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PRELIMINARY DRAFT REPORT ON THE REVIEW

UNDER PARAGRAPH 8 OF ARTICLE 5

REPORT UNDER PARAGRAPH 8 OF ARTICLE 5

OF THE MONTREAL PROTOCOL

PRELIMINARY DRAFT

Submitted to:

Sub-Committee for the Report
Multilateral Fund for the Implementation of the Montreal Protocol

Submitted by:

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India

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PREFACE

This report was prepared by a consortium of consultants led by ICF Incorporated of Washington, DC, USA. ICF's partners included the Tata Energy Research Institute (TERI) of New Delhi, India; the Centre for Environmental Technologies (CETEC) of Kuala Lumpur, Malaysia; and the Center for Global Change (CGC) at the University of Maryland, USA.

Sudhakar Kesavan of ICF was responsible for overall project direction while Peter Linquiti managed the project on a day-to-day basis. Other key ICF staff included Thomas Dillon, Abyd Karmali, Sandra Phillips, David Strelneck, and John Wasson. TERI's efforts were managed by Ravi Batra with critical input from DD Arora, Sandeep Chawla, and Ajay Mathur. Goh Kiam Seng led CETEC's activities with the help of Jenny Tan. CGC's work on the project was undertaken jointly by Alan Miller and Pamela Wexler.

Vital contributions to the report were also made by many individuals who generously made their time available to the Study Team to answer questions and provide data. Valuable input came from government and industry officials in developing countries, the staffs of the Secretariat and the four implementing agencies of the Multilateral Fund, the Ozone Secretariat, members of the Executive Committee, and numerous other individuals and organizations.

The Study Team would also like to thank the Sub-Committee for the Report, under the able direction of its Chairman, Mr. John Whitelaw, for its help and support during the study. In addition, the Team gratefully acknowledges the contribution of the Chief Officer of the Multilateral Fund, Dr. Omar El-Arini, and his staff in coordinating the project and responding promptly to numerous requests for information.

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EXECUTIVE SUMMARY

OVERVIEW

1. By signing the Montreal Protocol on Substances that Deplete the Ozone Layer, more than 130 of the world's nations have agreed to phaseout the consumption and production of ozone depleting substances. A key feature of the Protocol is that it includes separate phaseout schedules for two different types of countries. Developed countries are to complete their phaseout of the most significant ozone depleting chemicals by 1996. Special status under Article 5 of the Protocol has been accorded to 91 developing countries, which currently have until 2010 to complete their phaseout.

2. At their Second Meeting, the Parties to the Protocol called for a review of the situation of Article 5 countries. The Sub-Committee for the Report under Paragraph 8 of Article 5 of the Montreal Protocol was subsequently established and this study was initiated. As described in the Terms of Reference and refined during two meetings between the Study Team and the Sub-Committee, the fundamental purpose of the study is to assess the feasibility of alternative phaseout schedules for Article 5 countries, taking into account impediments to and incentives for technology transfer as well as the implementation of the financial mechanism.

3. A total of eleven phaseout schedules are analyzed in this study. Ten of the scenarios differ in terms of five key parameters discussed below. An eleventh scenario investigates the fastest economically feasible phaseout in Article 5 countries. The five parameters that collectively define the scenarios can be summarized as follows:

- London or Copenhagen Amendments: The London Amendments required that CFCs, halons, and carbon tetrachloride be phased out by 2000 and that methyl chloroform be phased out by 2005. The Copenhagen Amendments accelerated these dates to 1994 for halons and to 1996 for the remaining chemicals.

- Grace Period: Scenarios differ in terms of whether they provide Article 5 countries with a ten year grace period to comply with phaseout schedules.

- Servicing Tail for Existing Equipment: In certain scenarios, continued consumption of new ODS is allowed after the phaseout date to service existing refrigeration and air conditioning equipment. Such a tail eliminates the need for expensive retrofits or early retirement controls.

- Accelerated Servicing Tail for Existing Equipment: In the 2006 and 2010 phaseout scenarios, Article 5 countries are assumed to phase out ODS use in new refrigeration and air conditioning equipment in 1999 rather than in the final year of the phaseout. Consumption of ODS for servicing this equipment is then allowed after the phaseout date. This is in contrast to the tail scenario described above which allows continued use of ODS in new refrigeration and air conditioning equipment up until the phaseout date.

- Duration of Fund Reimbursed Operating Costs: Scenarios vary depending on whether the Multilateral Fund is assumed to reimburse incremental operating costs for either two or four years.

4. Using these parameters, a total of ten different phaseout scenarios are defined. Another scenario was also analyzed that assumed cost-effective reductions would be implemented as soon as possible and included a tail to service existing ODS-containing equipment. In this scenario, the Multilateral Fund was assumed to reimburse operating costs for two years. Exhibit ES-1 summarizes the features of these scenarios based on the various parameters described above while Chapter 2 describes them in more detail. In order to evaluate these scenarios, the Study Team developed a three-part approach to the project that included an extensive data collection effort, a structured policy and institutional analysis, and a model simulation component.

DATA COLLECTION

5. The Study Team visited eight Article 5 countries and interviewed over 170 individuals in-country to collect data required for the study. The purpose of the country visits was to develop a concise understanding of the situation in the countries regarding the phaseout of ODS and the penetration of non-ODS and low-ODS technologies. The country visits involved three to five days of interviews with government officials, staff of the ozone protection unit (OPU) or its equivalent, industry representatives, chemical distributors, ODS producers (if they exist in the country), and trade associations representing enterprises that use ODS, among others. These in-country interviews, as well as all other interviews conducted for the study, were conducted on a not-for-attribution basis.

6. Another component of the data collection effort involved use of a questionnaire to solicit information from additional Article 5 countries. Thirteen of fifteen countries responded to the questionnaire, which focused on the status of Country Program preparation; confirmation of target phaseout dates; feasibility of meeting various phaseout schedules; reductions in ODS use; and factors impeding or facilitating ODS phaseout.

7. The Study Team also reviewed materials provided by the Multilateral Fund Secretariat, including copies of 40 Country Programmes (CPS) and over 60 project proposals. Extensive data were extracted from the CPs, including the plans and policies of Article 5 countries, current and projected consumption and production of ODS, and estimated costs of ODS phaseout. The Ozone Secretariat in Nairobi also provided the Study Team with both production and consumption data for Article 5 countries, although it should be noted that these data were unavailable for a large number of countries. In addition, staff from the four Implementing Agencies of the Multilateral Fund (i.e., the World Bank, the United Nations Environment Programme, the United Nations Development Programme, and the United Nations Industrial Development Organization) were interviewed by members of the Study Team to obtain their insights and perspectives on the impediments to and incentives for technology transfer to Article 5 countries. They were also asked about the feasibility of various phaseout schedules, as well as the progress of phaseout efforts to date and the implementation activities of the IAs.

8. The Terms of Reference (TOR) of the study directed the Team to incorporate input from UNEP's Technical and Economic Assessment Panel (TEAP) in the study. Upon consulting the Co-Chair, however, the Team was informed that information from TEAP's current technical reviews were unavailable because the assessments are being updated. The Team followed the Co-Chair's advice to consult existing TEAP documents for data on feasibility, cost, and performance of alternatives. Members of the Study Team met with the Co-Chair of the Scientific Assessment Panel to obtain his input on the Team's approach for analyzing the impact of alternative phaseout schedule on the atmosphere. The Co-Chair also made suggestions regarding interpretation and presentation of results.

EXHIBIT ES-1: DEFINITION OF PHASEOUT SCENARIOS

Scenarios	London Amendments for Article 2	Copenhagen Amendments for Article 2	Ten Year Grace Period	Tail	Accelerated Tail	Two Years Operating Cost	Four Years Operating Cost
2000 Phaseout	✓					✓	
2010 Phaseout	✓		✓			✓	
2010 Phaseout w/ Tail	✓		✓	✓		✓	
1996 Phaseout		✓				✓	
2006 Phaseout		✓	✓			✓	
2006 Phaseout w/ Tail		✓	✓	✓		✓	
Fast as Cost-Effectively Possible	See Text						
2010 Phaseout w/ Accelerated Tail	✓		✓		✓	✓	
2006 Phaseout w/ Accelerated Tail		✓	✓		✓	✓	
2000 Phaseout w/ 4 Years Reimbursement	✓						✓
2010 Phaseout w/ 4 Years Reimbursement	✓		✓				✓

9. Representatives from a number of countries on the Executive Committee were interviewed to solicit their thoughts on the impediments to and incentives for technology transfer in Article 5 countries. Representatives from three donor countries were interviewed, as well as five representatives from Article 5 countries. The Study Team also solicited a variety of information from chemical and technology producers for use in both the model simulation and the policy and institutional analysis.

10. The Study Team interviewed a representative of the Centre for Science and Environment from Delhi, India about the rate of technology transfer to Article 5 countries and the possibilities for ODS phaseout. A representative of Greenpeace USA was also interviewed by the Study Team; he offered insights on the performance of IAs, the need to consider a broad range of not-in-kind alternatives, and policies regarding reimbursement of incremental costs. In addition, information was solicited from the Ozone Campaign Director for Friends of the Earth USA. The Study Team's approach to data collection is described in detail in Section 3.2 and a descriptive overview of the collected data is provided in Chapter 4.

POLICY AND INSTITUTIONAL ANALYSIS

11. The second element of the Study Team's approach entailed compilation of the collected data and its analysis during a week-long policy workshop. This workshop was attended by ten members of the Study Team who employed a structured analytical framework to identify, organize, and refine a series of qualitative policy and institutional issues that affect the phaseout of ODS in developing countries.

