11 is the most common blowing agent. In CFC-11 and CFC-12 consumption by end use, foams accounted for 9 percent of the total in 1990. Flexible polyurethane foam is used for furniture, bedding, carpet underlays, automotive interiors, and other transportation seating applications. Rigid polyurethane foam is used for insulation in refrigerators, freezers, buildings, tanks, pipes, and doors.

Cooling and Air Conditioning

47. Mobile air conditioners, which cool the passenger compartments of automobiles, trucks, and buses, represent a small use of CFC-12 in Ecuador. CFCs are used to charge new vehicle air conditioners and to replace the charge lost while operating the vehicles. Gas stations and automobile dealerships in Ecuador service mobile air conditioning systems.

EXHIBIT III-9

COMMERCIALLY AVAILABLE TECHNOLOGIES FOR MAJOR END USES IN ECUADOR

REFRIGERATION	COOLING/AIR CONDITIONING
Recovery/Recycling/Reclamation HCFC-22 Ammonia HFC-134a	Recovery/Recycling/Reclamation High Efficiency Purge Equipment Absorption Chillers HCFC-123 HFC-134a HCFC-22
FOAMS	**AEROSOLS**
CFC Recovery/Recycling Water Blown Foam HCFC-22	Hydrocarbons Alternative Application Methods HCFCs and HFCs Ethers Compressed Gases (e.g., nitrogen)
CLEANING	**FIRE PROTECTION**
Recovery/Recycling/Reclamation Controlled Atmosphere Wave Soldering Aqueous Cleaning Semi-aqueous Cleaning HCFC-based Cleaning Low-solids/No Clean Flux Alcohols	Decreased Halon Discharge for Training and Testing Recycling Non-halon Systems
ADHESIVES, COATINGS, AND INKS	**STERILIZATION**
Water-based Adhesives Hot-melt Adhesives Solvent Recovery Water-based Coatings High-solid Coatings Petroleum Distillates	Pure Ethylene Oxide (EO) EO Diluted Mixtures Pre-sterilized. Disposable Products

48. A large company, which holds 50 percent of the market for mobile air conditioners using CFC-12, is introducing recycling in 10 percent of their operations. Another company which has approximately 30 percent of the market for the servicing and installation of mobile air conditioning is not using recycling at this time.

Other Sectors

49. Small amounts of controlled substances are used in other end uses such as fire protection, cleaning operations and adhesives.

50. The annual consumption of Halon-1211 in Ecuador is estimated to be between 10 and 15 metric tons. Halons are supplied in metallic containers of different sizes, and are generally imported by firms engaged in the fire-extinguishing equipment business. For example, the Servicio y Seguridad Co. (SERVISEG) is the major user of Halon-1211 in Ecuador with 5 metric tons in 1990. An interview with the head of the Ecuadorean Firefighters Association (EFA) revealed that since 1990, EFA has issued a recommendation not to use halons in fire-extinguishing equipment. Instead, they recommend that carbon dioxide be used as a substitute. The high cost of halons restricts the use of these controlled substances in Ecuador.

D. Commercially Available and Emerging Substitute Technologies for Controlled Substances

51. For Ecuador to successfully implement the phaseout of controlled substances, it will require both commercially available and emerging substitute technologies for controlled substances. For the purposes of this document, commercially available technologies are defined as process controls, chemical substitutes or alternative processes that 1) reduce or eliminate the use of controlled substances, 2) are available today in the international marketplace, and 3) have been successfully employed in several applications. A summary of commercially available technologies is contained in Exhibit III-9. Emerging technologies are defined as likely chemical substitutes or alternative processes for controlled substances that are expected to become available in the early to mid-1990s. These technologies are listed in Exhibit III-10.

52. Some technologies that are already commercially available have not yet been accepted for widespread use. "Emerging" technologies will become "commercially available" as technology develops and alternatives to controlled substances are accepted for use in further applications.

53. Commercially available technologies to be applied to a specific end use of a controlled substance can consist of a change in operating practice, a control technology, a substitute chemical, or an alternative process technology. The major categories of end uses in Ecuador are defined as follows:

- **Aerosols:** Includes products where methyl chloroform (MCF) or CFCs function as solvents or propellants in aerosol formulations.

- **Refrigeration:** Includes cold storage and refrigeration systems used in large-scale industrial processes, as well as small-scale appliances.

- **Cooling and Air Conditioning:** Includes process and building chillers, and cooling of passenger compartments of vehicles.

- **Foams:** CFCs are used as blowing agents in the production of insulation, foams, and packaging materials.

- **Other End Uses:** This includes solvent cleaning of metals, electronics, and precision components; fire protection applications in which halons are used in portable extinguishers (Halon 1211) and installed systems (Halon 1301); adhesives where MCF is used; and sterilization where CFC-12 is used.

Commercially Available Technologies

54. Aerosols. Most Ecuadorean aerosol products that currently use CFC-12 or methyl chloroform (MCF) can be reformulated with alternative compounds. Several alternative control technologies can reduce MCF use in aerosol products. These include the following:

i) reformulating aerosols to hydrocarbons (propane, n-butane, isobutane, and pentanes)[8];

ii) switching to alternative methods of product application (e.g., pumps, sprays, sticks) to eliminate the need for the aerosol delivery system;

iii) using HFC and HCFC-based systems (HCFC-22, HFC-152a, and HCFC-142b are commercially available, while HCFC-123, HCFC-124, HFC-134a, HFC-125 and HCFC-141b are emerging chemical substitutes); and

iv) using ethers such as dimethylether (DME) and diethylether (DEE) which are currently available.

[8] Existing manufacturing equipment using CFC propellants can also be used to fill with hydrocarbon propellants, with some minor adjustments. Changes include incorporating a safety review of the gas storage distribution system, and constructing a filling station to minimize the risk of fire. An innovative concept for aerosol filling with flammable hydrocarbons has been successfully introduced in Mexico and could also be adapted to Ecuador. Further discussion of this concept is presented in Section IV-E.

EXHIBIT III-10

EMERGING TECHNOLOGIES FOR MAJOR END USES IN ECUADOR

<table>
<tr><th>REFRIGERATION</th><th>COOLING/AIR CONDITIONING</th></tr>
<tr><td>HCFC-125
HCFC-22/HCFC-124/HFC-152a Blend
Stirling Cycle
Non-azeotropic Refrigeration Mixtures (NARMs)
HFC-152a</td><td>Ether (E-134)
HCFC-22/HCFC-124/HFC-152a Blends
HCFC-124</td></tr>
<tr><th>FOAMS</th><th>AEROSOLS</th></tr>
<tr><td>HCFC-123
HCFC-141b
HCFC-22
HCFC-142b</td><td>HCFC-142b
Wider Use of Alternative Application Methods
HCFC-22</td></tr>
<tr><th>CLEANING</th><th>FIRE PROTECTION</th></tr>
<tr><td>Pressurized Gases
Super Critical Fluids
Plasma Cleaning
Ultraviolet Light Ozone Cleaning

Wider use of:
Semi-aqueous Cleaning
HCFC-based Cleaning
Aqueous Cleaning</td><td>Alternative Fluorinated Chemicals
Carbon Dioxide</td></tr>
<tr><th>ADHESIVES, COATINGS, AND INKS</th><th>STERILIZATION</th></tr>
<tr><td>Improved versions of:
Water-based Adhesives
Hot-melt Adhesives
Water-based Coatings
High-solid Coatings</td><td>HCFC Blend
EO/Carbon Dioxide Mixtures</td></tr>
</table>

59. In the manufacture of flexible polyurethane foams (used in packaging materials), CFC-11 used as a blowing agent provides cell formation, cooling of the chemical reaction, and softness to the foam product. Since open-cell flexible foam products do not retain most of the blowing agent, a significant contribution to CFC reduction can be achieved through capture and reclamation of the blowing agent during production.

60. For polystyrene sheet foam products, such as food service and packaging items, CFC-12 is the most common blowing agent. However, HCFC-22 can easily be substituted for CFC-12 in most of these polystyrene products with little or no loss in product quality. HCFC-22 has a far lower ozone depletion potential than CFC-12. In addition, it is non-flammable, low in toxicity, and exhibits high chemical and thermal stability.

61. **Cleaning Operations** The solvents used in Ecuadorean electronics and metal cleaning operations are CFC-113 and methyl chloroform (MCF). The first step to significantly reduce consumption of ozone-depleting solvents is to implement recycling and other conservation measures. Recycling and conservation measures are especially important in the near-term while new processes and substitutes are being developed and tested for use in specific applications or as other production changes are made to eliminate CFC-113 or MCF use altogether.

62. Specific engineering controls include adding filtration equipment, modifying the cleaning and assembly sequence to reduce cleaner use, wrapping parts between assembly steps, or wearing gloves while handling parts to eliminate the need for manual cleaning. Suggested improvements in metal cleaning operating procedures include physically removing large contaminants prior to degreasing and centrally locating systems for removing heavy contaminants to decrease the amount of cleaner used (UNEP Solvents 1989). Controls for batch degreasers used in electronics cleaning include retrofitting or redesigning with increased freeboard height, retrofitting automatic hoists and programming them for proper entry and exit speeds, and adding degreaser lids or covers that automatically close when the assembly is removed (U.S. EPA 1990). For in-line cleaners, specific controls include increased freeboard height, increased compressor capacity, extra cooling coils on inlets and outlets, and the optimization of cleaner configuration to handle output from two or more soldering machines (UNEP Solvents 1989).

63. New processes include aqueous and semi-aqueous cleaning systems. Both systems can be used for some applications in the Ecuadorean electronic and metal parts industries. Several other processes are also available. One is the low solids flux/"no clean" assembly. By carefully evaluating and selecting components and assembly processes, low solids fluxes can be used to eliminate cleaning in some instances. For instance, a new soldering process, inert gas wave soldering (or controlled atmosphere soldering), operates under a nitrogen atmosphere which prevents the formation of oxide contaminants and thus eliminates the need for solvent cleaning.

64. At least five organic solvents and HCFCs have been identified as possible substitutes for CFC-113 and MCF in electronics and metal cleaning applications: pentafluoropropanol, isopropanol, HCFC-225ca, HCFC-225cb, and an HCFC-141b/HCFC-123/methanol blend. Preliminary data suggest that these solvents have good cleaning performance.

55. **Refrigeration** There are a number of commercially viable technologies in the refrigeration sector. They include: recycling, engineering controls, and substitute refrigerants. Recycling and other conservation practices are economically feasible methods of immediately reducing and eliminating unnecessary emissions of CFCs and refrigerant substitutes. Recycling also ensures maintenance of a reserve of recycled CFCs, which can be used to service existing capital equipment. Certain applications in Ecuador, such as food preservation in cold storage equipment, can cause significant fugitive emissions. One possible control option is to install leak detection systems in compressor rooms and line/case trenches to identify leaks as they occur and to inform maintenance personnel of needed repairs. Finally, alternative refrigerants that can replace CFC-12, CFC-114, CFC-500, and CFC-502 in some applications include ammonia, HFC-134a, and HCFC-22.

56. **Cooling and Air Conditioning** Recycling equipment has been developed to service chillers and other large systems with capacities of 500 to 5,000 pounds. These recycling machines can be dedicated to one chiller system full time or mobilized to service multiple systems. Recycling units can also be adapted to other refrigeration systems. Recycling systems can reduce CFC emissions by 95 percent or more. Chillers lose refrigerant during normal operation due to purging. New purge systems can reduce refrigerant losses associated with this process by up to 98 percent. HCFC-123 has proven to be an effective substitute refrigerant for CFC-11 in commercial chillers. HCFC-123 is a virtual drop-in substitute for CFC-11 in most open shaft applications, with only minor system material changes required to retrofit existing CFC-11 units. New equipment designed specifically for HCFC-22 is also commercially available. One possible replacement for CFC-based chillers are lithium bromide (absorption) systems. Such systems can be gas-fired or powered using waste heat at the correct temperature.

57. Equipment is also now available to recover and recycle CFC-12 refrigerants from mobile air conditioners (MACs). These refrigerants would normally be vented to the atmosphere during servicing and/or repair. The most viable candidate refrigerant to replace CFC-12 in MACs is HFC-134a. This non-ozone depleting chemical has thermodynamic properties that are similar to those of CFC-12. HFC-134a is not, however, a drop-in replacement for CFC-12. As a result, system changes are necessary to successfully convert CFC-12-based systems to this refrigerant. In addition, HFC-134a is a potent greenhouse gas. Thus, recycling equipment is being developed to conserve its use.

58. **Foams** In Ecuador, CFC-11 is used as a blowing agent in the production of rigid polyurethane foam used for appliance insulation and polyisocyanurate foam board used in building insulation. The presence of CFC-11 in the cells of foam gives it high thermal resistance and enhances its value as an insulator. One alternative the Ecuadorean foam industry can use to achieve CFC reductions is to increase the substitution of water for CFC-11. Water reacts with the isocyanate to generate carbon dioxide as a blowing agent. One drawback of this technology is the higher thermal conductivity of the resulting foam as compared with the CFC-11 based foam. However, product improvements have helped minimize the difference in energy consumption between different foam systems. In fact, low-CFC foam has been successfully introduced in Europe and in parts of Asia.

Emerging Technologies

70. There are various technologies which are expected to become available in the early-to-mid 1990s. These are discussed below by end use:

Aerosols HCFCs, such as HCFC-142b and HCFC-22 are considered future feasible replacements for methyl chloroform (MCF) in applications where non-ozone-depleting alternatives or substitutes exist. For example, this would include instances where a non-flammable solvent/propellent system is essential. Prototype formulations for aerosol electronic cleaners are under development.

71. **Refrigeration** Extensive research and testing has been completed to identify potential substitutes for CFCs in refrigeration applications. Several new refrigerants and older ones being reconsidered exhibit the appropriate thermodynamic properties, and acceptable toxicity, flammability, and energy-efficiency criteria. Many of the potential substitutes are currently undergoing testing and will be available for use when they have received international approval.

72. One promising option to replace CFC-12 in large-scale refrigeration end uses is a ternary blend of HCFC-22 (36 percent), HFC-152a (24 percent) and HCFC-124 (40 percent). The ternary blend has thermodynamic properties which match CFC-12 closely. Other advantages include a 3 percent increase in energy efficiency compared to CFC-12 and an ozone-depleting potential (ODP) of 0.03 (UNEP Refrigeration 1989). Certain CFC-12 systems may also be retrofitted to use the ternary blend. For small-scale refrigeration, near- and mid-term alternatives include ternary blends, HFC-152a, and non-azeotropic refrigerant mixtures (NARMs).