12. The workshop participants began by considering each of the nine specific topic areas in the Terms of Reference in light of the data collected for the Study. The Team reached decisions on how to address each TOR item. The Team also discussed the feedback obtained from various Article 5 countries regarding the feasibility of the phaseout schedules being examined in this study.

13. The Study Team then moved on to generate an expansive list of policy and institutional issues affecting the phaseout in Article 5 countries. In doing so, the Study Team first approached the technology transfer process from the point of view of an ODS-using enterprise. As shown graphically in Exhibit ES-2, the Study Team identified the key actors and principal resource flows among them.

14. Second, the Study Team identified the steps in the process of transferring technology to an enterprise in an Article 5 country. Some of the steps in the process pertain only to an enterprise with a Fund-financed project, while other steps apply both to Fund-financed projects and projects taking place outside the Fund. The 12 steps identified by the Study Team are presented in Exhibit ES-3. The steps have been grouped into four logical summary stages to facilitate their presentation.

15. Third, the Study Team developed a matrix of key actors and steps involved in the technology transfer process, presented in Exhibit ES-4. The Study Team used the matrix to determine in which steps each key actor played a significant role and noted the result with a check mark in the matrix. The rationale behind this approach is that presence of impediments and/or incentives at these key steps could have a significant effect on technology transfer and hence on the feasibility of alternative phaseout scenarios. Once the matrix was filled in, workshop participants organized and developed the policy and institutional issues identified through the data collection that correspond to the significant cells in the matrix. A detailed description of the policy and institutional analysis is presented in Section 3.3 while results are provided in Chapter 5 of the report.

Exhibit ES-2
Principal Resource Flows Among Key Actors in ODS Phaseout in Article 5 Countries

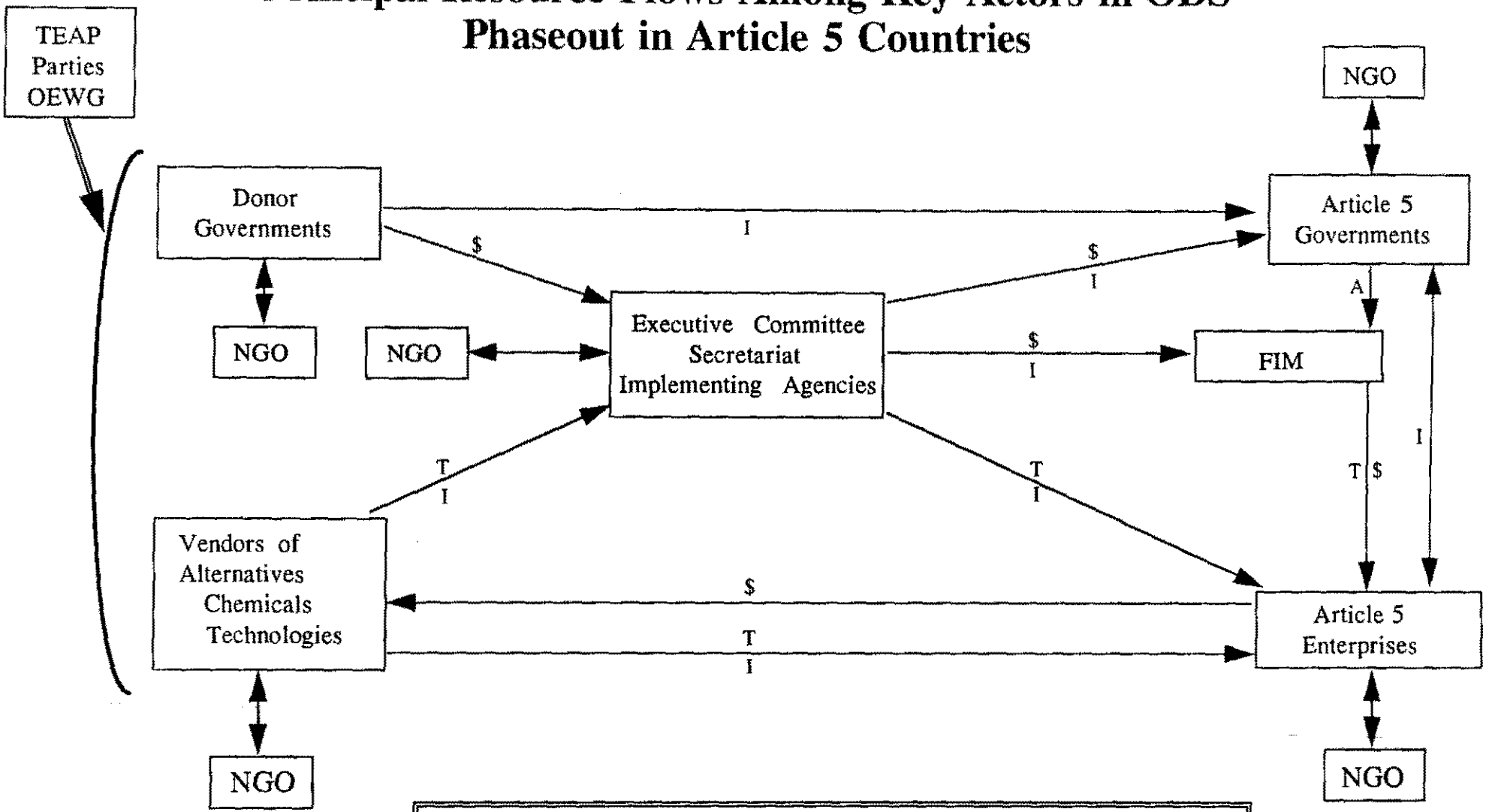

Exhibit ES-3

Summary Stages and Twelve Steps in the Technology Transfer Process

- An ODS-consuming enterprise decides to switch to non-ODS technologies:
  1. Enterprise becomes aware that a key input to its production process is disappearing
  2. Enterprise is motivated to act
- Non-ODS technologies are evaluated and specific options are selected:
  3. Enterprise identifies non-ODS technologies
  4. Enterprise evaluates non-ODS technologies
  5. Enterprise selects non-ODS technology
- A project is designed and financing is obtained:
  6. Project proposal is prepared
  7. Project receives final approval from Implementing Agency
  8. Project receives final approval from Executive Committee
  9. Funds are disbursed for the project
- The new technology is acquired, installed, and used:
  10. Terms of technology acquisition are negotiated
  11. Non-ODS technology is delivered and installed on the "shop floor"
  12. Non-ODS technology is used on the "shop floor"

Exhibit ES-4
Framework for Organizing the Discussion on Policy and Institutional Issues

	Decision to Switch		Selection of Technology			Project Design				Acquisition, Installation, and Use of Non-ODS Technology		
Step/ Actor	Become Aware of Situation	Be Motivated to Act	Identify Techno-logy	Evaluate Techno-logy	Select Techno-logy	Prepare Project Proposal	Receive IA Approval	Receive ExCom Approval	Transfer Funds	Acquire Techno-logy	Install Techno-logy	Use Techno-logy
Donor Countries		✓			✓			✓	✓			
Vendors of Alternatives	✓	✓	✓	✓	✓				✓	✓	✓	✓
Executive Committee						✓	✓	✓				
Secretariat						✓	✓	✓				
IAs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Article 5 Govern-ments	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FIMs							✓		✓	✓	✓	✓
Article 5 Enterprises	✓	✓	✓	✓	✓	✓				✓	✓	✓
NGOs	✓		✓	✓								

✓ = Actor plays a key role in this step of technology transfer.

SIMULATION OF FINANCIAL, ECONOMIC, AND ENVIRONMENTAL IMPACTS

16. The third and final element of the Study Team's approach was the development and use of a modeling tool to assess the financial, economic, and environmental impacts of alternative phaseout schedules. Sections 3.4, 3.5, and 3.6 summarize the simulation methodology in detail while Chapter 6 presents the results.

Model Outputs

17. The first two key outputs of the model for each phaseout scenario are the real resource costs and the costs borne by the Multilateral Fund. Real resource costs measure the increase in resources that will be expended by Article 5 countries in complying with the requirements of an ODS phaseout. Real resource costs can take the following forms: capital costs (i.e., cost of purchasing new equipment to replace ODS-containing equipment), one-time costs (i.e., product reformulations or industry retooling), and operating costs (i.e., chemical, labor, energy, material, and all other recurrent costs). Fund Costs are a measure of expected financial demand on the Multilateral Fund from projects eligible for reimbursement. The cost components included in the Fund costs were those specified in the document entitled "Indicative List of Incremental Costs" prepared by the Executive Committee of the Multilateral Fund. Both real resource costs and Fund cost are calculated at discount rates of ten, five, and zero per cent. Ten per cent is assumed to be a measure of the real cost of capital in Article 5 countries while a zero per cent rate allows consideration of nominal dollars. The five per cent rate is included as a sensitivity.

18. The third key model output for each scenario is annual projected consumption of ODS, which is simulated by the model each year until the phaseout is complete across all Article 5 countries. Estimates of annual ODS use are divided by chemical class (i.e., CFCs, MCF, carbon tetrachloride, and halons) and by the quantity of chemical used in new equipment and the quantity used to service existing equipment. For tail scenarios, the model also reports the quantity of ODS required each year after the phaseout date to service existing equipment (and thereby avoid costly retrofits or early retirements).

19. The final key model output is the adjusted stratospheric chlorine loadings estimated for each scenario. Given that the presence of chlorine and bromine in the stratosphere are considered to be the primary causes of ozone depletion, and that ODS compounds are the primary source of chlorine and/or bromine reaching the stratosphere, the impact of each scenario on adjusted stratospheric chlorine levels is a good indication of its potential harm to the ozone layer.

Model Inputs

20. The first important model input is an estimate of the total baseline ODS use in Article 5 countries for 1993 and the expected growth of this use in the absence of controls. The use estimate was developed based on a four step procedure. First, 40 Country Programmes approved by the Executive Committee were reviewed and key information on ODS use was extracted. Second, ODS use data reported by Article 5 countries to UNEP under the terms of the Protocol were obtained and incorporated in the analysis. Third, if a Country Programme had not been prepared for a given country, and that country had not reported its ODS use to UNEP, then total ODS use was estimated using a regression analysis correlating ODS use in Article 5 countries with Gross Domestic Product and population. Fourth, total ODP-weighted use in each Article 5 country was divided into the following six broad sector categories: refrigeration and air conditioning, foams, halons, solvent

cleaning, aerosols, and miscellaneous uses (sterilization and tobacco expansion). Total ODP weighted ODS use in 1993 for all Article 5 countries was estimated to be 235,000 tonnes and this use was assumed to grow at a rate of 8.9 per cent per year until the base year for reduction was reached when growth was frozen.

21. Baseline ODS use was then further subdivided into 33 segments to reflect specific end-uses within sector (e.g., flexible foams versus packaging foams), to allocate total ODS use between the formal and informal sectors, and to identify ODS use which would be phased out on accelerated basis because of multinational ownership or export orientation. In conducting this further division of ODS use, the Study Team felt it was critical to map groups of Article 5 countries with similar characteristics and did so based on Gross Domestic Product (GDP). This variable was selected because it was felt that countries with low GDP would tend to have their ODS use concentrated in refrigeration end uses, would be more likely to have a large informal sector, and would be unlikely to implement controls in an accelerated fashion. Countries with a high GDP, on the other hand, were assumed to have a more industrialized economy that would employ ODS in all the major end use sectors, would have a large proportion of formal industries, and would be more likely to implement controls in an accelerated fashion.

22. To group Article 5 countries, a graph was prepared plotting each Article 5 country for which a Country Programme had been prepared according to its GDP and total ODS use. The result was that most countries clustered into one of three groups according to of GDP. It was found that four countries did not fall into any of these three clusters -- Brazil, China, India, and Mexico. These countries were then each treated separately because they represent such a large portion of global use and because detailed information on ODS use in each was available from the Study Team's country visits. For each of the three groups and the four specific countries, the Study Team then mapped the use into the 33 segments.

23. The second major input to the simulation is a series of "model" projects. For each of the 33 use segments defined above, model projects were developed that characterized the control technologies available to eliminate this ODS use in that segment. For example, in the formal commercial refrigeration segment assumed to pursue an accelerated phaseout, three model projects were defined, including HCFC-22, HFC-134a, and HFC blends. A total of 98 model projects inclusive of retrofit and recycling controls were developed as part of this analysis. Model projects were characterized in terms of capital and operating cost; ODS use avoided each year; date of earliest availability; the time required to reach maximum market penetration; and maximum estimated market penetration, which is defined as the maximum fraction of the total ODS use in a given segment that can be replaced by a project. (The market penetrations across all projects in a given use segment always sum to 100 per cent.)

24. The model projects were developed and parameterized based on a review of the array of investment projects approved by the Executive Committee of the Multilateral Fund to-date, the control technologies identified as likely to be used in the eight Article 5 countries visited by the Study Team, information on control technologies contained in the 13 responses to the fax questionnaires, data from the various TEAP reports, and the professional judgement of the Study Team.

Model Operation

25. The model begins with the estimated baseline ODS use in the 33 segments across all Article 5 countries in the absence of controls. It then calculates the total reduction in ODS use that must be achieved each year to comply with the phaseout targets specified in a given scenario. This is simply the difference between unconstrained use and the total use allowed under the scenario. Next, the model simulates the implementation of the model projects in segments expected to pursue an accelerated phaseout and estimates the total reductions achieved by these projects. The model then determines the remaining reductions in total weighted ODP use required to meet the target. To achieve these additional reductions, the model determines the sequence of target driven model projects that must be implemented by implementing model projects in order of decreasing cost-effectiveness use. The cost-effectiveness of each project is measured using the real resource unit abatement cost (i.e., the real resource cost divided by the ODS use avoided).

26. Once the model has determined the sequence of model projects that must be implemented over time to achieve the targets, it calculates the Fund and real resource costs. Real resource costs are equal to the discounted sum of all project capital costs and chemical and operating costs throughout the economic life of the projects assuming baseline chemical prices. Fund costs are calculated only for projects with net incremental costs, meaning that projects with aggregate savings are not considered eligible for Fund support. For those projects which are supported, Fund costs are equal to the discounted sum of all project capital costs, chemical costs, and operating costs for the specified duration of operating costs assuming rising chemical prices. Furthermore, Fund grants are reduced to reflect the fraction of foreign ownership.

27. When evaluating results generated by the model, it is important to keep some key limitations in mind. First, the modeling framework tracks ODS use and implements projects on a global basis. It is thus not possible to make firm inferences about the capability of any individual or group of countries to achieve a particular phaseout date. Second, model project costs were based for the most part of projects approved by the Executive Committee. This may bias cost estimates upward, since by definition, inherently cost effective projects, which would lower the average cost, would not be presented to the Fund. Third, the estimation of ODS prices is an extremely difficult analytic undertaking. A very simplified approach was used in the Study. For a complete review of the model limitations and their implications, please refer to Section 3.4.

28. The Study Team also devised a relatively simple approach to estimating the likely demands on the Multilateral Fund associated with addressing ODS production. The Team compiled a profile of ODS production plants in Article 5 countries, developed a method for calculating conversion costs based on chemical prices, and applied the method to the profile to compute global costs. Two different assumptions about the global quantity of production capacity to be addressed and six approaches for computing grants from the Multilateral Fund were combined to yield twelve different estimates. Substantial uncertainty exists about production phaseout costs; results must be evaluated in the context of the limitations described in Section 3.5.

29. The non-investment costs incurred by the Fund for support of the Implementing Agencies, institutional strengthening, the clearinghouse function, and the operation of the Secretariat and the Executive Committee were also estimated and added to the sum of the ODS use and production phaseout costs.

30. Finally, based on the ODS use estimates developed for each scenario, the impacts of emitting this ODS consumed on stratospheric chlorine were calculated using the Atmospheric Stabilization Framework. Changes in stratospheric chlorine are reported as changes in cumulative chlorine over the period 1993 to 2030.

SCOPE OF STUDY

Boundaries of the Analysis

31. There were several topic areas deemed outside the scope of the study. Each of these issues has been discussed with and agreed to by the Sub-Committee for the Report.

- First, the study is not an evaluation of operation or policies of the Montreal Protocol Multilateral Fund, its financial mechanisms, or the Implementing Agencies.
- Second, the study does not make any recommendations about the various phaseout schedules, though it does note certain cases where a particular scenario is infeasible.
- Third, no analysis or summary information is presented on a country-specific basis. Nor are any cost estimates developed for individual enterprises. All data and conclusions are presented as applicable to the global community of Article 5 countries.
- Fourth, due to analytic complexity, tight schedules, and resource limitations, certain topics have been addressed in a simplified fashion. Examples include ODS prices which have not been rigorously forecast and production phaseout costs which are estimated in a summary manner.

32. Finally, it must be noted that the study does not directly incorporate the reviews that are currently being conducted by the Technical and Economic Assessment Panel, its Technical Options Committees, or the Scientific Assessment Panel. While the Co-Chairs of both Panels were interviewed, neither was able to offer any information from the current, ongoing reviews because these deliberations are not yet complete and definitive conclusions have not been reached. Final reports are expected to be issued publicly later this year.

Treatment of HCFCs

33. In addition to the four groups of chemical substances that are the primary focus of the study (i.e., CFCs, halons, MCF, and CTC), there are other chemicals with the potential to deplete stratospheric ozone. HCFCs can deplete ozone, as can methyl bromide. As agreed with the Sub-Committee for the Report, this Study does not directly address the phaseout of HCFCs and methyl bromide, although it does provide an overview of the status of substitutes.

34. The Study Team contacted the Technical and Economic Assessment Panel (TEAP) to determine what the TEAP plans to propose as an HCFC phaseout schedule and to learn more about possible substitutes for HCFCs. Explaining that the TEAP's deliberations were still in process, the Co-Chair of the TEAP was unable to share any information from the current review with the Study

Team. The Co-Chair wrote to the Team and provided a summary of the situation with respect to HCFCs.

35. The TEAP believes that HCFCs are important to the phaseout of CFCs and the selection of alternatives involves balancing the need to effect an early transition from CFCs with the need to ensure that HCFCs are not encouraged where other more environmentally appropriate technologies exist. HCFCs are considered by the TEAP to be technically and economically necessary for the transition in several uses, including the majority of refrigeration and air conditioning applications, manufacturing of insulating foams, selected and limited solvent applications, and certain fire protection applications where space constraints exist. The TEAP believes that other more environmentally acceptable alternatives to HCFCs are available in the following applications: most fire fighting applications, non-insulating foams, the majority of solvent applications, as an alternative to MCF, aerosols, sterilization, and solar tracking systems.