73. In the long-term, alternative cooling cycles may replace the traditional refrigerant-vapor compression cycle in some uses. For example, a modified Stirling cycle using a non-CFC refrigerant has been demonstrated in a working home refrigerator. A modified Stirling cycle differs from the standard vapor compression cycle in two ways: 1) the Stirling cycle does not depend on a phase change for heat transfer, and 2) the heat is transferred during a constant volume process rather than a constant pressure process.

74. **Cooling and Air Conditioning** While HFC-134a is the most viable solution for mobile air conditioners (MACs), other substitute refrigerants are also emerging. MAC systems may also be retrofitted to operate with near-azeotropic ternary blend refrigerants.

Foams There are a number of possible replacements for CFCs for insulating foam applications. HCFC-123 and HCFC-141b are possible interim substitutes for applications presently using CFC-11. Both exhibit physical properties similar to those of CFC-11 (boiling point, vapor thermal conductivity, and heat of vaporization), and both have significantly lower atmospheric lifetimes and lower ODPs than CFC-11 (ODPs of 0.02 and 0.12, respectively).

75. HCFC-22 and HCFC-142b are considered the leading replacement candidates in the packaging foam industry. HCFC-22 can be substituted for CFC-12 in the manufacture of some extruded polystyrene products. HCFC-22 has a far lower ODP than CFC-12 (0.05 compared to

65. An important category of cleaning is precision cleaning. Precision cleaning applications are defined as those where: 1) rigorous cleanliness standards of particulate and/or organic contaminants need to be satisfied, 2) the components have sensitive compatibilities, 3) the components have physical characteristics such as geometry and porosity which make de-watering crucial in the cleaning process, or 4) the components being cleaned are costly. A wide variety of alternative solvents can be considered as possible replacements in precision cleaning applications. In addition to the HCFCs, non-toxic solvents such as ethanol, isopropanol, several glycol ethers (methyl, n-butyl, and diethyl cellosolve), and the family of ketones (e.g. acetone) are also potential replacements. Many of these solvents have high polarity which contributes to their cleaning capability.

66. __Fire Protection__ Currently, halons are a preferred but not essential choice in a wide variety of fire protection applications in Ecuador. A number of control options exist to reduce and eliminate halon emissions from fire extinguishing systems during service and disposal, installation, and original equipment manufacture (OEM). These include eliminating halon discharge during training, utilizing alternative substances for discharge, using new detection systems to avoid false discharges, decreasing the frequency of system teardown, increasing recovery of halon during manufacturing and servicing, and recommending existing alternatives to halon (i.e., water, foam, powder, carbon dioxide, and alternative fire prevention strategies).

67. __Adhesives, Coatings, and Inks__ Methyl chloroform (MCF) is used in specialized adhesive applications because it dissolves many resins (the binding substance used in adhesives) and is non-flammable. The use of MCF may be reduced or eliminated by the use of substitutes such as water-based and hot melt adhesives, and by the use of solvent recovery systems. For coatings applications, MCF can be replaced with water-based and high-solids coatings. Water-based coatings contain water rather than conventional solvents. They are applied using methods similar to those used for high-solid coatings. Recent advances in technology have improved the dry-time, durability, stability, adhesion, and application of water-based coatings. High-solid coatings resemble conventional solvent coatings in appearance and use; however, high-solid coatings contain less solvent and a greater percentage of resin.

68. __Sterilization__ Currently, ethylene oxide (EO) is widely used for gas sterilization of medical equipment and devices. EO is especially useful for sterilizing heat sensitive products; however, EO is toxic, mutagenic, a suspected carcinogen, flammable, and explosive. In order to reduce flammability and explosion risks, EO is diluted with CFC-12. A commonly used mixture, known as "12/88" consists of 12 percent EO and 88 percent CFC-12 (by weight). Most users of "12/88" could switch to pure EO (UNEP Aerosols 1989).

69. As in many of the end use categories, recycling is an attractive alternative for sterilization. Add-on engineering systems are available for recycling CFC-12 and ethylene oxide (EO). These systems require handling of pure EO (with the necessary safety precautions) to replace lost amounts. All of the CFC-12 could be reclaimed in these systems using a cryogenic system. This could be cost effective on a large scale (UNEP Aerosols 1989). Using pre-sterilized, disposable products are another possible alternative to enable hospitals to reduce their dependence on CFC-12.

IV. PROPOSED IMPLEMENTATION PROGRAM

A. Introduction

83. This section introduces the implementation program by describing Ecuador's commitment to stratospheric ozone protection and by outlining the elements of the program.

84. The commitment of the Government of Ecuador was expressed in Presidential Decree 004 of April 22, 1990, that calls the 1990s the "Decade of Eco-Development." The decree mandates that development plans incorporate environmental considerations, and that projects take into account potential environmental impacts and ways to counter their effects.

85. The National Economic and Social Development Plan, which guides governmental action, incorporates political recommendations, programs, and projects which ensure the rational use of natural resources and environmental protection.

86. In Article 19 of the Constitution of the Republic, personal rights are defined as "...the right to live in an environment free of contamination. It is the government's responsibility to ensure that this right not be violated and that nature be preserved. The law will establish the limits of certain rights and liberties in order to protect the environment."

87. Within this general framework, one can see the importance the government has placed on strengthening international cooperation in the fight against the serious environmental problems that affect humanity. Such is the case with the depletion of the stratospheric ozone layer.

88. The Government of Ecuador signed and ratified both the Vienna Convention and the Montreal Protocol in April, 1990. Consequently, it agrees to abide by all of the regulations established by these international agreements, particularly those established in Article 5 which relate to developing countries.

89. At the present time, Ecuador does not have a centralized environmental agency to direct the actions of the government in the area of stratospheric ozone protection. However, Mr. Rodrigo Borja's administration has vigorously backed a series of proposals to prevent the deterioration of the environment.

90. In order to make its application for technical assistance under the Protocol immediately official, a committee was formed. It includes representatives from various government ministries and from the scientific and business community, with the goal of defining the terms of reference for undertaking a program for assessing the economic costs and technological options for phasing out the use of controlled substances under the Protocol.

91. CONADE, Ecuador's National Development Commission, as the coordinating entity within the committee, began the formalities necessary to gain technical and financial assistance for the completion of the Ecuador country program. Ultimately, CONADE agreed with the United States Environmental Protection Agency (USEPA) and the World Bank to assist in preparation of this document. The Ministry of Industry, Trade, Integration, and Fishing (MICIP) also made

1.0), is non-flammable, low in toxicity, and has high chemical and thermal stability. In most applications, the quality of products made using HCFC-22 is acceptable and comparable to that of products using CFC-12 (UNEP Foams 1989). When used alone or in combination with HCFC-22, HCFC-142b is a blowing agent/insulation gas alternative to CFC-12 in extruded polystyrene foam insulation boards. With an ODP of 0.06 and proven low toxicity, HCFC-142b differs little from CFC-12 with respect to permeability and product quality. Estimates are that HCFC-142b will be available by 1992 or 1993.

76. Another means of achieving CFC reductions in the foams sector is to increase the substitution of water for CFC-11 in rigid appliance insulation foam. Water reacts with isocyanate to generate carbon dioxide as a blowing agent. Additionally, in the future, advanced insulation techniques, such as highly efficient vacuum panels can replace CFC-blown foam in many applications. Extended research is underway to determine a cost-effective way to commercialize vacuum panel technology and to ensure the long-term reliability of the panels.

77. **Cleaning Operations** There is no single mid- or long-term substitute for the many and varied uses of CFC-113 and methyl chloroform (MCF) in cleaning operations. Most applications, however, have one or more options that can be evaluated for adoption in a particular cleaning use. Substitute solvents for CFC-113 and MCF in electronics and metal-fabricating applications which can provide equal or better cleaning performance at equal cost include terpenes (one source is derived from orange peels), organic and alcohol-based solvents, and HCFC solvent blends (UNEP Technology 1989). Other options are aqueous-based cleaning systems and "no clean" systems that eliminate the need for CFCs. In addition to these options, alternatives for precision cleaning applications include several new process technologies such as pressurized gases, super critical fluids, plasma cleaning, and ultraviolet light cleaning.

78. **Fire Protection** DuPont recently announced the introduction of products targeted to replace Halon 1301 in total flooding applications, such as computer rooms and control rooms of chemical plants. Final toxicity testing will soon be completed for these agents. Similarly, replacement chemicals for Halon 1211 in portable extinguisher applications have also been introduced. Existing alternative fire extinguishing agents such as foam, dry chemical, and carbon dioxide can be used more widely in many applications which now rely on Halon 1211.

79. **Adhesives, Coatings, and Inks** . Both water-based and hot-melt adhesives are undergoing improvements to ensure that the replacements will become cheaper than solvent-based systems. In the case of water-based adhesives, no major equipment changes are required and on a per-pound basis such alternatives are cheaper than dry adhesives. In the case of hot-melt adhesives, improvements are being sought to enhance their performance under certain conditions.

80. Improvements in water-based coatings are underway to improve dry-time, durability, stability, adhesion, and application. Similarly, improvements in applying high-solid coatings and powder coatings will increase their potential for use in a wider variety of applications.

81. **Sterilization** The most promising future alternative for the sterilization sector is an HCFC-based, proprietary blend of HCFC-22, HCFC-124, and HFC-152. This blend can serve as a virtual drop-in for existing "12/88" equipment, and could also be used in "10/90" equipment (i.e., equipment using a sterilant blend composed of 10 percent EO and 90 percent carbon dioxide) with minimal changes.

110. The last unit within NOEA, the Studies, Technical Assistance, and Technology Transfer Unit, will coordinate with the National Center for Industrial Development (CENDES) and the Ministry of Public Health in the formulation of programs relating to studies, technical assistance and transfer of technology relating to manufactured substances and the environment.

111. In addition to the three fields of operation, NOEA will also have links with a Technical Advisory Committee composed of experts in the different industry sectors affected by the Montreal Protocol. The proposed Decree declares that the committee will include staff from CENDES and will serve as an advisory board on technical matters involving ozone protection projects and other environmental activities. The Committee will provide recommendations and will delegate all operative aspects to the Control and Environmental Affairs Unit. Committee members will serve three-year terms.

D. Proposed Legal Framework

Presidential Decree

112. The institutional and legal framework for implementing the Montreal Protocol in Ecuador is to be created by a Presidential Decree. This Decree applies specifically to activities related to the importation, production, commercialization, and utilization of ozone-depleting substances as established by the Montreal Protocol.

113. The Decree would establish that the Council for National Development (CONADE) will include initiatives for the application of the Montreal Protocol as part of its development policies.

114. The Decree would define controlled substances as those indicated in Annex A of the 1987 Montreal Protocol and those substances subsequently added to the Protocol for which ratification by the Congress of Ecuador is granted.

115. The Decree would designate the Ministry of Industry, Commerce, Integration and Fisheries (MICIP) as the lead agency in charge of the implementation of the Protocol control measures. The Decree also provides for cooperation between MICIP and other government agencies to be formalized through a number of Ministerial Agreements.

Ministerial Agreements

116. The design and implementation of policies and projects to comply with the Montreal Protocol requires close cooperation between MICIP, the Central Bank, the Ministry of Foreign Affairs, the Ministry of Public Health, and other institutions. The ministerial agreements shall delineate the role of each agency cooperating with MICIP in its ozone protection program. The contents of five such agreements are summarized below:

- In conjunction with MICIP, the Ecuadorean Center of Industrial Development (CENDES) will coordinate specific studies and provide technical assistance in the preparation of ozone protection projects. CENDES has an archive center in Guayaquil which contains informative documents on alternative industrial technologies which would be expanded to include a data bank on substitutes for controlled substances.

substantial contributions to the country program. Other ministries providing advice during the preparation of the country program include: the Ministry of Foreign Affairs, the Ecuadorean Institute for Sanitation, the National Polytechnic Institute, the Ecuadorean Institute for Standards, the Ecuadorean Commission for Atomic Energy, and the Pichincha Chamber of Industries.

92. The program for phasing out controlled substances in Ecuador consist of six elements: policy framework, institutional framework, legal framework, investment projects, action plan, and budget. These elements are described in the following sections.

B. Proposed Implementation Policy

93. In line with Ecuador's commitment to environmental protection, this program proposes to accelerate implementation of the Montreal Protocol in Ecuador to match the phaseout schedule of industrialized nations. This strategy is justified for various reasons: (1) the increasingly deteriorating condition of the ozone layer requires a more aggressive and faster response; (2) an accelerated phaseout is both technically and economically feasible with the assistance of the Interim Multilateral Fund.

94. Eliminating CFC use in aerosols is feasible and can be implemented in the short term once a supply of substitute propellants is made available. In addition, a large portion of CFC emissions are unnecessary and can be eliminated by retraining service personnel on proper conservation practices including the use of recycling equipment.

95. A faster phaseout also reduces the total costs to Ecuadorean society of implementing the Protocol. Based on an analysis of the total costs to Ecuador of eliminating consumption of controlled substances, it is estimated that the costs of phasing out controlled substances by the year 2010 range from US$26 million to US$47 million. If the phaseout is accelerated to the year 2000, total costs are estimated to range from US$18 to US$37 million. Thus, accelerating the phaseout schedule by 10 years results in total savings to the economy in the order of US$8 to US$10 million. (See Appendix D for a detailed description of the economic analysis leading to these estimates).

96. These savings are primarily due to the savings generated in the refrigeration sector. Most of the existing refrigeration equipment is recharged with CFCs during maintenance. If Ecuador followed a 2010 phaseout schedule and allowed production of CFC-using equipment (e.g., domestic refrigerators) to continue during the 1990s, greater future demand for CFCs would result because of the increased stock of equipment requiring CFCs. As the supply of CFCs is reduced and eliminated, it would become increasingly difficult to find CFCs to service all of the existing equipment. Since most refrigeration equipment cannot accommodate substitute refrigerants, lack of CFCs would cause some of that equipment to be retired prematurely. Thus, a phaseout of controlled substances by the year 2010 would be accompanied by this capital loss.

97. An accelerated elimination of controlled substances induces a rapid introduction of substitute refrigerants in the production of new refrigeration equipment. This contributes to the reduction and eventual elimination of future demand for refrigerants in equipment servicing faster than in the scenario where the phaseout occurs by the year 2010. Retirement of useful equipment is minimized and the total costs to society are therefore reduced.