Treatment of Methyl Bromide

36. Methyl bromide is used throughout the world as a fumigant to control a variety of nematode, disease, weed, and insect pests for soils, commodities, and structures. The Study Team's approach to assessing the phaseout of methyl bromide was similar to that used for HCFCs. As with HCFCs, the TEAP Co-Chair was unable to refer any materials or information from the current review being conducted by the Methyl Bromide Technical Options Committee, but did provide a summary of the status of substitutes for methyl bromide. The TEAP believes that while there is no single alternative for the broad spectrum of applications for which methyl bromide is currently used, there are substitute chemicals and alternative procedures available for specific applications that could lead to reduced anthropogenic methyl bromide emissions to the atmosphere. More specifically:

- For soil fumigation applications, methyl bromide use may be decreased by changes in application practices, combining methyl bromide with other pesticides, utilizing chemical substitutes, implementing non-chemical pest control practices, use of tarping procedures, and new farming systems. Other techniques such as flooding, soil solarization, biological control, and cultural management may help to reduce the use of methyl bromide for certain applications.

- Quarantine regulations often require 100 per cent control effectiveness for commodity treatments. These uses rely on methyl bromide and there are no foreseeable alternatives. The use of gas tight structures, recycling, and volume displacement techniques may be technically feasible and may reduce emissions. Major alternatives for non-quarantine treatment alternatives include phosphine, irradiation, biological control, atmosphere modification, and hot and cold procedures.

- There are technically and economically feasible alternatives to specific structural applications. In some countries there are limited alternatives for certain applications such as food processing, warehouses, aircraft, and historic buildings. Volume displacement technologies for structural fumigation are available in some markets.

- Across all methyl bromide uses, certain technologies (i.e., containment and recovery) can decrease the rate of leakage to the atmosphere, but these are only in limited use worldwide. Good containment is a prerequisite for efficient recovery. The overall scope of recovery is likely to be low and impractical in most situations.

RESULTS OF THE STUDY

37. The fundamental purpose of this study was to assess the feasibility of alternative phaseout schedules for Article 5 countries. The Study Team examined seven such scenarios, as presented in Chapter 2, from a variety of technological, institutional, and policy perspectives. In addition, the Study Team considered variations of several of those scenarios. This section reports the major conclusions of this assessment. (Note that all costs in this chapter are presented on a discounted basis using a 10 per cent discount rate.)

38. At the outset, it is important to consider that, in the context of the current Protocol with its single phaseout schedule for all Article 5 countries, the feasibility of any scenario is determined not by the prospects for phaseout in countries that will act first, but rather by the situation in those countries that will phase out last.

39. Phaseout by 1996. The Study Teams concluded that global phaseout by 1996 is not feasible. None of the CPs target such a phaseout and every country that provided feedback for this study stated that it could not meet a 1996 phaseout target. For this phaseout date to be met, tens to hundreds of field level projects would have to be implemented in approximately ninety countries within the next sixteen months. Article 5 governments, ODS-consuming enterprises, and technology suppliers do not have the capacity to complete a global transition within this time frame. Only four per cent of the Multilateral Fund-supported investment projects initiated to date have been completed and market forces and Article 5 government actions cannot be expected to change enough to drive an immediate ODS phaseout. The quantitative modeling results support this assessment by showing that targets for 1996 phaseout could not be met.

40. Phaseout by 2000. Global phaseout by 2000 would be extremely difficult, if not impossible. Although more than twenty Article 5 countries anticipate in their CPs that they can phase out by 2000, the remainder either specify later dates in their CPs or have yet to even finalize a CP with firm targets. Additionally, the time required for alternative technologies to completely penetrate certain informal sectors is six to seven years, effectively ruling out the 2000 target date. Furthermore, the capacities of implementing agencies, Article 5 governments and enterprises, and technology suppliers would be severely tested by this phaseout date. Many Article 5 governments, for example, have spent several years constructing policy frameworks based on targets well after 2000. Changing these targets would require immediate and definitive action by a large number of Article 5 countries, along with determined efforts to lead their industries through a very accelerated phaseout. If a 2000 phaseout is politically and institutionally possible, the quantitative modeling results show total Fund costs of US $6.7 billion and real resource costs of US $7.9 billion.

41. Phaseout by 2006. The Study Team concluded that a 2006 phaseout is feasible depending on how a significant number of policy and institutional constraints are dealt with. Approximately thirty CPs, or 75 per cent of those submitted to date, indicate the country's intention to eliminate ODS use near 2006. It is important to point out, however, that some of the higher ODS-consuming countries have some of the latest phaseout dates. The number of years until 2006 also is sufficient to allow for complete penetration of alternative technologies in all sectors. The primary constraint, therefore, is whether the government, the Multilateral Fund, and the private sector in each Article 5 country can implement phaseout plans by 2006 that are based on the specific factors that drive local ODS consumption. As Chapter 5 highlights, these factors vary considerably between countries due to economic, technological, political, and cultural diversity. While it may be possible to group most Article 5 countries into three or four sub-categories, based on their gross domestic product and

generalized ODS consumption and technology patterns, achieving a 2006 phaseout would probably still require distinct and deliberate actions to address the specific factors that affect each of these sub-groups. The feasibility of the 2006 and earlier phaseout scenarios also depends, of course, on the time it takes the parties to the Montreal Protocol to agree to the revised date. The quantitative modeling estimates total Fund costs of US $897 million and real resource costs of US $2 billion for this scenario.

42. Phaseout by 2006 with a Servicing Tail. The only difference between this and the previous scenario, 2006 without a servicing tail, is that the servicing tail avoids the need for a significant portion of equipment retrofits, effectively lowering costs but delaying the actual ODS phaseout by approximately 10 years, to 2016. A number of countries that provided feedback on the issue stated that they could meet this phaseout date. For this scenario, Fund costs are estimated at US $545 million and real resource costs at US $1.4 billion.

43. Phaseout by 2010. This scenario is feasible. All forty countries with CPs expect to phase out by this date, and the technology, policy and institutional constraints described above are less binding, though still important. The interplay of specific factors affecting phaseout in each individual country would still need to be addressed. For this scenario, the model estimates total Fund costs of US $909 million and real resource costs of US $1.9 billion.

44. Phaseout by 2010 with a Servicing Tail. A servicing tail under the 2010 phaseout scenario would eliminate all need for equipment retrofits, thereby lowering the costs of the phaseout and delaying ultimate phaseout to 2016. As such, costs of this phaseout are estimated at US $584 million for Fund costs and US $1.2 billion for real resource costs.

45. Phaseout as Fast as Cost-Effectively Possible. The Study Team estimated the fastest possible phaseout, subject to a cost effectiveness constraint that equipment retrofits would never be required. Under this scenario, new ODS using equipment need not be installed anywhere as of 2002. Based on the modeling results, virgin production of ODS can then be halted in 2011, with demand for ODS in existing equipment met through the year 2019 by recycling. This phaseout scenario produces total Fund costs of US $667 million and real resource costs of about US $2 billion.

46. Variations on these scenarios. In the quantitative modeling exercise the Study Team conducted sensitivity analyses regarding accelerated servicing tails and the duration of operating costs to be covered by the Multilateral Fund. An accelerated servicing tail indicates that ODS produced for the servicing tail could only be used for equipment manufactured prior to 1999. The results of these analyses are that an accelerated tail increases the speed of phaseout only in certain parts of the refrigeration sector and also increases the costs of the phaseout slightly. For the 2006 target date the accelerated phaseout costs projected in the quantitative model are US $704 million for Fund costs and US $1.8 billion for real resource costs. A 2010 phaseout with accelerated tail yields estimated Fund costs of US $787 million and real resource costs of US $1.7 billion. The impact of a variation in the duration of operating costs to be covered by the Multilateral Fund depends on the scenario being evaluated. For a 2000 phaseout, the Fund cost associated with reimbursing 4 years of operating cost instead of two years is about US $44 million less, while for the 2010 target, the difference is about US $8 million more.

47. In summary, the earliest feasible phaseout date among those considered is 2006. Servicing tails lower costs by avoiding the need for equipment retrofits but do not affect the ultimate feasibility of any target date.

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

48. By signing the Montreal Protocol on Substances that Deplete the Ozone Layer, more than 130 of the world's nations have agreed to phaseout the consumption and production of ozone depleting substances. A key feature of the Protocol is that it includes separate phaseout schedules for two different types of countries. Developed countries are to complete their phaseout of the most significant ozone depleting chemicals by 1996. Special status under Article 5 of the Protocol has been accorded to 91 developing countries, which currently have until 2010 to complete their phaseout.

49. At their Second Meeting, the Parties to the Protocol called for a review of the situation of Article 5 countries. The review is to assess the implementation of financial cooperation and technology transfer to such countries, as well as possible revisions of the applicable phaseout schedules. The Executive Committee of the Multilateral Fund was subsequently charged by the Parties with responsibility for preparing the required review. The Sub-Committee for the Report under Paragraph 8 of Article 5 of the Montreal Protocol was then established and this study was initiated. The Terms of Reference (TOR) are included as Attachment 1.

50. As described in the TOR and refined during two meetings between the Study Team and the Sub-Committee, the fundamental purpose of the study is to assess the feasibility of alternative phaseout schedules for Article 5 countries. It first characterizes the factors that affect the phaseout of ozone depleting substances (ODS), including the specific incentives for and impediments to the implementation of new technologies in developing countries. The study then measures the financial implications and environmental impacts of several alternative ODS phaseout targets. By doing so, the report illuminates some of the policy issues that will be important during deliberations about adjustments to the phaseout schedule for Article 5 countries.

51. The remainder of this introductory chapter addresses several topics. A brief overview of the Study Team's approach is presented first to set the context of the report. The scope of the study is defined next and a related discussion of the treatment of HCFCs and methyl bromide is provided. The chapter closes with a quick review of the organization of the document.

1.2 APPROACH

52. In conducting the analysis, the Study Team pursued a three-part approach. First, an extensive data collection effort was undertaken. Eight Article 5 countries were visited and more than 170 individuals interviewed in-country. An additional 13 Article 5 countries responded to a faxed questionnaire. Staff from the Secretariat of the Multilateral Fund, the Ozone Secretariat, and the Implementing Agencies of the Multilateral Fund were interviewed as were several members of the Executive Committee. Representatives of industry and other non-governmental organizations were also interviewed. Meetings were held with the Co-Chairs of the Technical and Economic Assessment Panel and the Scientific Assessment Panel. Forty Country Programmes were collected and reviewed. In addition, several dozen investment project proposals approved by the Executive Committee were studied to extract cost and technical data. Statistical analyses of the Inventory of Approved Projects were also conducted by the Multilateral Fund Secretariat staff.

53. The second element of the Study Team's approach entailed compilation of the collected data and its analysis during a week-long policy workshop. This workshop was attended by ten members of the Study Team who employed a structured analytical framework to identify, organize, and refine a series of qualitative policy and institutional issues that affect the phaseout of ODS in developing countries. During the workshop, the key steps in the process of technology transfer were identified as were the multiple actors who are involved in implementing the Montreal Protocol. By considering the role of each actor at each stage of technology transfer, a comprehensive set of incentives and impediments was defined.

54. The third and final element of the Study Team's approach was the development and use of a computerized modeling tool to assess the financial, economic, and environmental impacts of alternative phaseout schedules. The inputs for the modeling effort were, for the most part, drawn from the data collected during the first phase of the project. This ensured, for example, that the cost of ODS phaseout projects reflected actual experience in developing countries and that the factors affecting the speed of project implementation were incorporated in the model inputs. In addition, the conclusions from the policy and institutional analysis workshop were used to validate and refine the modeling assumptions. Participants in the workshop were, for example, able to group Article 5 countries into clusters across which the patterns of ODS use varied markedly; these variations have subsequently been incorporated into the model.

1.3 SCOPE OF THE STUDY

55. As noted above, this study is being conducted pursuant to Paragraph 8 of Article 5 of the Montreal Protocol which defines its basic scope. The nature of the study was further elucidated by the Terms of Reference adopted by the Sub-Committee for the Report and refined during two meetings in Montreal, Canada.[1]

56. The focus of the study is on the phaseout schedules for CFCs, halons, methyl chloroform (MCF), and carbon tetrachloride (CTC).[2] Eleven distinct phaseout schedules are evaluated in the study. Key quantitative outputs are, for each scenario, an estimate of the cost to the Multilateral Fund, the real resource cost, the quantity of ODS used per year, and the environmental impact of ODS emissions on the stratosphere.

57. There are also several topic areas outside the scope of the study.

- First, the study is not an evaluation of operation or policies of the Montreal Protocol Multilateral Fund, its financial mechanisms, or the Implementing Agencies.
- Second, the study does not make any recommendations about the various phaseout schedules, though it does note certain cases where a particular scenario is infeasible.

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1 The first meeting was held 23-24 May 1994 and the second on 24 July 1994. Summaries of both meetings are included in Attachment 1.

2 Other ozone depleting substances are addressed in Section 1. 4 below.

- Third, no analysis or summary information is presented on a country-specific basis. Nor are any cost estimates developed for individual enterprises. All data and conclusions are presented as applicable to the global community of Article 5 countries.

- Fourth, due to analytic complexity, tight schedules, and resource limitations, certain topics have been addressed in a simplified fashion. Examples include ODS prices which have not been rigorously forecast and production phaseout costs which are estimated in a summary manner.

Each of these issues has been discussed with and agreed to by the Sub-Committee for the Report.

58. Finally, it must be noted that the study does not directly incorporate the reviews that are currently being conducted by the Technical and Economic Assessment Panel, its Technical Options Committees, or the Scientific Assessment Panel. While the Co-Chairs of both Panels were interviewed, neither was able to offer any information from the current, ongoing reviews because these deliberations are not yet complete and definitive conclusions have not been reached. Final reports are expected to be issued publicly later this year.

1.4 TREATMENT OF HCFCS AND METHYL BROMIDE

59. In addition to the four groups of chemical substances that are the primary focus of the study (i.e., CFCs, halons, MCF, and CTC), there are other chemicals with the potential to deplete stratospheric ozone. A family of chemicals, known as hydrochlorofluorocarbons (or HCFCs), can deplete ozone, as can methyl bromide. This section briefly summarizes the factors that affect the feasibility of phasing out HCFCs and methyl bromide.

1.4.1 HCFCs

60. Prior to the adoption of the Montreal Protocol, there was only one chemical in the HCFC family, HCFC-22, in widespread use on a global basis. Its use is primarily in refrigeration and air conditioning with some applications in foam blowing. Other HCFCs, such as HCFC-141b and HCFC-123, are in the process of being developed and commercialized as substitutes for CFCs in multiple applications. Because they contain chlorine and have significant atmospheric lifetimes, HCFCs can deplete stratospheric ozone, although their ozone depletion potential (ODP) is typically less than that of the CFCs.

61. HCFCs have been recognized as transitional substances important to the phaseout of CFCs. Because of their environmental impact, however, HCFCs are slated to be phased out by developed countries by the year 2030. The feasibility of an HCFC phaseout among Article 5 countries is not quantitatively addressed in this study for two reasons.[3]

- In situations where HCFCs are expected to replace an existing CFC application, predicting the nature and timing of the subsequent replacement of the HCFC with an as yet undetermined third chemical is extremely difficult. In the absence of such

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[3] This approach is consistent with direction from the Sub-Committee for the Report that "the modeling will ... not [include] substitutes for HCFCs or methyl bromide." See UNEP/OzL.Pro/ExCom/13/39.

information, it is not analytically possible to assess the cost and environmental impact of an HCFC phaseout.

- In many situations where HCFC-22 is currently in use, there is substantial disagreement among technical experts about whether substitutes are readily available. Moreover, the Executive Committee has not to date considered HCFC phaseout projects, meaning that no firm data are available to estimate technical and economic project parameters in the context of Multilateral Fund policies and practices.

62. Accordingly, the Study Team contacted the Technical and Economic Assessment Panel (TEAP) to determine what the TEAP plans to propose as an HCFC phaseout schedule and to learn more about possible substitutes for HCFCs. Explaining that the TEAP's deliberations were still in process, the Co-Chair of the TEAP was unable to share any information from the current review with the Study Team. The Co-Chair wrote to the Team and provided a succinct summary of the situation with respect to HCFCs which was based upon the "1994 Report of the TEAP, Including Recommendations on Nominations for Essential Use Production/Consumption Exemptions for Ozone Depleting Substances," published in March 1994.[4] Excerpts from the Co-Chair's memorandum follow:

63. "HCFCs are important to the phaseout of CFCs and the selection of alternatives involves balancing the need to effect an early transition from CFCs with the need to ensure that HCFCs are not encouraged where other more environmentally appropriate technologies exist. HCFCs are technically and economically necessary for the transition in several uses:

- The majority of refrigeration and air conditioning applications: HCFCs, primarily HCFC-22, are being used in many types of equipment. As a result, a substantial amount of equipment using HCFCs, as well as CFCs, remains to be converted to other zero-ODP refrigerants.

- Manufacturing of insulating foams: Some zero-ODP conversions are being made in appliance and boardstock insulation foam applications but the lead time for testing and development of some substitutes in certain applications could be several years.

- Selected and limited solvent applications: HCFC solvents may be necessary for some solvent applications such as the cleaning of components with sensitive materials, cleaning of certain oxygen systems, and cleaning of sensitive materials with delicate decorations. It is expected, however, that HCFC-141b and HCFC-225 together will not replace more than 1 per cent of global CFC-113 use unless HCFC-225 becomes a substitute for CFC-113 in dry cleaning, which could increase use up to 5 per cent.

- Certain fire protection applications where space constraints exist: Such constraints may exist where cylinder storage of non-halon extinguishers is impractical.

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4 Memorandum from Stephen O. Andersen, Panel Co-Chair, TEAP, to Peter Linquiti, ICF Incorporated, July 30, 1994, lines 33 to 85.

64. "The TEAP believes that other more environmentally acceptable alternatives to HCFCs are available in the following applications:

- Most fire fighting applications: Alternatives include zero-ODP chemical replacements and not-in-kind technologies.
- Non-insulating foams: Virtually all flexible foam and packaging foam applications can use zero-ODP alternatives.
- The majority of solvent applications: No large scale use of HCFCs has been reported as solvents.
- As an alternative to [MCF]: Small use of HCFC has been reported in solvents, coatings, or adhesives applications.
- Aerosols: Some use may remain as a partial replacement for CFC-113 where non-flammability is critical. Otherwise, hydrocarbons, dimethyl ether, compressed gases, non-aerosol delivery systems, and product substitutes can be used.
- Sterilization: HCFC-124 is being commercialized but is not technically required as a short term substitute of CFC-12. Alternatives include ethylene oxide/carbon dioxide mixtures, 100 per cent ethylene oxide mixtures, and radiation sterilization. The HCFC substitute does allow use of existing equipment, a substantial economic saving compared to replacement.
- Solar tracking system: Use in this application will represent a very minor fraction of total global consumption of HCFCs."

1.4.2 Methyl Bromide

65. Methyl bromide is used throughout the world as a fumigant to control a variety of nematode, disease, weed, and insect pests for soils, commodities, and structures. The Study Team's approach to assessing the phaseout of methyl bromide was similar to that used for HCFCs. As noted above, it was agreed with the Sub-Committee for the Report that a quantitative analysis of the costs of methyl bromide would not be a part of the study. In addition, as with HCFCs, the TEAP Co-Chair was unable to offer any materials or information from the current review being conducted by the Methyl Bromide Technical Options Committee, but did provide a summary of the status of substitutes for methyl bromide based on the 1992 "Interim Technology and Economic Assessment of Methyl Bromide Uses, Alternatives, and Substitutes," the pertinent parts of which are presented below.[5]

66. "There is no single alternative for the broad spectrum of applications for which methyl bromide is currently used. The major end uses of methyl bromide include soil, commodity (durable and perishable), and structural fumigation. There are substitute chemicals and alternative procedures available for specific applications that could lead to reduced anthropogenic methyl bromide emissions to the atmosphere.