1. First Phase (1992-1996)

119. The first phase includes projects in the aerosols and refrigeration sectors. As indicated in Section III, these two sectors make up approximately 85 percent of total consumption of controlled substances in Ecuador. Thus, the Government believes that early reductions in these two sectors are critical if Ecuador is to achieve significant reductions as soon as possible.

A. Aerosols

a. Hydrocarbon Propellants and Open Air Filling Platforms

120. This project includes three components: (1) a pre-feasibility study to assess the optimum means of securing a supply of aerosol-grade hydrocarbons in Ecuador, (2) conversion of six large aerosol manufacturing plants from CFC to hydrocarbon propellants, and (3) implementation of an aerosols manufacturing safety program.

121. Hydrocarbons (i.e., n-butane, isobutane, and propane) are widely recognized as suitable replacements for CFCs as propellants in aerosols. Although hydrocarbons are quite light in liquid form, as gases they are much heavier than air. This chemical characteristic, combined with hydrocarbon's high potential for combustion, has important implications for manufacturing safety. When hydrocarbons are leaked, they require strong air movement in order to dissipate. One recent innovation based on "open-air aerosol filling," which originated in Mexico and could be easily applied in Ecuador, would successfully address the safety issues associated with using hydrocarbon propellants in Ecuador.

122. Rather than using a closed filling room, the technique involves filling aerosol containers in a room completely open to natural ventilation. It allows the wind to dissipate any hydrocarbons released routinely during the filling of each can. Open air filling is inexpensive and virtually eliminates any potential for human error (Nardini 1990). Ecuador's climate is well suited to such a technology. The use of hydrocarbons in Ecuador would result in a 100 percent reduction of CFC-12 use in propellants, i.e. approximately 500 tons per year.

123. Ecuador does not produce hydrocarbons at the level of purity required for aerosol applications. Two options exist for ensuring adequate supply of hydrocarbons for the aerosol industry: importation or domestic production. Ecuador could import hydrocarbons from other countries. Alternatively, it could purify and commercialize gases extracted from indigenous gas fields and oil refineries. The latter would require investment in purification facilities and institutional cooperation between Petroleos de Ecuador, which controls Ecuador's domestic supply of petroleum products, and the Ecuadorean institution designated to implement the Montreal Protocol. The USEPA has agreed to provide bilateral funding for a pre-feasibility study to assess the institutional, technical, and economic feasibility of each of these alternatives.

124. Once a supply of aerosol-grade hydrocarbons can be assured, the second part of the project will involve the conversion of several large aerosol manufacturing plants. The project will consider several factors in each of the six plants:

- Production equipment which will need to be adapted for using hydrocarbons;

103. The goals of the program require an adequate institutional and legal framework capable of conducting the import controls and incentive measures described above. The next two sections discuss these aspects.

C. Proposed Institutional Framework

104. Based on an analysis of the institutional needs for implementing this program, the Government has decided to delegate this function to the Ministry of Industries, Trade, Integration, and Fisheries (MICIP) as the lead agency in charge of Protocol implementation. For this purpose, MICIP would create an inter-ministerial and inter-institutional coordination mechanism. Given its experience with industrial development, import controls, and the existence of qualified technical and administrative staff, MICIP will be an adequate institution for assuming responsibility for this program. Coordination among various ministries and government bodies will be essential because the program requires input from such bodies for a number of activities, most importantly, import controls (which involve current functions of the Central Bank), and the financing of industrial projects (which would require a financial intermediary, possibly the Corporacion Financiera Nacional (CFN)).[9]

105. To implement the Protocol and to address other environmental issues affecting industry, MICIP is creating a National Office of Environmental Affairs (NOEA). This office would also formulate, direct, and implement environmental policy affecting industry in Ecuador as stated in the Prevention and Control of Environmental Pollution Law.

106. NOEA will consist of three operative units: (1) Control and Environmental Affairs; (2) Prevention and Regulation; and (3) Studies, Technical Assistance, and Technology Transfer.

107. The Control and Environmental Affairs Unit will have two full-time staff in charge of managing all aspects of the Montreal Protocol as they relate to Ecuador. The Montreal Protocol unit would be staffed with a technical coordinator and an institutional coordinator. A detailed description of the staff's roles and budget can be found in Appendix E.

108. In addition to its Montreal Protocol staff, the Control and Environmental Affairs Unit will have other full-time staff responsible for monitoring the application of laws and regulations relating to environmental protection. This will include maintaining a database containing information relevant to environmental protection, as well as maintaining a system of permits for the use of manufactured substances which affect the environment.

109. The second unit within NOEA, the Prevention and Regulation Unit, will establish criteria, regulations and norms relating to manufacturing and its impact on environmental protection. It will also coordinate activities relating to the establishment of technical norms with INEN and the Department of Policies and Import Mechanisms.

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[9] With the assistance of the World Bank, the Government held preliminary discussions with this institution which indicate that the financing needs of this program would be adequately served with the existing structure of CFN. The Government will confirm the feasibility of CFN's participation in this program.

- Adopt good safety and checking procedures for detecting leakage or accumulation of ignitable mixtures;

- Ensure that all equipment is adequately bonded and checked regularly to prevent accumulation of electrostatic charges and occurrence of electrical charges;

127. Costs for converting CFC propellant plants to hydrocarbons would include retrofitting tank storage and handling systems, constructing an outdoor filling room, and reformulating the aerosol products. The conversion costs for a 100 cans per minute line (capable of 10 million cans per year on a one shift per day basis) can run from approximately US$50,000 to US$750,000, depending on the amount of retrofitting and/or relocation needed (UNEP 1991.)

128. The final project component involves the implementation of a manufacturing safety training program and a review of operating practices in the aerosol plants that switch to hydrocarbons. Representatives from each plant selected for conversions will be required to participate in manufacturing safety training program. The training program will be conducted in each plant to address the special circumstances of each company. Estimated costs of the manufacturing safety program are presented below. The review of operating practices will result in a set of recommendations on ways to enhance safety measures and an explanation of the risks likely to be eliminated with such changes.

129. The training program will include consideration of the following issues (USEPA, Smith, 1991):

- Precautions will need to be taken in receiving, unloading, transferring, and storing flammable hydrocarbon propellants at the aerosol manufacturing plant site. Minimum hydrocarbon propellant storage for any filling plant is usually 10,000 gallons (37,850 L).

- The design of the propellant charging operation will need to incorporate safety considerations. This is particularly important when propellant filling and pump rooms (gas houses) are physically separated from the main plant building. If the propellant filling operation is conducted within a large enclosure also used for other operations (filling of liquid concentrate, checking the weight of cans, and detecting leaks in hot tanks), the usual safety approach is to apply the items listed below to the entire area. Installations of this latter type will need to be designed with extreme care since a fire or explosion in such a large area could have far greater consequences than if contained in a separate gas charging house.

- The production area where the propellant charged cans are immersed in a tank of hot water (57 - 66^0 C) will need to be visually inspected for leakage, can distortion, or rupture.

- The liquid compounding area will need to be inspected. Most plant fires arise in connection with either the hydrocarbon propellants or the aerosol "concentrate" (usually containing ethanol or petroleum distillates although other flammable

- With the help of MICIP, the Ecuadorean Institute of Standards (INEN) will coordinate preparation of technical norms which may be used to define product characteristics, intermediary products, and quality control in the new substitute processes.

- The Central Bank will coordinate the transfer of resources from the Interim Multilateral Fund of the Montreal Protocol to Ecuador with the assistance of MICIP. The Central Bank is constitutionally responsible for functions relating to the fiscal and financial matters of the Government. The institution is thus responsible for the economic management of domestic and international markets as they relate to Ecuador, including imports, exports, and control of the exchange rate of the national currency.

- The Ministry of Foreign Relations will coordinate, along with MICIP, all activities relating to possible further international renegotiations of the Protocol, and cooperation with international organizations and foreign governments.

- The Ecuadorean Institute of Public Health Works (IEOS), which is within the Ministry of Public Health, is in charge of controlling health impacts associated with water management, solid waste, and air quality. Cooperation between IEOS and MICIP in analyzing the environmental and health impacts of proposed substitutes for controlled substances is important in light of the Protocol's requirements.

117. To foster inter-institutional cooperation, the Presidential Decree specifically calls for the creation of an Inter-institutional Coordination Committee charged with coordinating the different government ministries and agencies in matters involving the Montreal Protocol. This committee will be comprised of representatives from CONADE, MICIP, the Central Bank of Ecuador, the Ecuadorean Development Bank, the Ministry of Public Health, the Center for Industrial Development of Ecuador, INEN, and the Ministry of Foreign Relations.

E. Proposed Projects for Reducing or Eliminating Consumption of Controlled Substances

118. CONADE and MICIP propose implementing several projects[10] over the next eight years in order to achieve early reductions in consumption of controlled substances. The Government has determined that these projects would best be implemented into two phases (1992-1996 and 1996-2000.) Projects chosen for the first phase can be implemented immediately using cost-effective and commercially available technology. Moreover, these projects achieve a reduction of approximately 540 ODP-weighted tons of controlled substances per year (or 13,700 ODP-weighted tons projected to 2010) in Ecuador's most significant consuming sectors. The projects are presented below in order of priority.

[10] As discussed in the Report of the Third Meeting of the Executive Committee for the Multilateral Fund under the Montreal Protocol, the term "projects" is used to describe any activity qualifying for assistance under the Fund. A project could include, inter alia, training programs, technical assistance activities, pre-investment studies, country programs, or capital investments to modify or establish a manufacturing facility.

B. Refrigeration

a. Reduction of CFC-11 Use in Refrigerator Foam Insulation

130. Technology that reduces the amount of CFC-11 foam used in refrigerator manufacturing is now available. Such technology uses standard equipment and would only require slight modifications to Ecuador's factory specifications. These facilities are located in Quito, Guayaquil, and Cuenca. Reduced CFC-11 foam insulation is capable of meeting the necessary performance criteria of traditional CFC-11 foam. Reductions of up to 50 percent of the CFC-11 normally used can be achieved by substituting water for CFC-11 and adjusting the polyol mix. In addition to reducing the amount of CFC-11, other desirable properties of low CFC-11 foam include completeness of cabinet filling, foam friability, dimensional stability of the foam, structural stability of the cabinet, removal of exothermal heat, and improved viscosity of the process chemicals. Increasing the amount of water used in the foam insulation would include no capital costs, but would result in a 5 percent increase in operating costs due to changes in the chemicals used.

131. The goal of this project is to reduce CFC foam insulation while maintaining the refrigerators's performance and consumer satisfaction. The latter would be addressed through consumer awareness activities. This project is expected to introduce low-CFC foam in three refrigerator manufacturing facilities using standard equipment only requiring modification to individual factory specifications. The project would involve several steps: (1) meetings between interested refrigerator manufacturers and foam suppliers, (2) initial factory screening to verify compliance with performance needs, (3) a short production trial, (4) review of results from the short production trial, (5) process and product modifications to reflect production trial results (6) a full production trial (7) quality control and assurance verification tests and (8) full production. Investment requirements for this project are summarized below:

ESTIMATE OF FINANCING REQUIRED FROM INTERIM MULTILATERAL FUND

TOTAL BUDGET[13]	**$100,000**
ANNUAL ODP-WEIGHTED TONS PHASEOUT	**15**
TOTAL ODP-WEIGHTED TONS PHASED OUT (1992-2010)	**400**

b. Training for Refrigeration Equipment Servicers

132. In the refrigeration sector, approximately 20 percent of refrigerant is recoverable through the implementation of CFC refrigerant conservation and material handling measures. This project will promote such measures through a training program for refrigeration equipment service

[13] A total of three plants will be modified. The budget assumes an average cost of US$30,000 per plant modification as per USEPA (1991) draft terms of reference, "Reduction of CFC-11 Use in Refrigerator Foam Insulation," plus US$10,000 for operator training.

- The following items will need to be purchased and/or checked:

  -- hydrocarbon storage tanks
  -- hydrocarbon pumps
  -- hydrocarbon piping and connections
  -- hydrocarbon destenching system;

- All electric switchboards, motors, and sensors will need to be made flame proof (EX-type);

- All lighting systems will need to be changed to EX-type;

- Adequate ventilation systems (to prevent hydrocarbon gas accumulation) will need to be constructed in the following areas:

  -- Production line area
  -- Gassing room
  -- Warehouses
  -- Product storage area;

- The following warning systems and fire-fighting systems will need to be put in place or enhanced:

  -- Sprinkler system
  -- Deluge system
  -- Alarm system
  -- Ventilation;

- Adequate warehouses and storage areas will need to be constructed.

125. The storage area usually includes equipment such as crude hydrocarbon storage tanks. destenching columns (absorbers), purified (deodorized) hydrocarbon storage tanks, unloading, transfer, and process hydrocarbon pumps, deluge-sprinkler underground water basin and its pumps, hydrocarbon gas and flame detectors. and EX-proof lighting. It should be established according to the following considerations: the international regulations, requirements, and rules for safe handling, transportation, and storing of hydrocarbon; the maximum daily off-take required; the time taken to process an order and to receive deliveries; and the requirements for increasing the production capacity in future (Meshaal, S. 1989).

126. After conversion and before new operations are initiated, the following guidelines should be observed to reduce the risk of ignition:

- Ensure all electrical equipment is flame proof;

- Avoid using uncovered light bulbs and causing sparks, which can be fire hazards;

- Ensure that there is adequate ventilation;

B. Refrigeration

a. Substitute HCFC-142b Alone or HCFC-22/142b for CFC-11 Refrigeration Foam Insulation

135. While reducing the amount of CFC-11 used in foam blowing is an effective short-term measure for refrigerator manufacturing plants, in the long-term, HCFCs appear to offer a superior alternative. Most HCFCs are not yet, however, available in large quantities.

136. Using HCFC-142b, plant conversions in Ecuador might include the capital investment cost resulting from the need to incorporate increased ventilation to reduce the flammability risk associated with HCFC-142b. This would not be necessary if HCFC-142b were blended with HCFC-22 because the mixture would likely not be flammable. There would be a 10 percent increase in operating costs in converting a plant to HCFC-142b alone or blended with HCFC-22. Each of these two options will be explored further.

Preliminary Budget (US$):	600,000
Estimated Annual Reduction (ODP-Weighted Tons):	16
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	400

b. Recycling of CFC-12 from Mobile Air Conditioners

137. Recycling CFC-12 from mobile air conditioners (MACs) is a technology that is receiving international acceptance. For example, in the United States, it is estimated that by the end of 1991, the number of recycling machines in operation will reach 140,000. Major automobile manufacturers worldwide such as Ford, General Motors, Nissan, and Volvo have pledged to implement recycling while new refrigerants are developed, approved by regulatory authorities, and introduced to the marketplace. In Ecuador, CFC-12 recycling machines could be used by dealerships and specialized automobile air conditioner repair shops. Depending upon the type of recycling system and the level of automation, recycling machines can range from US$2,000 to US$8,000. CONADE and MICIP will select fifteen to twenty servicing sites to receive a recycling machines and training for service technicians. To ensure the cost effectiveness of the project, only sites with a sufficiently large volume of MACs servicing will be selected.

Preliminary Budget (US$):	100,000
Estimated Annual Reduction (ODP-Weighted Tons):	10
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	150

c. Purge/Recycling and Conservation for CFC-11 Chillers

138. This project has three main components: (1) conversion/retrofitting of large CFC-11 chillers to HCFC-123, (2) implementation of high efficiency purge devices, and (3) implementation of on-site recycling program.

components may sometimes be employed such as methyl ethyl ketone, methanol, isopropanol, and methyl isobutyl ketone). The usual cause of a fire in the liquid compounding area of a plant where the concentrates are blended is the ignition of the air/vapor mixture by a spark from an electric motor, switch, or static electricity.

- Care will need to be taken in the quality assurance/product development laboratory. Laboratory operations involve safety concerns often equivalent to those associated with the propellant filling operation. It is more practical for the laboratory operation, however, to address safety concerns in specific laboratory work areas rather than for the entire laboratory.

- The disposal of rejected products presents several hazards. Such products can include leakers, R&D samples, quality control samples, or defective products (overfills, low weights, unacceptable performance, incorrect ingredient assay, etc.). This can amount to several thousand rejected aerosol units per day for large fillers.

- Precautions will need to be taken in the end of production line temporary storage. Flammable aerosol products may be kept in production areas such as in staging areas where finished products await transfer to a warehouse.

ESTIMATE OF FINANCING REQUIRED FROM INTERIM MULTILATERAL FUND

PROGRAM COMPONENT	ESTIMATED BUDGET
• Plant Conversion (6 plants)[11]	$2,400,000
• Manufacturing Safety Program[12]	
- In-Plant Training	$50,000
- Plant Safety Review	$50,000
TOTAL BUDGET	**$2,500,000**
ANNUAL ODP-WEIGHTED TONS PHASED OUT	**500**
TOTAL ODP-WEIGHTED TONS PHASED OUT (1992-2010)	**12,700**

[11] Assumes an average cost of US$400,000 per plant conversion (this includes resources for project preparation activities and post evaluations, both of which may require the use of external experts.)

[12] This includes preparation, materials, and summary reports required for a one week in-plant training session and a plant safety review.

C. Fire Protection

a. Halon Conservation Training Program

145. Increased training of personnel working in areas protected by halon systems significantly reduces the amount of halon discharged from the system by 30 percent at essentially no additionally no extra cost. In addition, implementing alternative training and testing systems will eliminate unnecessary halon discharges. Commercial users of halon systems will be provided with educational materials to raise awareness about the need for prudent use of halons and about improved maintenance of halon fire protection systems.

As currently proposed, this project will substantially reduce halon-1211 use where it is not essential through implementing appropriate training and testing procedures and will develop a network for halon-1211 recycling. This project will be developed further with the assistance of halon suppliers in Ecuador.

Preliminary Budget (US$):	150,000
Estimated Annual Reduction (ODP-Weighted Tons):	15
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	350

D. Solvent Cleaning

a. Substitute Aqueous Cleaning for Methyl Chloroform (MCF) in Metal Cleaning

146. Methyl chloroform (MCF) cleaning can be replaced with commercially available aqueous cleaning processes. The common active ingredients in aqueous cleaning chemical formulations include alkyl benzene sulphonates and other anionic surfactants. Corrosion inhibitors have been added to the process to minimize the effect of the cleaners on the metal surface. Hundreds of aqueous cleaning formulations are commercially available and have been used successfully in blends in various metal working industries. Options include ultrasonic cleaning, immersion cleaning, and spray cleaning. The project would consist of small-scale engineering studies, pilot testing, and equipment conversion to eliminate MCF use from metal cleaning operations. The cost of an aqueous cleaning system is highly dependent on the volume of parts cleaned and the type of cleaning process selected. In Ecuador, most solvent cleaning is undertaken by several small dispersed users with low-volumes of parts which require cleaning.

Preliminary Budget (US$):	1,000,000
Estimated Annual Reduction (ODP-Weighted Tons):	2
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	30

people. Representatives from refrigerant distributors, service shops for industrial and household air conditioners/refrigerants, hotels, supermarkets, restaurants, and refineries will be trained for improved refrigerant conservation and handling.

ESTIMATE OF FINANCING REQUIRED FROM INTERIM MULTILATERAL FUND

TOTAL BUDGET	**$100,000**
ANNUAL ODP-WEIGHTED TONS PHASEOUT	**25**
TOTAL ODP-WEIGHTED TONS PHASED OUT (1992-2010)	**600**

2. Second Phase (1996-2000)

133. The second phase of projects will complement the projects undertaken in the first phase and will address low consuming end uses of controlled substances in the foams, refrigeration, fire protection, and solvent cleaning sectors. Cost estimates for projects in phase two are based on preliminary data.

A. Foams

a. Substitute HCFC-123 for CFC-11 in Flexible Polyurethane Foams

134. CFC-11 has long been used as a blowing agent in manufacturing flexible polyurethane foam. However, many effective alternatives are now available as substitutes for CFC-11. One of the most viable alternatives is HCFC-123. This chemical, with an ODP of 0.02, has similar physical properties to those of CFC-11. Internationally, commercial production of HCFC-123 began during 1991. In making the conversion from CFC-11 to HCFC-123 in Ecuadorean industry, some minor modifications may be necessary. For example, depending upon the allowable exposure levels for HCFC-123, some additional ventilation may be required in manufacturing plants.[14] Increases in the amount of tin catalyst may also be necessary. Finally, the compatibility of components such as seals and gaskets will need to be verified.

Preliminary Budget (US$):	200,000
Estimated Annual Reduction (ODP-Weighted Tons):	16
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	800

[14] As with all of the new HCFCs, HCFC-123 is still undergoing extensive toxicity testing. As cited in USEPA (1991), "Technical Support Information for Implementation of the Montreal Protocol Interim Multilateral Fund," prepared by ICF Incorporated, recent data has become available on HCFC-123 showing non-malignant tumors in male rats.

H. Proposed Implementation Schedule and Budget

154. A summary of the proposed projects and their anticipated start dates is also presented in Exhibit IV-1.

155. The estimated total budget is US$3,085,000 for 1992 through 1996. Of this amount, approximately US$2,500,000 is proposed for plant conversions in the aerosols sector; US$200,000 for projects in the refrigeration sector; and, US$385,000 for the operation of the ozone protection unit within MICIP.

156. The Government of Ecuador intends this country program to cover government actions and projects from 1992 to 1996. In late 1996, CONADE and MICIP will assess the progress made in implementing this proposed action plan and consider the necessity of requesting further financing from the Interim Multilateral Fund for the next phase of projects to eliminate consumption of controlled substances. A preliminary estimate of the funding required for the second phase is presented in Exhibit IV-2.

139. Selected large CFC-11 chillers will be retrofitted to use HCFC-123. Unfortunately, HCFC-123 is not a drop-in substitute and requires substantial technical evaluation prior to any change. HCFC-123's aggressiveness as a solvent makes it necessary to change seals and elastomer components to more resistant materials. In most hermetic designs, it is usually incompatible.

140. The project will also demonstrate technology for reducing emissions of CFC-11 from the purge devices on centrifugal chillers in Ecuador. Centrifugal CFC-11 chillers are normally equipped with purge units. By removing water and non-condensible gases (e.g., air) from refrigeration systems, these units improve refrigeration efficiency by ensuring that the presence of non-condensible gases does not artificially inflate the condensor pressure. Because they remove moisture, purge units can also successfully prevent the occurrence of corrosion caused by moisture build-up and acids that are formed when small amounts of moisture mix with the refrigerant.

141. In removing the unwanted non-condensibles and water, however, the purge units also remove some CFC-11 and vent it to the atmosphere. In order to minimize the amount of CFC-11 vented, high efficiency purge units have been developed and are now manufactured by several companies. Most of these high efficiency purge units are one of two basic designs: mechanical or thermal. Mechanical units employ a compressor in removing a mixture of refrigerant, air, and other non-condensibles from the refrigeration condensor. The mixture is compressed to a higher pressure which condenses the refrigerant and water vapor. In comparison, thermal purge units use the pressure differential between the operating refrigeration system condensor and evaporator to remove a vapor mixture of refrigerant, air, and other non-condensibles. A second stream of high-pressure refrigerant passes through purge unit coils at a lower temperature to condense the refrigerant out of the mixture that has been drawn off. For both types of systems the cost of a high efficiency purge device is approximately US$2,500 - 7,000.

142. This project will involve the installation of purge units in all chiller units where it is not technically and/or economically feasible to retrofit them to HCFC-123. An additional component of the project will include the establishment of a training program for certifying chiller service technicians.

143. Finally, an on-site CFC recycling program will be implemented. High volumes of CFC-11 are emitted from refrigeration equipment due to improper maintenance practices. Typically, a large portion of the refrigerant charge is vented during the repair of particular components of the system (e.g., the compressor, condenser, etc.). Portable CFC-11 recycling units that can be fitted to the refrigeration systems to recover the used refrigerant have recently been marketed. In Ecuador, the largest consumption of CFC-11 to service chillers is in the coastal area, primarily in Guayaquil.

144. Portable CFC-11 recycling units are available for US$6,000 each. One unit can recycle the refrigerant while the chiller is in operation. The system can achieve a 65 percent reduction in CFC emissions and reduce the associated refrigerant costs. This project would encourage service firms involved in chiller maintenance to use these portable recycling units. In addition, a recycling training program would be provided.

Preliminary Budget (US$):	50,000
Estimated Annual Reduction (ODP-Weighted Tons):	73
Estimated Total ODP-Weighted Tons Phased Out (1992-2010):	700

EXHIBIT IV-11
FIRST PHASE FOR ECUADOR'S COUNTRY PROGRAM

GOVERNMENT ACTION PROGRAM

Year(s)	Description of Action	Sector (if any)	Intended Effect
1992	Define the detailed administrative procedures for allocating import quotas	All	Establish the method to set reference for reductions
1992	Institute a system for tracking imports by importer; explain the operation of the import controls	All	Monitor import reductions; ensure industry's understanding of import controls
1992	Identify an industry CFC task force which can interact with government on behalf of all CFC importers and users	All	Facilitate communication and cooperation with industry
1993-94	Initiate discussions to provide technical assistance to industry for the preparation of projects	All	Provide guidance on eligibility criteria and proposal preparation
1993-94	Oversee preparation of projects for the first phase	Aerosols Refrigeration	Prepare documentation needed for technical approval
1993-94	Work with the financial intermediary to prepare financing proposals	Aerosols Refrigeration	Prepare documentation for funding approval
1993-94	Ensure timely implementation of projects of the first phase	Aerosols Refrigeration	Obtain reductions in controlled substances as scheduled in country program

F. Action Plan

147. Ecuador's action plan for the next four years would follow a two-pronged approach. The first step would be to include the execution of all the actions to establish the institutional, policy, and legal frameworks. The second step would be to prepare and implement projects in the two most significant sectors, aerosols and refrigeration.

148. During 1992, MICIP and CONADE will be working to prepare and present the Presidential Decree and Ministerial Agreement to the President. In addition, the unit within MICIP which is designated in charge of the Protocol will be formed and trained to assume full responsibilities of the program.

149. Once established, MICIP's ozone protection unit will articulate its import control policy by:

- defining the detailed administrative procedures for allocating import quotas;
- instituting a system for tracking imports by importer;
- identifying an industry CFC task force which can interact with the government on behalf of all CFC importers and users; and,
- explaining the operation of the import controls.

150. In the area of investment projects, MICIP will work from 1992 to 1996 in the following areas:

- initiating discussions to provide technical assistance to industry for the preparation of projects;
- overseeing preparation of feasibility studies for Phase 1 projects to be implemented during the first phase;
- working with the financial intermediary to prepare financing proposals; and,
- ensuring timely implementation of projects.

151. To support these activities, the unit will work with UNDP to disseminate technical information on alternative technologies and guidance for the preparation of investment projects. UNDP will also help prepare terms of reference for three projects in the refrigeration and foams sectors to be implemented in the second phase. Furthermore, as an immediate action the U.S. EPA and the World Bank will assist in early 1992 with the preparation of pre-feasibility studies for the aerosol and foam projects described in the previous section.

152. In addition, the World Bank will continue to assist the Government in establishing a mechanism for transferring the resources of the Multilateral Fund through a financial intermediary in support of the proposed ozone protection projects. The Government also plans to participate in UNEP's activities such as regional workshops and conferences.

153. A summary of the Government's action plan over the next four years is presented in Exhibits IV-1. The schedule for implementation and budget are discussed below in Section H.

APPENDICES

APPENDIX A:

REFERENCES

UNEP Aerosols 1989. Aerosols. Sterilants and Miscellaneous Uses of CFCs. Report prepared by the UNEP Technical Options Committee on Aerosols, Sterilants and Miscellaneous Uses. Pursuant to Article (6) of the Montreal Protocol on Substances that Deplete the Ozone Layer. June 30, 1989.

UNEP Foams 1989. Technical Progress on Protecting the Ozone Layer. Flexible and Rigid Foams Technical Options Report prepared by the UNEP Foam Technical Options Committee. Pursuant to Article (6) of the Montreal Protocol on Substances that Deplete the Ozone Layer. June 30, 1989.

UNEP Solvents 1989. Technical Progress on Protecting the Ozone Layer. Electronics. Degreasing and Dry Cleaning Solvents Technical Options Report prepared by the UNEP Solvents Technical Options Committee. Pursuant to Article (6) of the Montreal Protocol on Substances that Deplete the Ozone Layer. June 30, 1989.

UNEP Refrigeration 1989. Technical Progress on Protecting the Ozone Layer. Refrigeration. Air Conditioning and Heat Pumps Technical Options Report prepared by the UNEP Refrigeration and Air Conditioning Technical Options Committee. Pursuant to Article (6) of the Montreal Protocol on Substances that Deplete the Ozone Layer. June 30, 1989.