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[5] Memorandum from Stephen O. Andersen, Panel Co-Chair, TEAP, to Peter Linquiti, ICF Incorporated, July 30, 1994, lines 86 to 138.

67. "For soil fumigation applications, methyl bromide use may be decreased by changes in application practices, combining methyl bromide with other pesticides, utilizing chemical substitutes, and implementing non-chemical pest control practices. Some agricultural systems have developed a dependence on methyl bromide applications (i.e., soil pests and pest complexes are difficult to control without methyl bromide). Use of tarping procedures for these use areas could reduce application rates.

68. "New farming systems demonstrate the feasibility of eliminating soil fumigation applications for glasshouses, and also raised beds and open fields. More investigation is needed to determine the costs and the applicability of these systems to other agricultural systems and regions.

69. "Other techniques such as flooding, soil solarization, biological control, and cultural management may help to reduce the use of methyl bromide for certain applications. These techniques require further investigation to determine their technical feasibility and cost effectiveness.

70. "Quarantine regulations often require 100 per cent control effectiveness for commodity treatments. These uses rely on methyl bromide. For these applications, there are no foreseeable alternatives. The use of gas tight structures, recycling, and volume displacement techniques may be technically feasible, and may reduce or control emissions.

71. "The prospects for non-quarantine treatment alternatives are positive for both durable and non-food commodities. Major alternatives include phosphine, irradiation, biological control, atmosphere modification, and hot and cold procedures.

72. "There are technically and economically feasible alternatives to specific structural applications. In some countries there are limited alternatives for certain applications such as food processing, warehouses, aircraft, and historic buildings. Volume displacement technologies for structural fumigation are available in some markets.

73. "Across all end uses, certain technologies (i.e., containment and recovery) can decrease the rate of leakage to the atmosphere, but these are only in limited use worldwide. Good containment is a prerequisite for efficient recovery. The overall scope of recovery is likely to be low and impractical in most situations. As a special case, recovery from fumigation of perishables carried out in gastight chambers appear likely to be technically feasible with potential recoveries often exceeding 90 per cent of applied dose. Equipment is expected to commercially available soon and some recapture equipment, without recycling, is already in operation."[6]

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[6] The final two sentences in this paragraph were provided to the Study Team by Jonathan Banks, Chair, Methyl Bromide Technical Options Committee, by fax on August 2, 1994.

1.5 STRUCTURE OF THE REPORT

74. The remainder of this report consists of six chapters. More specifically:

- Chapter 2 gives an overview of the phaseout scenarios evaluated;
- Chapter 3 describes the methodology of the study, including an overview of the data collection, the policy and institutional analysis, and the modeling simulation;
- Chapter 4 offers a descriptive overview of the data collected and is organized around the specific elements of the Terms of Reference;
- Chapter 5 presents the conclusions of the policy and institutional analysis;
- Chapter 6 presents the modeling results, including costs and environmental impacts; and
- Chapter 7 integrates the findings of Chapters 4, 5, and 6 to assess the feasibility of alternative phaseout schedules, as per the Terms of Reference.

CHAPTER 2

OVERVIEW OF SCENARIOS EVALUATED

75. This chapter describes the ODS phaseout scenarios for Article 5 countries analyzed in this study. These phaseout scenarios were developed based on input from the Subcommittee for the Report.[7] A total of eleven scenarios are analyzed in this study. Ten of the scenarios differ in terms of five key parameters discussed below. An eleventh scenario investigates the fastest economically feasible phaseout in Article 5 countries. The five parameters that collectively define the scenarios are summarized below.

76. London or Copenhagen Amendments: Scenarios differ based on whether they reflect the London Amendments or the Copenhagen Amendments. The London Amendments required that the production of CFCs, halons and carbon tetrachloride be phased out by 2000 and that the production of methyl chloroform be phased out by 2005 in Article 2 countries. The Copenhagen Amendments required that production of CFCs, carbon tetrachloride, and methyl chloroform be phased out by 1996 and that the production of halons be phased out by 1994 in Article 2 countries. Both schedules also imposed interim reductions in the production of these compounds prior to the phaseout date.

77. Grace Period: Scenarios differ in terms of whether or not they provide Article 5 countries with up to a ten year grace period to comply with phaseout schedules for Article 2 countries contained in the Copenhagen and London Amendments.

78. Servicing Tail for Existing Equipment: In certain scenarios, a provision is made for Article 5 countries to continue consumption of new ODS to service existing refrigeration and air conditioning ODS equipment after the ODS production phaseout date. Such a tail eliminates the need for expensive retrofits or early retirement controls.

79. Accelerated Servicing Tail for Existing Equipment: In certain scenarios, it is assumed that Article 5 countries must accelerate their phaseout of ODS use in new refrigeration and air conditioning equipment to no later than 1999 in order to take advantage of a servicing tail that provides ODS to service existing refrigeration an air conditioning equipment after the phaseout date. This is in contrast to the regular tail scenario described above which allows Article 5 countries to continue to consume ODS in new refrigeration and air conditioning equipment up until the phaseout date.

80. Period of Time that the Fund Reimburses Operating Costs: Scenarios can differ in terms of the number of years that it is assumed that the Multilateral Fund will reimburse incremental operating costs. Such costs are assumed to be reimbursable for either two or four years.

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[7] See "Report of the Sub-committee for the Report on the Review Under Paragraph 8 of Article 5 of the Montreal Protocol," (UNEP\OzL.Pro\ExCom\13\39).

81. Using these parameters, a total of ten different phaseout scenarios are defined. Exhibit 2-1 summarizes the features of these scenarios based on the various parameters described above (see Scenarios 1 to 6 and 8 to 11).

82. Finally, another scenario (Scenario 7) was analyzed that assumed (1) the maximum possible cost-effective reductions would be implemented as soon as possible; (2) the availability of a tail to service existing ODS-containing refrigeration and air conditioning equipment; and (3) that the Multilateral Fund would reimburse operating costs for two years. This scenario was implemented by assuming that technologies available to replace ODS use in new equipment and recycling controls would be implemented as early and as fast as technically possible (this implicitly assumes that all of these technologies are also cost-effective). Given the existence of the servicing tail, retrofit or early retirement controls were not implemented under this scenario.

EXHIBIT 2-1
DEFINITION OF PHASEOUT SCENARIOS

Scenarios	London Amendments for Article 2	Copenhagen Amendments for Article 2	Ten Year Grace Period	Tail	Accelerated Tail	Two Years Operating Cost	Four Years Operating Cost
2000 Phaseout	✓					✓	
2010 Phaseout	✓		✓			✓	
2010 Phaseout w/ Tail	✓		✓	✓		✓	
1996 Phaseout		✓				✓	
2006 Phaseout		✓	✓			✓	
2006 Phaseout w/ Tail		✓	✓	✓		✓	
Fast as Cost-Effectively Possible	See Text						
2010 Phaseout w/ Accelerated Tail	✓		✓		✓	✓	
2006 Phaseout w/ Accelerated Tail		✓	✓		✓	✓	
2000 Phaseout w/ 4 Years Reimbursement	✓						✓
2010 Phaseout w/ 4 Years Reimbursement	✓		✓				✓

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

83. This chapter presents the methodology used to conduct the study. Section 3.2 discusses the methodology for the data collection effort. The method used to perform the policy and institutional analysis is presented in Section 3.3 of the chapter. Section 3.4 describes the modeling tools used to estimate the costs of implementing investment projects to phase out ODS use under each of the phaseout scenarios and to assess the atmospheric impacts of each of the scenarios. Section 3.5 presents the approach for estimating the costs of phasing out the production of ODS at production plants in Article 5 countries. Section 3.6 details the method used to estimate non-investment costs associated with the phaseout including the costs of supporting (1) the activities of Implementing Agencies, the Secretariat, and the Executive Committee, (2) institutional strengthening for Article 5 governments, and (3) the information clearinghouse functions.

3.2 DATA COLLECTION

84. This section presents the methods undertaken for the extensive data collection effort involved in this study. This data collection effort provided the inputs for both the policy and institutional analysis and the model simulation. Data were obtained through a variety of sources, which are described below.

3.2.1 Country Visits

85. The Study Team visited eight countries to collect data required for the study: two in Africa, three in Asia, and three in Latin America. The purpose of the country visits was to develop a concise understanding of the situation in the countries regarding the phaseout of ODS and the penetration of non-ODS and low-ODS technologies. Prior to the visits, the Study Team developed hypotheses regarding possible impediments and incentives to technology transfer in Article 5 countries. These hypotheses served as the basis for the development of an extensive data collection form for use by team members conducting interviews in the countries. The topics of discussion addressed during the in-country visits included the following:

- Overview of progress to date, current policies, and future plans of the country, to characterize the basic situation in the country with respect to ODS phaseout
- In-country production of ODS, to determine if the country produces ODS and the impact of in-country production on the country's phaseout efforts

- Potential impediments to and incentives for technology transfer, to capture factors that control the rate of transfer of non- and low-ODS technologies:

  -- availability of information on alternative technologies
  -- market dynamics
  -- industry structure
  -- legislative/regulatory efforts undertaken to promote the ODS phaseout
  -- effectiveness of the OPU or its equivalent
  -- Multilateral Fund activities
  -- activities underway outside the Fund and IAs
  -- other potential impediments/incentives

- Penetration of non- and low-ODS technologies by sector, to capture the likely rate of technology transfer under current conditions (i.e., with no change in phaseout schedules or the size of the Multilateral Fund)

- Description of completed projects, if any, to capture any lessons learned or insights from material available on projects already completed in the country visited.