UNEP Technical Options Committee 1991. Aerosols. Sterilants. Miscellaneous Uses and Carbon Tetrachloride. 1991.

SEDUE 1991. Project Proposals Eligible for Funding Under the Interim Multilateral Fund of the Montreal Protocol on Substances that Deplete the Ozone Layer. April, 1991.

Meshaal, S. 1989. An Optimal Conversion Model for an Aerosol Production Plant Using LPG as a Propellant Instead of CFCs. Submitted to the USEPA. 1989.

Smith, D. 1991. ICF Incorporated. Personal Correspondence received from Dean Smith. U.S. EPA. Research Triangle Park. North Carolina. 1991.

USEPA 1991. Technical Support Information for Implementation of the Montreal Protocol Interim Multilateral Fund. 1991.

EXHIBIT IV-11 (Continued)
FIRST PHASE FOR ECUADOR'S COUNTRY PROGRAM

SUMMARY OF PROJECTS TO BE IMPLEMENTED DURING FIRST PHASE (1992-1996)

Start Year	Type of Project	Project Description	Project Cost (US Dollars)[a]	Participating Agencies	Tons x ODP Phased-out[b]
1992	1) Creation of the Montreal Protocol unit within the Environmental Affairs Office at MICIP (management support)	Assisting in the implementation of ozone protection program and supporting in the identification of projects. Liaison with implementing agencies and other Latin American countries to promote both technical cooperation and information exchange.	385,000[c]	World Bank	n/a
1992	2) Conversion of 6 large aerosol manufacturing plants from CFC to hydrocarbon propellants and implementation of manufacturing safety training program (investment/training)	Projects involve: (1) converting six large aerosol manufacturing plants from CFC-12 to hydrocarbon propellants, and (2) implementing a manufacturing safety training program.	2,500,000	USEPA World Bank	12,700
1992	3) Reduction of CFC-11 in refrigerator foam insulation produced at three refrigerator manufacturing plants (investment)	Reduction of CFC-11 use in foam at three refrigerator manufacturing plants	100,000	World Bank USEPA	400
1992	4) Implementation of CFC refrigerant conservation and material handling training program (training)	Representatives from refrigerant distributors, service shops for industrial and household air conditioners/refrigerants, hotels, supermarkets, restaurants, and refineries will be trained for improved refrigerant conservation and handling.	100,000	UNDP	600
TOTAL			3,085,000		13,700

[a] Project cost is the incremental cost.
[b] This column contains the cumulative ODP-weighted metric tons that would be phased out from project implementation date to the Article 5 country phaseout date.
[c] This amount represents the incremental cost to the Government of establishing and operating the Montreal Protocol unit and is independent of the resources designated for MICIP's Environmental Affairs Office.

APPENDIX B

SUMMARY OF PROVISIONS OF THE MONTREAL PROTOCOL

A. DEFINITIONS

1. **"Controlled substance"** means any of the substances listed in Annexes A and B of Exhibit B-1.

2. **"Transitional substance"** means any of the substances described in the "Annex C" section of Exhibit B-1.

3. **"Production"** means the amount of the controlled substances produced, minus the amount destroyed[1] by approved technologies, and minus the amount used as a feedstock for other chemicals. The amount recycled and reused is not "production".

4. **"Consumption"** means production plus imports minus exports.

5. **"Calculated levels of production"** of controlled substances in a country is determined by multiplying annual production of each controlled substance in the country by the ozone depleting potential of that substance (as given in Exhibit B-1), and then adding together the resulting figures from each substance in the country.

6. **"Calculated level of imports"** and **"calculated level of exports"** of controlled substances in a country is determined by the same method as for production, except that annual imports and annual exports, respectively, are substituted for annual production in the formula.

7. **"Calculated level of consumption"** of controlled substances in a country is determined by adding together the country's calculated levels of production and imports, and subtracting the country's calculated level of exports.

B. CONTROL MEASURES

Each party will adhere to the following timetable of caps, except for the developing countries, which can delay compliance by ten years. 1986 serves as the base year (equal to 100%) in item 1, and 1989 serves as the base year (equal to 100%) in items 2, 3, 4, and 5. Consumption and production, for the purposes of these controls, are "calculated level of production" and "calculated level of consumption" (see the definitions). Unless otherwise noted, an extra 10% of the base year amount is allowed on each production cap to meet the basic needs of developing countries.

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[1] The term "destroyed" refers to a series of destruction technologies such as high-temperature thermal incineration which can successfully break down controlled substances into non ozone-depleting constituent parts.

Exhibit B-1
Substances Controlled by the Montreal Protocol

Substance		ODP Relative to CFC-11
ANNEX A		
Group I:		
CFC-11	Trichlorofluoromethane	1.0
CFC-12	Dichlorodifluoromethane	1.0
CFC-113	Trichlorotrifluoroethane	0.8
CFC-114	Dichlorotetrafluoroethane	1.0
CFC-115	Chloropentafluoroethane	0.6
Group II:		
Halon-1211	Bromochlorodifluoromethane	3.0
Halon-1301	Bromotrifluoromethane	10.0
Halon-2402	Dibromotetrafluoroethane	6.0
ANNEX B		
Group I:		
CFC-13	Chlorotrifluoromethane	1.0
CFC-111	Pentachlorofluoroethane	1.0
CFC-112	Tetrachlorodifluoroethane	1.0
CFC-211	Heptachlorofluoropropane	1.0
CFC-212	Hexachlorodifluoropropane	1.0
CFC-213	Pentachlorotrifluoropropane	1.0
CFC-214	Tetrachlorotetrafluoropropane	1.0
CFC-215	Trichloropentafluoropropane	1.0
CFC-216	Dichlorohexafluoropropane	1.0
CFC-217	Chloroheptafluoropropane	1.0
Group II:		
CCl_4	Carbon Tetrachloride (tetrachloromethane)	1.1
Group III:		
MCF	Methyl Chloroform (1,1,1-Trichloroethane)	0.1

ANNEX C

At present, partially halogenated fluorocarbons (including HCFC-22, HCFC-123, and HCFC-141), all with ODPs of less than 0.15, are not considered to be "controlled substances". They are, however, listed as "transitional substances" in Annex C of the Protocol.

5. For Group III of Annex B (i.e., methyl chloroform) --

- consumption and production capped at 70% on January 1, 1995.

- consumption and production capped at 30% on January 1, 2000.

- consumption and production capped at zero on January 1, 2005. 15% (rather than 10%) additional production is allowed for meeting the basic needs of developing countries.

For easy reference. Exhibit B-2 summarizes the phase-out schedule for controlled substances in developing countries.

C. NON-BINDING RESOLUTIONS FOR OTHER HALONS AND TRANSITIONAL SUBSTANCES

1. For halons not listed in Exhibit B-1, the parties are resolved to refrain from authorizing or to prohibit their production and consumption. to refrain from their use except in essential applications, and to report estimates of annual consumption and production.

2. For transitional substances, the parties are resolved to review the situation with a view to replacing them by 2040, or if possible by 2020, and to:

   - limit their use to those uses without suitable alternatives.

   - limit their use to those applications currently met by controlled or transitional substances.

   - make selections to minimize ozone depletion.

   - use emission controls, recovery, recycling, and destruction.

D. FURTHER PROVISIONS FOR DEVELOPING COUNTRIES

1. In order to obtain the 10-year postponement of the compliance schedule, such a country cannot exceed an annual calculated level of consumption of controlled substances in Annex A in Exhibit B-1 of 0.3 kg. per capita, or in Annex B of 0.2 kg. per capita.

2. The base amount of production and consumption for compliance with control measures on substances in Annex A will be the average for the 1995-97 period, or 0.3 kg. per capita, whichever is lower. For Annex B, the base amount of production and consumption will be the average for the 1998-2000 period, or 0.2 kg. per capita, whichever is lower.

EXHIBIT B-2

PHASE-OUT SCHEDULE FOR DEVELOPING COUNTRIES UNDER THE MONTREAL PROTOCOL

YEAR	Primary CFCs	Secondary CFCs	Carbon Tetra-chloride	Methyl Chloro-form	Halons
1999	100%	--	--	--	--
2000	100%	--	--	--	--
2001	100%	--	--	--	--
2002	100%	--	--	--	100%
2003	100%	80%	100%	100%	100%
2004	100%	80%	100%	100%	100%
2005	50%	80%	15%	70%	50%
2006	50%	80%	15%	70%	50%
2007	15%	15%	15%	70%	50%
2008	15%	15%	15%	70%	50%
2009	15%	15%	15%	70%	50%
2010	0%	0%	0%	30%	0%
2011	0%	0%	0%	30%	0%
2012	0%	0%	0%	30%	0%
2013	0%	0%	0%	30%	0%
2014	0%	0%	0%	30%	0%
2015	0%	0%	0%	0%	0%

APPENDIX C

DETAILED DESCRIPTIONS OF SUBSTITUTES AND ALTERNATIVE TECHNOLOGIES

This appendix describes some of the substitute compounds and alternative technologies discussed in Section III-D. It focuses on the three main sectors of controlled substances used in Ecuador: aerosols, refrigeration, and foams.

Aerosols

Aerosol packaging is a popular method for storing and dispensing products such as insecticides and cleaners. In an aerosol package, the contents are stored under pressure in a metal container and dispensed in a controlled manner by activating a valve. The effectiveness of the propellant over time, the shape of the opening from which the contents are expelled from the can, and the composition of the product determines the form in which the product is delivered. This form can range from a fine mist (the most common) to a liquid stream to a foamy lather.

In general, the contents of an aerosol are the active ingredient, the solvent or carrier, and the propellant. The active ingredient is responsible for the product effectiveness (i.e., the compound that allows a cleaner to clean); the solvent or carrier solubilizes all ingredients in the formulation; and the propellant expels the contents from the container. CFCs and methyl chloroform (MCF) typically function as either active ingredients or as solvents in aerosol formulations (e.g., degreasers and cleaners).

Most Ecuadorean aerosol products that currently use CFC-11, CFC-12, or methyl chloroform (MCF) can be reformulated with substitute compounds or alternative product delivery systems.

Factors that must be considered when developing alternative formulations include the following:

- Production of sprays with desired particle size distribution
- Control of flammability
- Precautionary use of questionable solvents, such as methylene chloride
- Minimum changes in anticipated use patterns
- Cost and availability of alternative formulations including regulatory considerations
- Pressure limitations
- Product utility or efficacy for intended uses
- Toxicological factors
- Spray rate and use-up rate optimization.[4]

[4] Air and Energy Engineering Research Laboratory, United States Environmental Protection Agency, "Alternative Formulations to Reduce CFC Use in U.S. Exempted and Excluded Aerosol Products," pp. 39-40.

- use of pneumatic or electric filling machines
- wind direction.

In designing a plant, it is essential that the filling room have only one solid wall (one that runs parallel to the rest of the factory) and that no other walls, equipment, tanks, or other obstacles block the natural movement of air near the gassing room.

It is equally important that no source of fire or sparks be located nearby. Driveways, parking lots, materials handling areas, electrical installations, or pump, compressor, or boiler rooms in the area of the gassing room are obviously forbidden. This is a strong limitation when considering whether to retrofit existing filling facilities.

Open air filling has two principal advantages: it is low cost (which is important to companies with limited capital) and it eliminates human error. No mechanical or electrical systems need to be calibrated or checked continually and there will always be a wind, however moderate. In order to install open-air filling stations in Ecuador, training will be necessary. However, it does not have to be as extensive as with enclosed gassing rooms.

Pressurized Gas Systems

Another alternative is to use compressed gas propellants such as carbon dioxide, nitrous oxide, and nitrogen.[6] Such propellants are usually of high pressure and can be injected into containers in gaseous form instead of as liquids under pressure. Of the three alternatives, carbon dioxide has had the widest use. Carbon dioxide propellants were first used internationally in 1840 in the pressurization of certain milk products. Since then, both carbon dioxide and nitrous oxide have been used in food products as diverse as whipped creams, salad dressings, meat sauces, and popcorn sprays. In addition, carbon dioxide has been used in starting fluids, stain repellents for upholstery, deodorants, engines cleaners, and windshield de-icers.

Some major problems are associated with the use of carbon dioxide propellants. In alcohol-based products, only slightly less than 5 percent carbon dioxide can be used at about 90 psig pressure. This is normally insufficient to maintain a desirable spray pattern towards the end of the product's lifetime. However, this problem can be overcome by using aluminum cans which have a higher pressure resistance than the more common three piece tinplate cans. Another problem is that the gases used are at high pressure. Thus, when leakage occurs there is usually a much higher gas loss. This results in a poor spray pattern and an inconsistent product delivery rate. Unfortunately, only a few grams of propellant loss can have a significant effect on the quality of the aerosol product.

Several valve manufacturers have designed valve systems that can effectively handle carbon dioxide's variable pressure and resulting spray performance. In summary, carbon dioxide propellants have thus far experienced many problems in their development but may yet to prove to be a promising alternative for CFC-based propellant systems in certain aerosol product applications.

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[6] Johnsen, M. (1982) "Aerosol Handbook", pp. 361-365.

E. TRADE ISSUES

1. Trade with non-parties of controlled substances and of products containing controlled substances are to be banned by each party. If determined feasible, trade with non-parties of products made with, but not containing, controlled substances must be banned[3].

2. Each party is to avoid supplying non-parties with technology, new subsidies, aid, credits, guarantees, or insurance programs related to controlled substances, unless such action reduces emissions.

F. INTERIM MULTILATERAL FUND

1. A multilateral fund is established which will--

   - be funded by parties other than developing countries. Some of this assistance can be bilateral or regional.

   - meet the incremental costs to developing countries of complying with the provisions of the Montreal Protocol.

   - assist developing countries by: helping them identify their needs, through country-specific studies and other technical support; facilitating technical cooperation to meet those identified needs; distributing information and materials, holding workshops, training sessions, and related activities; monitoring and facilitating other available aid.

2. An Executive Committee for the Multilateral Fund is established, which will consist of a balanced representation of the parties, and will implement the work of the fund, including the disbursement of resources. It will operate with the assistance of the World Bank, the United Nations Environment Program, the United Nations Development Program, and other appropriate implementing agencies.

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[3] An example of a product "made with, but not containing controlled substances, might be a printed circuit board that has been cleaned using CFC-113 during its manufacturing process. CFC-113 is not, however, present in the final product.

reducing and eliminating unnecessary emissions of CFCs and refrigerant substitutes. Recycling also ensures a reserve of recycled CFCs, which can be used to service existing capital equipment. Recycling technologies for large-scale applications of CFC-12 and CFC-502 refrigerants have existed for many years. Recycling in these applications can occur either on-or off-site. Many industrial facilities employ a stationary receiver tank that temporarily stores CFC-11 refrigerant while the system is being repaired. Receiver tanks help avoid venting of the refrigerant to the atmosphere and collect refrigerant for reclamation. Portable units are appropriate for uses such as chillers in office building and refrigerated transport. Portable recycling units generally process 1 to 4 pounds of refrigerant per minute and are used for systems with charges ranging from a few ounces to several hundred pounds. Food processing and cold storage equipment can have significant fugitive emissions. Therefore, it is important to install leak detection systems in compressor rooms and line/case trenches to identify leaks as they occur and to inform maintenance personnel of needed repairs.

Alternative refrigerants include ammonia and HCFC-22. Indirect ammonia systems are already utilized in some industrial applications such as cold storage. Ammonia biodegrades quickly and has zero ozone depletion potential. It is, however, toxic to humans in concentrations above 110 parts per million (ppm) after eight hours of exposure. It is also flammable in concentrations of 16 to 25 percent by volume in air.[8] Harmful concentrations are easy to detect because of ammonia's pungent odor, making it easier to repair leaks and evacuate personnel if necessary. Because of toxicity concerns associated with ammonia systems, equipment rooms must be isolated and monitored for leaks.

HCFC-22 based refrigeration systems can be used as a replacement for CFC-502 systems. HCFC-22 has been thoroughly tested, and a two-stage system is currently available for use in commercial systems in North America.

A variety of technologies are available for small-scale refrigeration applications. One innovative development for small-capacity systems is the plastic recovery bag. Developed by Whirlpool Corporation, a large appliance manufacturer, it is a multi-layer plastic refrigerant recovery bag for refrigerators and freezers. The recovery bag can be attached to a refrigerator or freezer prior to servicing to remove and hold the refrigerant. Following servicing, a technician can take the old refrigerant to a recovery center for transfer to a pressurized tank. In turn, the tank is shipped to a reprocessor. The 24-ounce capacity of the bag allows it to be used for two or three jobs before being emptied. The plastic material is durable enough to be filled and emptied up to four times, after which it should be cut up and discarded properly along with other plastic waste. If the compressor for the refrigerator being serviced operates, it can be used to pump down the system for a recovery rate greater than 90 percent. If the compressor does not run, the recovery rate is 50 to 65 percent.

General Electric (GE) has developed a recovery system for refrigerators using a portable vacuum pump which transfers refrigerant into 32 ounce cylinders. Refrigerant from the cylinder is transferred at a recovery center into a larger container which is then sent to a reprocessor. Recovery time for the system is 5-10 minutes. GE has a goal of 90 percent recovery.

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[8] United Nations Environment Programme 1989, "Refrigeration Technical Options Report", UNEP Refrigeration Technical Options Committee, June 30, 1989.

Alternative Technologies for Aerosols

Hydrocarbons

One alternative technology which can reduce the use of controlled substances in aerosol products involves the use of hydrocarbons (propane, n-butane, iso-butane, and pentanes).

The use of hydrocarbons, however, presents a slight problem due to their high flammability, a characteristic which affects the safety of aerosol filling facilities. In gaseous form, hydrocarbons are heavier than air, which means that any leak occurring in an aerosol filling room, storage area, or tank farm will not rise, but rather spread along the floor or ground thereby increasing the risk of explosion. Thus, a strong air movement is necessary to dissipate hydrocarbons that have leaked. This is the most important factor in determining plant design. Moreover, once hydrocarbons leak and convert to a gaseous state mixed with air, they become odorless which is an important characteristic for optimal plant design.[5]

When switching from non-flammable propellants to flammable propellants (i.e. hydrocarbons), various plant design requirements must be met. The plant needs special explosion-proof equipment and instrumentation, sophisticated leak detection systems, plant shut-down equipment, alarms and escape routes. Because of the risk of explosion, plants must usually be situated far from populated areas.

Open-air filling platforms provide one example of how new plant design requirements can be adapted to local circumstances. In most industrialized countries, where winter conditions are harsh and possible freezing and clogging of gas lines is a concern, it is a common practice to construct filling areas (gas houses) in a closed room with concrete walls. The room is isolated from the rest of the aerosol filling line. It is also equipped with leak detectors, alarms, and devices for shutting down gas supply lines in case excessive concentrations of hydrocarbons accumulate. The cost associated with the construction and design of these gas houses is high. In cases where space adjacent to the plant is available, filling lines are positioned outside the plant building with a carefully designed explosion-proof wall separating the filling line from the rest of the aerosol production line. Adequate ventilation is provided by either natural air currents or by explosion-proof fans. This design approach has been found by Mexican aerosol experts to be cheaper and safer than traditional hydrocarbon aerosol plant designs. Thus, open-air filling platforms are a viable option for Ecuadorean industry.

The following information would be required to evaluate the specific circumstances of an aerosol plant:

- present plant design and layout
- plant location (distance to populated and/or industrial areas)
- design and location of propellant storage tanks
- availability of hydrocarbons
- climate (minimum and maximum temperatures, humidity)

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[5] Nardini, G., "Open Air Filling of Hydrocarbon Propellants," International Conference on CFCs and Halon Alternatives, Baltimore, MD, Nov. 26-29, 1990, p. 1.

recycled CFC-12 supplied in containers from other recycle sources (i.e. non-MACs) must meet the more stringent ARI 700-88 standard. Recycling can reduce CFC emissions at servicing by 90 percent or more.

The most viable replacement for CFC-12 in MACs is HFC-134a. This non-ozone depleting chemical has thermodynamic properties that are similar to those of CFC-12. HFC-134a is not, however, a drop-in replacement. As a result, system changes are necessary to make a successful conversion to this refrigerant. For example, HFC-134a requires a new lubricant, hoses made from composite materials that have lower permeability, and a switch in materials used for hose connections. HFC-134a will be commercially available in North America and Europe by 1992, and will reach maximum penetration in those markets three to five years later. Several new HFC-134a plants are under construction. For example, ICI has a plant in the United Kingdom that should be completed by the end of 1991 and one under construction in the U.S. that is expected to be completed by 1993. HFC-134a is expected to be more expensive than CFC-12 due to higher capital and energy costs. SAE is currently developing a new purity standard, J-2099, for use in HFC-134a recycling from MACs.

Alternative Technologies for Foams

CFCs are used to make products of polyurethane, polystyrene, polyolefin (polyethylene and polypropylene), and phenolic plastic foams (UNEP 1989)[9]. In Ecuador, CFC-11 is predominantly employed as a blowing agent in the production of rigid polyurethane foam for appliance insulation and polyisocyanurate foam board used in building insulation. CFC-11 is also used in other applications such as the manufacture of flexible polyurethane foam which is used for cushioning and bedding.

Ecuadorean manufacturers of foam products have a variety of alternatives to controlled substances. A combination of options is ideal. To achieve the right combination, manufacturers must consider the following factors unique to their operations: product mix, production equipment, manufacturing environment and regulatory constraints. Also, the opportunity for additional innovative technology may yield new alternative practices within the next few years.[10] The following discussion of substitutes and alternatives for controlled substances in the production of foam is separated into the major foam categories.

Polyurethane Foams

Polyurethane can be manufactured into rigid or flexible foam products. In Ecuador, applications for rigid polyurethane foams include appliance insulation, building material, and packaging material. Applications for flexible polyurethane foam include mattresses, furniture cushioning, carpet underlay, and packaging (EPA 1991). Both types of foams use CFC-11 and CFC-12 as blowing agents in the production process.

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[9] United Nations Environment Programme 1989, "Flexible and Rigid Foams Technical Options Report", June 30, 1989, UNEP Foam Technical Options Committee, pp.71-74.

[10] United States Environmental Protection Agency (1991), "Handbook for Reducing and Eliminating Chlorofluorocarbons in Flexible Polyurethane Foams," p. 4.

HFC- and HCFC-based Systems

Using HFC- and HCFC-based systems provides another means of reducing the use of CFCs in aerosol products. HCFC-22, HFC-152a, and HCFC-142b are commercially available, while HCFC-123, HCFC-124, HFC-134a, HFC-125, and HCFC-141b are emerging chemical substitutes.

HFC-134a looks promising as an aerosol propellant of exceptionally low toxicity. Its effectiveness as a solvent is comparable to the CFC-12 now used in certain applications.

HCFC-141b, which is slightly flammable, is also low in toxicity. When blended with HCFC-123, it is non-flammable. The blend contains the highest practical level of slightly flammable HCFC-141b to minimize lung-related exposures to HCFC-123.

HCFC-142b is used in a few applications in the U.S. and is presently unavailable elsewhere. It has many properties in common with HCFC-22, its parent compound, except high pressure. It is more than 12 times as costly as hydrocarbon propellants. Higher costs have restricted its use in aerosol applications.[7]

HCFC-142b and HCFC-22 are future feasible replacements for MCF in applications where non-ozone depleting alternatives do not exist. This scenario would result where the use of a non-flammable solvent/propellant system is essential.

A blend of HCFC-22/HCFC-142b (40:60) is non-flammable. In addition, the blend has been commercialized for perfumes and colognes and also displays good solvent properties. When used as less than 28 percent of the total propellant, its ethanol solutions are lower in pressure than those of CFC-12 and ethanol.

HFC-152a is close to an ideal propellant, except that it is flammable. It is less flammable than hydrocarbon gases, however, and it has typically been used to produce propellants for shaving creams, depilatories, and mousse products where the foam surface will not momentarily flash if ignited. HFC-152a is also noted for its exceptionally low odor and good solvency. As a result of these properties, it is used to make less flammable colognes and perfumes.

Other Delivery Systems

Finally, CFC and MCF use in aerosols can also be eliminated by using alternative means of delivering the product. Examples of non-propellant systems include roll-ons, pumps, and manual wet brush methods.

Alternative Technologies for Refrigeration

For refrigeration, there are commercially available technologies including recycling and other conservation practices. They provide economically feasible methods of immediately

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[7] Air and Energy Engineering Research Laboratory, United States Environmental Protection Agency, "Aerosol Industry Success in Reducing CFC Propellant Usage," Nov. 1989, pp.8-9.

products, based on economic considerations.

Substitutes for CFC-11 and CFC-12 in the production of polyurethane foams include methylene chloride, water, and HCFCs. As indicated earlier, however, caution must be taken in using HCFCs as they are defined as transitional substances, and are listed in Annex C of the Montreal Protocol.

Methylene chloride is the most common substitute used for polyurethane slabstock foam. Methylene chloride possesses many attractive qualities. It is not an ozone depleting chemical, nor a volatile organic chemical, and it is a non flammable substance (EPA 1991). Some manufacturers have mentioned that it is more difficult to produce foams with a consistent density and softness with methylene chloride, because more energy is required to volatilize methylene chloride relative to CFCs (UNEP 1989). Additional precautions should be used when working with methylene chloride because preliminary tests in which animals are exposed to large doses of the substance have produced malignant tumors in the exposed animals (EPA 1991). USEPA has thus classified methylene chloride as a "probable carcinogen" pending further toxicity testing.

It is also possible to manufacture flexible polyurethane slabstock foam without using an auxiliary blowing agent. In this process, only the primary blowing agent, water, is used to create the foaming action. While some manufacturers assert that all grades of foam can be manufactured using this process, others stated that very soft foams cannot be made using this process. In addition, this process is reported to be more expensive than processes relying on an auxiliary blowing agent.

Several HCFCs can be considered as transitional substitute chemicals for controlled substances. HCFC-123 and HCFC-141b are possible interim substitutes for applications presently using CFC-11. Both exhibit physical properties similar to those of CFC-11 (boiling point, vapor thermal conductivity, and heat of vaporization), and both have significantly lower atmospheric lifetimes and lower ozone depletion potentials than CFC-11 (ODPs of 0.02 and 0.15, respectively). HCFC-123 results in a slight decline in thermal performance, slightly lower blowing efficiency, and greater solvency (UNEP Foams 1989). HCFC-141b is a more efficient blowing agent than CFC-11, but is flammable and may require plant modifications to accommodate its use (UNEP Foams 1989).

There is some question about the reactivity of foams blown with HCFC-123 and HCFC-141b with plastic liners and other materials used in refrigerator cabinets; this question is being investigated by appliance manufacturers. A blend of HCFC-123 and HCFC-141b is being evaluated by two major chemical manufacturers. This blend appears to be one of the most promising future substitutes for foam insulation applications. It is also a viable replacement candidate for flexible foams production.

In addition to these considerations, toxicity testing has not been completed on HCFCs, although preliminary tests indicate that they are not toxic.[11] It is likely that these blowing agents will be introduced into the North American market by 1992 or 1993. Achieving

[11] More recently data has become available on HCFC-123 which shows non-malignant tumors in male rats. In response, the acceptable exposure limit has been reduced by several manufacturers. The use of HCFC-123 within these revised exposure limits appears possible in chillers and is being evaluated in refrigerator foam and insulating foam.

Alternative Technologies for Cooling

Recycling equipment has also been developed to service chillers and other large systems with capacities of 500 to 5000 pounds. The recycling machines can be dedicated to one chiller system full time or mobilized to service multiple systems. Recycling units can also be adapted to other refrigeration systems. Recycling systems can reduce CFC emissions by 95 percent or more.

Refrigerant recovery systems used to prevent the release of CFCs during routine servicing of centrifugal chillers have recently been introduced onto the U.S. market by at least two manufacturers of chillers. The storage tanks of these units hold 1600 or 3300 pounds of refrigerant. The units are capable of recycling the refrigerant during all servicing and downtime and can reduce CFC emissions by up to 95 percent.

Chillers also lose refrigerant during normal operation due to purging. New purge systems can reduce the refrigerant losses associated with this process by up to 98 percent. These systems perform a two-step process. First, the system recondenses and returns as much refrigerant as possible from the purge gas. Second, the purge gas passes through a carbon adsorption bed before it is vented to the atmosphere. This purge process is now available in North America.