86. The country visits involved three to five days of interviews with government officials, staff of the ozone protection unit (OPU) or its equivalent, industry representatives, chemical distributors, ODS producers (if they exist in the country), and trade associations representing enterprises that use ODS, among others. Interviews were conducted on a not-for-attribution basis. At the conclusion of the country visits, each team member that visited a country prepared a 10-15 page report organized around the topic areas listed above.

3.2.2 Fax Questionnaires

87. A second component of the data collection effort involved the preparation and dissemination of a questionnaire to solicit information from additional Article 5 countries. The Study Team solicited information from 15 Article 5 countries other than the eight countries visited. The Study Team determined that the use of a fax questionnaire would be more effective than telephone interviews because it would eliminate the need to coordinate the scheduling of the telephone interviews and provide greater consistency in the questions asked to each respondent.

88. The Study Team prepared two versions of the questionnaire: one for countries with an approved Country Programme (CP), and one for countries without a CP. Additional questions were prepared and sent to one Article 5 country that produces ODS. The fax questionnaires solicited the following information:

- Status of CP preparation or confirmation of target phaseout dates

- Feasibility of meeting various phaseout schedules

- Reductions in ODS use

- Factors impeding or facilitating ODS phaseout:

- -- awareness/availability of alternative technologies
- -- trends in ODS prices
- -- degree of export orientation
- -- extent and impact of foreign ownership
- -- domestic legislation/regulations and their impact
- -- activities of the OPU or its equivalent
- -- impact of the Multilateral Fund

- Expected market share of alternative technologies

89. As with the country visits, respondents were informed that their comments would not be attributed to them. Thirteen of the 15 countries that were sent the questionnaire responded.

3.2.3 Multilateral Fund Secretariat

90. The Multilateral Fund Secretariat provided extensive materials and data to the Study Team. Some of the materials provided include the following:

- Letters of introduction to the governments of the eight countries visited and the 15 countries that received a fax questionnaire
- Copies of approved CPs
- Project proposals, IA work programmes and amendments, and IA progress reports

91. In addition, the Fund Secretariat responded to numerous requests for extracts from the database of projects approved by the Executive Committee and other data. The Fund Secretariat also arranged for members of the Study Team to attend the 13th meeting of the Executive Committee as observers, to witness the deliberations firsthand.

3.2.4 Ozone Secretariat

92. The Ozone Secretariat in Nairobi provided the Study Team with both production and consumption data for Article 5 countries, for the baseline year as well as years 1991 and 1992 (it should be noted that data were unavailable for a large number of countries). The Ozone Secretariat also was consulted regarding the best means of estimating ODS consumption for Article 5 countries without a CP that have not reported to UNEP. The data resulting from this effort are summarized in Chapter 4 and were used in the development of the model simulation in Chapter 6. In addition, members of the Study Team interviewed the Ozone Secretariat via telephone regarding issues relating to Article 5 ODS consumption and production and on the feasibility of various phaseout schedules for Article 5 countries to contribute to the policy and institutional analysis.

3.2.5 Implementing Agencies

93. The four Implementing Agencies (IAs) were interviewed by the Study Team to obtain their insights and perspectives on the impediments to and incentives for technology transfer to Article 5 countries and the feasibility of various phaseout schedules, as well as the progress of phaseout efforts to date and the implementation activities of the IAs. Interviews were held with the following IAs:

- Various task managers at the World Bank who work on Montreal Protocol projects
- UNDP's Montreal Protocol Unit
- UNIDO's Industrial Sectors and Environment Division
- UNEP's Industry and Environment Programme Activity Centre (IE/PAC)

Interviewees were guaranteed that comments would not be attributed to individuals or to specific IAs.

3.2.6 The Executive Committee

94. Members of the Study Team interviewed representatives from a number of countries on the Executive Committee. Representatives from three donor countries were interviewed, as well as five representatives from Article 5 countries. Again, interviews were conducted on a not-for-attribution basis.

3.2.7 Technical and Economic Assessment Panel

95. The Terms of Reference (TOR) of the study indicated that the Team was to incorporate input from the TEAP in the study. Upon consulting the Co-Chair, the Team was informed that the Co-Chair could not provide any information from this review because the assessments currently are being updated. The Co-Chair recommended that the Team rely on existing TEAP documents for data on feasibility, cost, and performance of alternatives. The Co-Chair also provided a memorandum summarizing the key findings of earlier materials on alternatives to HCFCs and methyl bromide.

3.2.8 Scientific Assessment Panel

96. Members of the Study Team met with the Scientific Assessment Panel (SAP) to obtain its input on the Team's approach for the atmospheric chlorine analysis and its thoughts on the impact of changes to the phaseout schedule on the atmosphere. The Team consulted the Chair of the SAP, who agreed with the Team's methodology for performing the atmospheric chlorine analysis. The Chair also made suggestions regarding interpretation and presentation of results.

3.2.9 Chemical and Technology Producers

97. The Study Team solicited a variety of information from chemical and technology producers for use in both the model simulation and the policy and institutional analysis. Several chemical manufacturers in both developed and developing countries were contacted for the following information: current and pre-Protocol prices of ODS and substitutes; potential future prices of ODS; ODS production capacities in Article 5 countries; and the costs of converting production of ODS to alternatives. It should be noted that all manufacturers contacted said they were unable to provide price forecasts because of the existing instability in ODS markets.

98. The Study Team used its in-house experts to obtain information on alternative technologies. The experts' judgments, informed by ongoing discussions with vendors of alternative technologies, were used to verify the parameters of the model projects used in the model simulation (see Section 3.3 below). In addition, representatives of an ODS-producing firm in an Article 5 country were interviewed to obtain their perspectives on the issues associated with phaseout of ODS production.

3.2.10 Environmental Organizations

99. The Study Team interviewed a representative of the Centre for Science and Environment from Delhi, India about the rate of technology transfer to Article 5 countries and the possibilities for ODS phaseout. A representative of Greenpeace USA was also interviewed; he offered insights on the performance of IAs, the need to consider a broad range of not-in-kind alternatives, and policies regarding reimbursement of incremental costs. In addition, information was solicited from the Ozone Campaign Director for Friends of the Earth USA.

3.3 POLICY AND INSTITUTIONAL ANALYSIS

100. The results of the data collection effort provided the foundation for the policy and institutional analysis conducted by the Study Team. The method used to conduct this analysis of factors affecting the phaseout of ODS in Article 5 countries involved a week-long brainstorming workshop during which the Study Team reviewed all the data that had been collected.

101. The workshop participants reached decisions on how to address the findings from the data on the nine TOR topic areas. The Team also discussed the feedback obtained from various Article 5 countries regarding the feasibility of the phaseout schedules being examined in this study. The findings are presented in Chapter 4 of the report.

102. The Study Team also generated an expansive list of policy and institutional issues affecting the phaseout in Article 5 countries. To organize the policy and institutional issues having the most significant impact on the phaseout, the Study Team approached the technology transfer process from the point of view of an ODS-using enterprise. First, the Study Team identified the key actors and principal resource flows among them. Exhibit 3-1 presents the diagram of the resource flows among the key actors in the phaseout of ODS in Article 5 countries.

103. Second, the Study Team identified the steps in the process of transferring technology to an enterprise in an Article 5 country. Some of the steps in the process pertain only to an enterprise with a Fund-financed project, while other steps apply both to Fund-financed projects and projects taking place outside the Fund. The 12 steps identified by the Study Team are presented in Exhibit 3-2. The steps have been grouped into four logical summary stages to facilitate their presentation.

104. Third, the Study Team developed a matrix of key actors and steps involved in the technology transfer process, presented in Exhibit 3-3. This matrix provides the framework for organizing the policy and institutional issues identified by the Study Team. The Study Team used the matrix to determine in which steps each key actor played a significant role. These steps are indicated with a check mark in the matrix. The rationale behind this approach is that presence of impediments and/or incentives at these key steps could have a significant effect on technology transfer and hence on the feasibility of alternative phaseout scenarios.[8]

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[8] Portions of this methodology were adopted from analyses presented in "Strategic Planning to Promote International Technology Cooperation," as prepared by David M. Strelneck for the World Wildlife Fund and Harvard University in June, 1992.