HCFC-123 is currently being tested in several industrialized countries as a substitute refrigerant for CFC-11 in commercial chillers. HCFC-123 is a virtual drop-in substitute for CFC-11 in most open shaft applications, with only minor system material changes required to retrofit existing CFC-11 units. New equipment designed specifically for HCFC-123 is also commercially available. A manufacturing plant has been built in the U.S. to produce the new refrigerant. Capital costs of new packaged units are competitive with CFC-11 systems; however, due to efficiency losses of 5-20 percent, the operating costs will be higher. HCFC-22 based-systems have also been tested and are currently available for use in some applications. Because HCFCs will eventually be phased out, they should be considered only as transitional solutions.

Alternative Technologies for Mobile Air Conditioning

Equipment is also available to recover and recycle CFC-12 refrigerants from vehicles with mobile air conditioners (MACs). These refrigerants would normally be vented to the atmosphere during servicing and/or repair. Based on the results of a joint research and development program between industry and the U.S. Environmental Protection Agency, a standard of purity for recycled refrigerant was accepted by several automobile manufacturers. The standard has been published by the Society of Automotive Engineers (SAE) as SAE J-1991. SAE has developed two other industry standards for the recovery and recycling of CFC-12 from MACs: SAE J-1989 entitled, "Recycling Servicing Procedures for the Containment of R-12", which provides service guidelines for service technicians, and SAE J-1990 entitled, "Extraction and Recycle Equipment for Mobile Air Conditioning Systems", which provides equipment specifications for CFC-12 recycling and/or recovery, and recharging systems. In addition, several organizations in the United States offer training and certification programs for MACs service technicians.

The Air-Conditioning and Refrigeration Institute (ARI) has also developed a purity specification for CFC-12. This specification, ARI 700-88, entitled "Specification for Fluorocarbon Refrigerants," has even stricter requirements for recycled refrigerants. SAE J-1991 requires that notably butane). However, there is considerable concern over the use of hydrocarbons as substitutes. Additional equipment may have to be installed to monitor, contain, and in some cases incinerate hydrocarbons. Appropriate ventilation is also needed to prevent clouds of flammable gas from collecting in one location, thereby increasing the chance of explosion.

Polypropylene foams. Substitutes in the polypropylene production process include HCFC-22, -142b, 134a, and butane. In higher density applications, chemical blowing agents, such as azodicarbamide may also be used as substitutes in expanded polypropylene foams. Of these substitutes, hydrocarbons are the least expensive. It should be noted that butane is a volatile organic compound that contributes to the formation of ozone in the troposphere in both polyethylene and polypropylene applications. In addition, like other hydrocarbons, butane has flammable characteristics.

Rigid polyurethane foams have a cellular structure that results in a material having a high fraction of internal voids. As a result, these expanded polymer foams can be made with a range of relatively low densities, which contributes to the low cost and utility of this foam. In Ecuador, CFC-11 and CFC-12 are the most widely used blowing agents for rigid polyurethane foams. A major end used for rigid polyurethane is refrigerator insulation. Polyurethane and polyisocyanurate foam boardstock are often laminated to various facing materials, including aluminum foil, paper, glass, roofing felts, steel, and plasterboard. It is used in these cases for insulation in buildings, tanks, and solar collectors. Substitutes for CFCs in the production of rigid polyurethane foams are water and HCFC-22. It is important to note that while HCFC-22 has a much lower ozone depleting potential (0.05), it is defined as a transitional substance and is listed in Annex C of the Montreal Protocol.

Immediate reductions in CFC-11 applications can be achieved in rigid polyurethane. This is achieved by adjusting the polyol mix and substituting water for CFC-11. In using a high water formulation, the water-isocyanate reaction generates carbon dioxide. A critical factor is to assure that the reduction of CFC-11 does not adversely affect the thermal conductivity of the foam and, therefore, the energy consumption of the appliance. Other necessary properties of reduced CFC-11 foam systems include completeness of cabinet filling, dimensional stability of the foam, sufficient removal of exothermic heat, and viscosity of process chemicals.

The amount of water that can be substituted in appliance foam insulation will be dependent upon the isocyanate base that the manufacturer uses, either toluene diisocyanate (TDI) or diphenylmethane diisocyanate (MDI), and the desired energy efficiency value of the insulation. Substitution of carbon dioxide, with a higher thermal conductivity in the vapor phase than CFC-11, will result in more heat transfer through the foam unless foam cell size and cabinet filling is improved. A number of recent developments have been successful in providing equivalent thermal conductivity (k-value) in foams with lower CFC-11 content. Foam systems are being marketed based on reduced levels of CFC-11 (5 to 10 percent decrease by weight) and modifications in base polyols and isocyanates which are comparable in thermal conductivity to conventional foams. Advances in microcell technology are taking place to reduce the cell size that can be used effectively with increased water when CFC-11 use is decreased.

In the future, use of advanced insulation techniques, such as highly efficient vacuum panels, would have application to many refrigeration applications where CFC-blown foams are now used. Vacuum panel technology still needs to undergo considerable development before being commercialized. Home refrigerators have been made using vacuum panels, but the panels have not proven to be reliable or cost effective. The following issues need to be resolved: material selection, improvement of long-term performance, enhanced production methods, and decrease in cost. The successful development of vacuum panels could provide substantial energy savings in refrigeration systems. These vacuum panels are expected to be commercially available in North America by 1995 or soon thereafter.

Flexible polyurethane foam is used because it is comfortable, soft, and firm. It is also relatively inexpensive compared to alternatives. The biggest challenge facing the Ecuadorean flexible polyurethane foam industry is to implement cost-effective alternatives for super-soft and low-density foams. Without effective alternatives, manufacturers of flexible polyurethane foam could lose their markets. End users might switch from flexible foam to competitive cushioning

APPENDIX D:
ANALYSIS FOR ESTIMATING COSTS OF ELIMINATING CFC CONSUMPTION IN ECUADOR

A. Economic Analysis of Proposed Phase-Out Schedule

Introduction

1. This section estimates the total cost of eliminating CFC consumption in Ecuador and shows the relative scale of these costs with respect to two alternative reduction scenarios: a phaseout by 2010, and an accelerated scenario where CFCs are phased out by the year 2000. The purpose of this section is to indicate the reduction in total costs that result from eliminating CFC use in the accelerated phase out scenario. This analysis also determines which sectors will bear the majority of the costs.

2. The cost estimates should not be used to project the level of funding that Ecuador should seek from the Interim Multilateral Fund. Although these costs are useful in providing a first estimate of the scale of resources involved in implementing the Protocol, they do not include indirect costs associated with the adoption of substitute technologies or products. These indirect costs include, for example, funds required for public education, industry seminars, and institutional strengthening. In addition, these estimates do not consider substitution costs that may already have been incurred due to consumer awareness of the ozone depletion issue, e.g., in the aerosols industry. Since these costs may be significant, the Government of Ecuador should not use the estimates provided here as a guideline for funding required to implement the Protocol but rather as guidance for assessing phaseout scenarios.

Types of costs considered

3. Two types of costs were considered in estimating costs of phasing out CFCs in Ecuador : (a) short-medium term costs, and (b) long term costs. Short-medium term costs are incurred in the shift to alternative production technologies and substances during the phaseout period, and include the following:

- cost of converting existing equipment and product manufacturing facilities;
- capital cost of new equipment;
- operating cost, including the cost of raw materials except where otherwise provided for; and
- cost of collecting and recycling CFCs.

4. In contrast, long-term costs are incurred well into the future, when the imports of CFCs cease. From the year 2010 forward, all servicing and recharging requirements of old CFC-using equipment will need to be met with recycled CFCs. Therefore, when the stock of CFCs available for recycling runs out, all such equipment still in service will need to be replaced with equipment that does not use CFCs. Equipment will need to be replaced even though it may have several years of otherwise useful life remaining. This premature retirement of the equipment amounts to a significant additional capital cost for Ecuador. For instance, under an accelerated phase out target, a consumer in Ecuador may purchase and install a CFC-using refrigerator in the year 2010.

9. The inputs required for calculating the short and medium term costs include the following: the date that each alternative technology becomes available for adoption; the number of years required to reach maximum market penetration; the amount of reduction in CFC consumption that can be achieved by each technology; and whether the technology can be applied to both new and existing equipment or just to new equipment. These inputs are summarized in tabular form in Exhibit D-3 (for a 2010 phaseout) and Exhibit D-4 (for a 2000 phaseout). The complete methodology is summarized below.

Methodology

10. **Assumptions**. The following assumptions were made in estimating (a)short-medium, and (b) long term costs of phasing out CFCs by either 2000 or 2010:

- Growth rate: The growth rate of CFC consumption in the absence of Protocol restrictions was assumed to be either 2% (likely) or 5% (high).

- Cost of substitute technologies and products: The costs of introducing substitute technology and alternative chemicals were determined to be between 5% (likely cost) and 30% (high cost) higher than the U.S. Costs of substitutes are likely to be higher in Ecuador because of the following factors:

  -- transportation costs for imported equipment;
  -- maintenance and servicing costs for new technologies;
  -- incremental infrastructure development costs;
  -- costs due to exchange rate variations;
  -- technology transfer costs; and
  -- costs due to the absence of economies of scale.

11. **Discount rate**: A discount rate of 2% was used to calculate the net present value of capital stock that will be prematurely retired due to lack of availability of recycled CFCs.

12. **Calculating the costs of the phaseout**. Short-medium and long term costs are computed on an incremental basis with respect to costs already incurred when using CFCs. For example, if a raw material can be used as a substitute for a CFC, only the difference between the cost of the substitute and the CFC is considered. Similarly when equipment is replaced, only increases in capital costs are included in the calculation. By calculating incremental costs we can estimate the net costs to Ecuador of reducing and eliminating use of CFCs.

13. The calculation of costs to be incurred by Ecuador in phasing out CFCs was divided into two parts: (i) calculation of short-medium term costs, and (ii) estimation of long term costs.

14. Short-medium term costs are directly linked with the shift to new technologies and substitute substances, and occur primarily during the phase out process. These costs were calculated through the use of a computer model whose operation is discussed in Annex F. Cost estimates were calculated for two rates of growth in CFC consumption: (i) a "likely growth rate" assumed to be 2% per year throughout the period; and (ii) a "fast growth" scenario of 5% per year.

The only way to recharge this refrigerator will be to use recycled CFC. However, at a later date recycled CFC may no longer be available. If the stock of recycled CFC is depleted by the year 2030, and the refrigerator has a forty-year life, then the refrigerator will have to be replaced the first time after 2030 that it needs to be serviced or recharged. Thus, the refrigerator may become obsolete be as much as twenty years earlier than necessary. The cost to the country of this premature retirement of useful equipment is equal to the cost of capital, assumed to be 2% of the cost of the new refrigerator compounded over twenty years.

5. By aggregating the capital costs for all equipment retired early we can calculate the total phase out cost. This total cost is then calculated for different phase-out schedules, the result being an illustration of the sensitivity of these costs to the choice of phase out schedule.

6. For Ecuador, only the costs for home refrigerators were included in this calculation because it is the sector in which the most important costs of this type would be expected to occur. In addition, it is the only sector for which data sufficient to make a reasonable calculation exists.

Phaseout schedules considered

7. Two CFC phaseout schedules were tested in the calculation of the short/medium-term costs and the long-term costs. The first schedule consists of the consumption ceilings specified by the Montreal Protocol for Article 5, paragraph 1 countries:

- freeze consumption at 1996 consumption levels by 1999;
- reduce consumption by 20% of the 1996 levels by 2003;
- reduce consumption by 50% of the 1996 levels by 2005;
- reduce consumption by 85% of the 1996 levels by 2007; and
- reduce consumption by 100% of the 1996 levels by 2010.

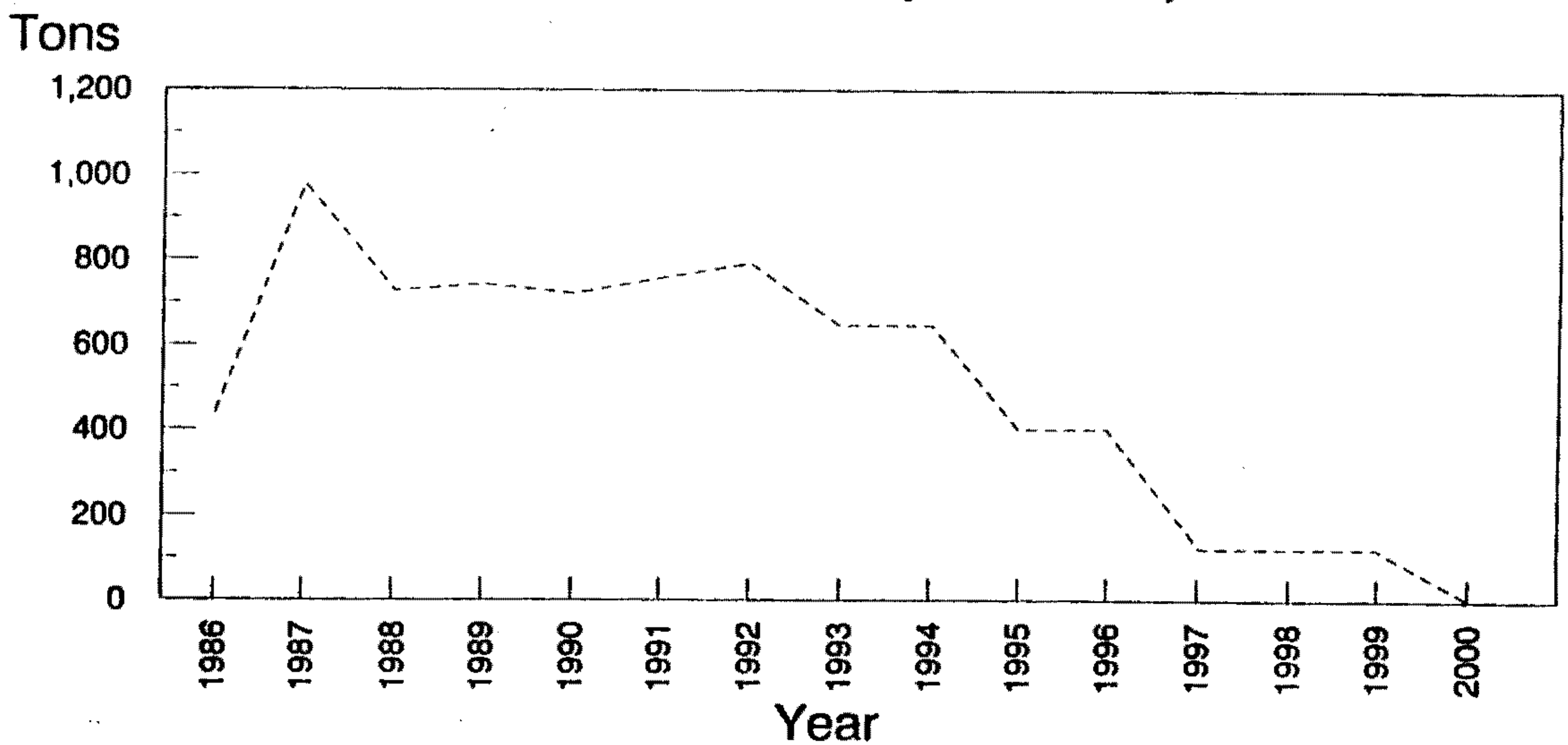
The second schedule is one which accelerates the process so that the phaseout is complete by the year 2000:

- reduce consumption to 80% of 1991 levels by 1993;
- reduce consumption to 50% of the 1991 levels by 1995;
- reduce consumption to 15% of the 1991 levels by 1997;
- reduce consumption to zero by 2000.

The two phase-out schedules described above are depicted graphically in Exhibits D-1 and D-2.

8. Two CFC growth rate assumptions were tested in both calculations. These were a "likely growth rate" assumption of 2% per year throughout the period, and a "high growth" scenario of sustained 5% per year growth in CFC consumption throughout the period.

Exhibit D-1
Phaseout of CFCs in Ecuador[1]
(Industrialized Country Schedule)



[1] Assumes a 5% per year increase in consumption of CFCs.

15. In the second part of the calculation the long term costs were estimated. These costs are borne by the country when CFC using equipment (such as domestic refrigerators) has to be discarded before the end of its useful life due to lack of availability of recycled CFCs. These capital costs are incurred beyond the phase out date, because some CFC-using equipment can operate for years on recycled CFCs[12].

Results

16. The estimates of short/medium-term costs to Ecuador for the phase out of CFC consumption are shown in Exhibit D-5. The sensitivity of these costs to the growth rate in CFC consumption and to the rapidity of phase out is illustrated. As would be expected, the calculation results in higher short/medium-term costs when the higher base growth rate assumption is used. This is because faster growth in CFC consumption leads to a higher quantity of CFCs that will have to be eliminated.

17. Short/medium-term costs are less responsive to the rapidity of the phase out. In this case, the net costs decrease as the phase out date is delayed. The incremental cost of eliminating CFCs as time passes is more than offset by the savings in capital cost achieved through making the expenditures later rather than earlier, and by the increase with time of the number of available technologies. Some of the substitute technology may be less expensive at a later date than those available at an earlier date.

18. Exhibit D-6 and Exhibit D-7 show the breakdown by use sector of short/medium-term costs. Results for the four scenarios of a 2010 phase out are given. In general, the larger uses account for the larger costs. An exception to this is household refrigeration, where increased energy efficiencies of alternate technologies offset the cost of the changeover.

19. In the aerosols sector, it was assumed that the alternative technology to be adopted is the replacement of CFCs with HCFC-22 in the aerosol product formulation. This technology carries a significant cost. However, another option, which is much less expensive, is to replace the CFCs with hydrocarbons. If a supply of suitably pure hydrocarbons for this sector can be developed, the phase out cost will decrease.

20. The long-term costs are shown in Exhibit D-8. Results show the sensitivity of these future costs of early capital retirement with respect to phase out schedule and base growth rate. The savings associated with an accelerated phaseout schedule are substantial, and range from approximately US$15 million to US$28 million.

21. Finally, Exhibit D-9 illustrates the trade-off in costs involved in the choice of phaseout schedules. For each of the four growth/cost scenarios, accelerating the phaseout from 2010 to 2000 causes the increase in short and medium term costs shown in the first column (approximately US$ 8 million to US$17 million), but allows the savings in long term costs shown in the second column (approximately US$ 16 million to US$ 28 million), resulting in the net savings given in the third column (approximately US$ 8 million to US$ 14 million).

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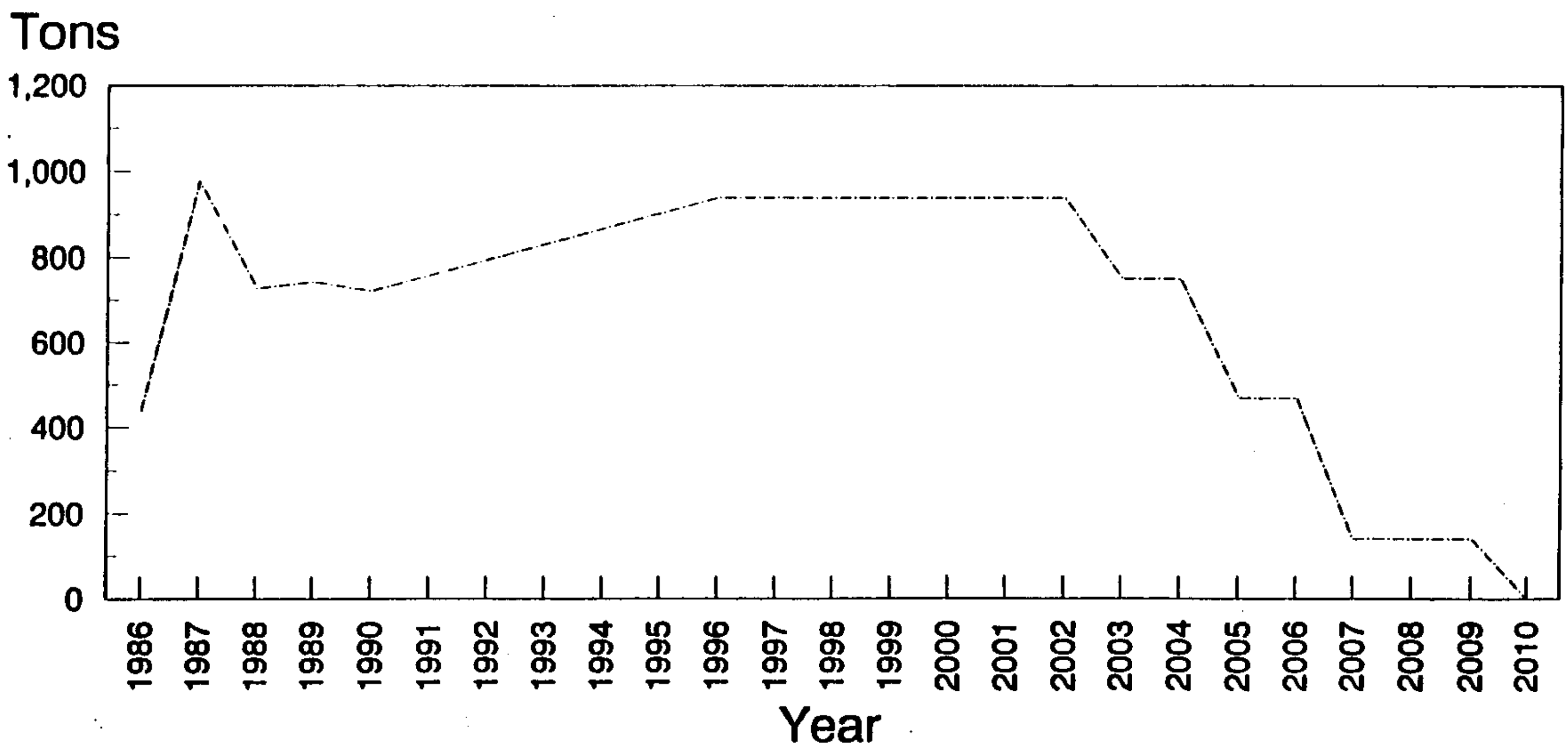
[12] The use of recycled CFCs is not considered consumption for the purposes of the Montreal Protocol.

EXHIBIT D-3. CHARACTERISTICS OF CONTROL TECHNOLOGIES DEVELOPING COUNTRY PHASE OUT SCHEDULE (2010)

Controlled Substance	End Use	Control	Start Year	Years to Reach Maximum Penetration	Use Reduction	Applicable to New (N) and to New and Existing (N/E)
CFC-11	Aerosols	HCFC-22	2000	3	100%	N
	Insulation foam	HCFC-141b/HCFC-123	2000	3	100%	N
	Flexible foam	HCFC-141b/HCFC-123	2000	3	100%	N
CFC-12	Household refrigeration	Reduce charge Ternary blend	1995 2000	3 4	50% 100%	N N
	Aerosols	HCFC-22	2000	3	100%	N
	Industrial/commercial refrigeration	Recycling Ternary blend	1995 2000	3 4	50% 100%	N/E N
	Mobile air conditioning	Recycling HFC-134a	1995 2000	3 4	50% 100%	N/E N
CFC-114	Industrial/commercial refrigeration	Recycling Ternary blend	1995 2000	3 4	50% 100%	N/E N

Exhibit D-2
Phaseout Schedule of CFCs in Ecuador[1]
(Developing Country Schedule)



[1] Assumes a 5% per year increase in consumption of CFCs.

EXHIBIT D-5

SUMMARY OF SHORT/MEDIUM TERM COSTS OF PHASING OUT THE CONSUMPTION OF CFCs IN ECUADOR[13]

SCENARIO	DEVELOPING COUNTRY PHASE-OUT (2010)	ACCELERATED PHASE-OUT (2000)
LIKELY GROWTH RATE LIKELY COST	US$7.0	US$14.9
LIKELY GROWTH RATE HIGH COST	US$8.7	US$18.5
HIGH GROWTH RATE LIKELY COST	US$12.2	US$26.2
HIGH GROWTH RATE HIGH COST	US$15.0	US$32.4

[13] All figures in millions of 1991 U.S. dollars.

EXHIBIT D-6
SHORT AND MEDIUM-TERM COSTS TO ECUADOR OF PHASING OUT CFC CONSUMPTION
DEVELOPING COUNTRY SCHEDULE OF MONTREAL PROTOCOL (2010 PHASE OUT)
(millions of $ 1991)

CONTROLLED SUBSTANCE	END-USE	CONTROL	1 LIKELY GROWTH LIKELY COST	2 LIKELY GROWTH HIGH COST	3 HIGH GROWTH LIKELY COST	4 HIGH GROWTH HIGH COST
CFC-11	Aerosols	HCFC-22	0.09	0.11	0.14	0.17
	Insulation foam	HCFC-141b/HCFC-123	0.61	0.76	1.05	1.31
	Flexible foam	HCFC-141b/HCFC-123	0.32	0.39	0.55	0.68
CFC-12	Household refrigeration	Reduce charge Ternary blend	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Aerosols	HCFC-22	4.55	5.63	7.19	8.90
	Industrial/commercial refrigeration	Recycling Ternary blend	0.06 0.27	0.08 0.33	0.10 0.44	0.13 0.55
	Mobile Air Conditioning	Recycling HFC-134a	0.27 0.14	0.33 0.17	0.72 0.75	0.90 0.93
CFC-114	Industrial/commercial refrigeration	Recycling Ternary blend	0.15 0.57	0.19 0.71	0.22 0.98	0.27 1.21
Total			7.03	8.70	12.15	15.04

EXHIBIT D-7
SHORT AND MEDIUM-TERM COSTS TO ECUADOR OF PHASING OUT CFC CONSUMPTION
DEVELOPED COUNTRY SCHEDULE (2000 PHASE OUT)
(millions of $ 1991)

CONTROLLED SUBSTANCE	END-USE	CONTROL	1 LIKELY GROWTH LIKELY COST	2 LIKELY GROWTH HIGH COST	3 HIGH GROWTH LIKELY COST	4 HIGH GROWTH HIGH COST
CFC-11	Aerosols	HCFC-22	0.13	0.16	0.22	0.27
	Insulation foam	HCFC-141b/HCFC-123	2.08	2.58	3.52	4.36
	Flexible foam	HCFC-141b/HCFC-123	1.07	1.32	1.82	0.68
CFC-12	Household refrigeration	Reduce charge Ternary blend	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Aerosols	HCFC-22	6.52	8.07	11.04	13.67
	Industrial/commercial refrigeration	Recycling Ternary blend	0.09 0.89	0.11 1.10	0.15 1.64	0.19 2.03
	Mobile Air Conditioning	Recycling HFC-134a	0.60 1.40	0.74 1.73	1.12 2.16	1.38 3.41
CFC-114	Industrial/commercial refrigeration	Recycling Ternary blend	0.20 1.93	0.25 2.39	0.33 3.56	0.41 4.40
Total			14.91	18.46	26.15	32.37

EXHIBIT D-8

LONG-TERM COSTS TO ECUADOR FOR PHASING OUT CFC CONSUMPTION[14]

(Capital Cost of Early Equipment Retirement)

	EXISTING MONTREAL PROTOCOL (2010)	ACCELERATED PHASE OUT SCHEDULE (2000)	SAVINGS DUE TO ACCELERATION IN PHASE OUT
LOW-GROWTH SCENARIO	19.0	3.5	15.5
HIGH-GROWTH SCENARIO	32.1	4.4	27.7

[14]Expressed in millions of 1991 dollars.

Industry Support Activities

25. To continue and expand existing activities to support industry's transition to alternative technologies, the Montreal Protocol unit shall undertake the following activities:

- Support identification and preparation of technical projects to be proposed to Interim Multilateral Fund Implementing Agencies (i.e., the World Bank, UNDP, and UNEP);

- Coordinate with INEN the designing of technical norms for product characteristics and intermediary products produced without controlled substances;

- In coordination with NOEA's other departments, formulate programs relating to studies, technical assistance and transfer of technology; and,

- Participate in international fora and networking activities organized abroad to report to local industry the latest developments in alternative technologies.

Budget

26. A budget for these activities for the years 1992-96 is presented below in Exhibit E-1.

EXHIBIT E-1
ECUADOR'S PROPOSED PROGRAM FOR IMPLEMENTING THE MONTREAL PROTOCOL

IMPLEMENTING UNIT COSTS (1992-96)

COMPONENT	ESTIMATED COSTS
1. OFFICE EQUIPMENT	17,000
2. SALARIES & BENEFITS	180,000
3. TRAINING	15,000
4. TRAVEL AND CONFERENCES	60,000
5. COMMUNICATIONS & PUBLICATIONS	24,000
6. OFFICE SUPPLIES & TRANSLATION SERVICES	12,000
BASE COST	308,000
PRICE CONTINGENCIES (10%)	30,800
PHYSICAL CONTIGENCIES (15%)	46,200
TOTAL	**US$ 385,000**