Exhibit 3-1
Principal Resource Flows Among Key Actors in ODS Phaseout in Article 5 Countries

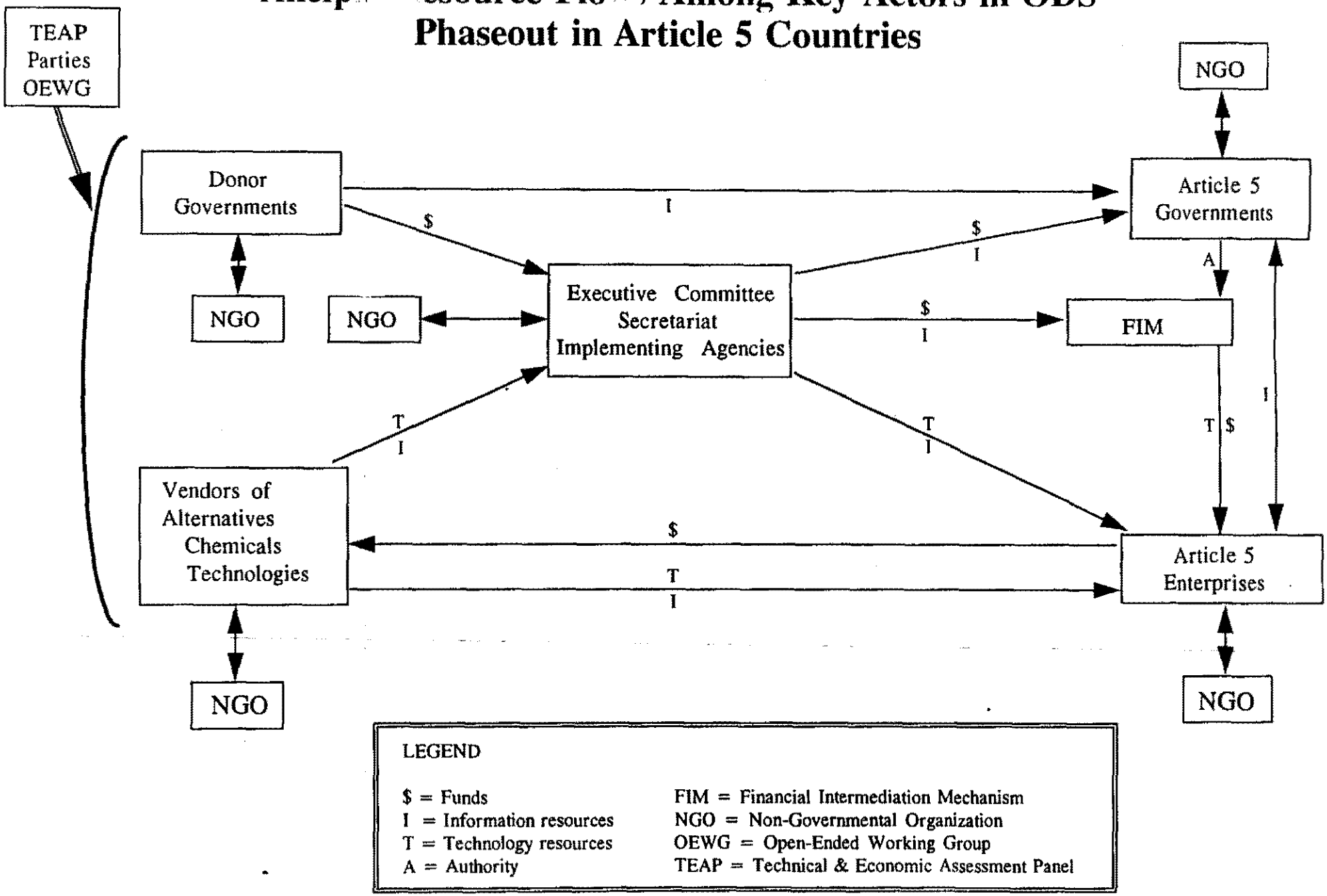

Exhibit 3-2

Summary Stages and Twelve Steps in the Technology Transfer Process

- An ODS-consuming enterprise decides to switch to non-ODS technologies:

  1. Enterprise becomes aware that a key input to its production process is disappearing
  2. Enterprise is motivated to act

- Non-ODS technologies are evaluated and specific options are selected:

  3. Enterprise identifies non-ODS technologies
  4. Enterprise evaluates non-ODS technologies
  5. Enterprise selects non-ODS technology

- A project is designed and financing is obtained:

  6. Project proposal is prepared
  7. Project receives final approval from Implementing Agency
  8. Project receives final approval from Executive Committee
  9. Funds are disbursed for the project

- The new technology is acquired, installed, and used:

  10. Terms of technology acquisition are negotiated
  11. Non-ODS technology is delivered and installed on the "shop floor"
  12. Non-ODS technology is used on the "shop floor"

Exhibit 3-3
Framework for Organizing the Discussion on Policy and Institutional Issues

	Decision to Switch		Selection of Technology			Project Design				Acquisition, Installation, and Use of Non-ODS Technology		
Step/ Actor	Become Aware of Situation	Be Motivated to Act	Identify Techno-logy	Evaluate Techno-logy	Select Techno-logy	Prepare Project Proposal	Receive IA Approval	Receive ExCom Approval	Transfer Funds	Acquire Techno-logy	Install Techno-logy	Use Techno-logy
Donor Countries		✓			✓			✓	✓			
Vendors of Alternatives	✓	✓	✓	✓	✓				✓	✓	✓	✓
Executive Committee						✓	✓	✓				
Secretariat						✓	✓	✓				
IAs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Article 5 Govern-ments	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FIMs							✓		✓	✓	✓	✓
Article 5 Enterprises	✓	✓	✓	✓	✓	✓				✓	✓	✓
NGOs	✓		✓	✓								

✓ = Actor plays a key role in this step of technology transfer.

105. Once the matrix was filled in, workshop participants organized and developed the policy and institutional issues identified through the data collection that correspond to the significant cells in the matrix. The results of the policy and institutional analysis are presented in Chapter 5 of the report.

3.4 SIMULATION OF INVESTMENT COSTS TO PHASE OUT ODS USE AND ANALYSIS OF ATMOSPHERIC IMPACTS

106. This section presents the modeling tools used to estimate (1) the real resource and Multilateral Fund costs resulting from the implementation of investment projects to comply with each of the phaseout scenarios; and (2) the likely impact on the atmosphere of each of the phaseout scenarios. The modeling activities described in this section build on and are informed by the data collection activities and policy and institutional analyses described in the previous two sections. These modeling tools have also incorporated many of the techniques and approaches previously developed by the Study Team for estimating the economic and atmospheric implications of policies designed to protect the ozone layer.

3.4.1 Overview of Simulation

107. In considering approaches that could be used to estimate the costs associated with phasing out the use of ODS in Article 5 countries, the Study Team recognized that multiple factors were impacting the rate of implementation of investment projects to reduce ODS use in such countries. First, projects are and will continue to be implemented for economic reasons as the price of ODS rises. Second, the implementation of projects may be accelerated for non-economic reasons. This can occur because multinational companies are implementing corporate policies to phase out ODS use across all of their factories globally in an accelerated fashion. In addition, such multinational and many domestic enterprises in Article 5 countries are currently phasing out their use of ODS to protect export markets in Article 2 countries.[9] Lastly, projects may be accelerated because many Article 5 governments have adopted aggressive phaseout schedules that are forcing enterprises in these countries to implement investment projects sooner than mandated under the current Protocol.

108. It is apparent that any simulation tool used to estimate the costs of the phaseout must adopt a hybrid approach that considers all of these factors. Indeed, a simulation technique that only considered the economic incentives driving the phaseout would be inadequate as would one that only focused on the non-price related factors accelerating the phaseout. The approach adopted was purposefully kept simple because attempting to simulate all of these factors in a sophisticated fashion would be difficult, expensive, and require significant quantities of input data.

109. Within this context, the Study Team believed that the best use of resources was in collecting the most accurate and current data to be used in informing the simulation model. Emphasis was therefore placed on obtaining as much data as possible on the use and emissions of ODS substances in Article 5 countries, the types of control technologies that might be used to reduce this use, the potential availability and rate of penetration of such technologies, and the range of costs of these technologies when implemented in Article 5 countries.

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[9] Under the terms of the Montreal Protocol, Article 2 countries are not allowed to import ODS-containing equipment after the ODS phaseout date. As a result, enterprises in Article 5 countries manufacturing products for export to Article 2 countries must switch out of ODS by the phaseout date set for Article 2 countries.

110. The remainder of this subsection describes the simulation techniques used to calculate the phaseout costs associated with the implementation of investment projects and the atmospheric implications of each of the phaseout scenarios. Exhibit 3-4 presents an overview of the simulation model.

111. The discussion of the approach used to estimate the costs associated with implementing investment projects to reduce ODS use is divided into three parts. First, Section 3.4.2 presents the model outputs. These outputs are presented first to define and provide an overview of the key variables assessed in the analysis. Section 3.4.3 describes the model inputs. This input data was collected through the extensive efforts described earlier in this chapter. Finally, Section 3.4.4 describes the model algorithms for estimating the economic and atmospheric impacts and Section 3.4.5 details the model limitations.

3.4.2 Model Outputs

112. The key outputs of the model for each scenario are real resource costs, the cost to the Multilateral Fund, annual consumption of ODS, and impact on adjusted atmospheric chlorine loadings. Each of these outputs is discussed below.

3.4.2.1 Discounted Real Resource Costs

113. Real resource costs measure the increase in resources that will be expended by Article 5 countries in complying with the requirements of an ODS phaseout. Other analyses often use the equivalent term "social cost" when discussing real resource costs. Real resource costs can take the following forms: capital costs (i.e., cost of purchasing new equipment to replace ODS-containing equipment), one-time costs (i.e., product reformulations or industry retooling), and operating costs (i.e., chemical, labor, energy, material, and all other recurrent costs).

114. Not all phaseout costs are real resource costs. For example, if a tax increases the price of a commodity, consumers pay more for the commodity, but no extra resources are required to produce the product.[10] The tax only transfers money from consumers to the government. Similarly, if the supply of a commodity is restricted by government regulation (as is the case for ODS), consumers will have to pay more for the commodity, but again no additional resources (machinery, labor, raw materials, etc.) will be needed to produce the commodity. If the price rises, it provides extra profit -- that is, money is transferred from consumers to producers, but no additional resources are used. Economists distinguish such transfer payments from real resource costs. The distinction is important because to the degree that policy or regulation increases the real resource costs of production, society (or Article 5 countries) as a whole expend resources that could produce other goods and services while the net effect of transfer payments on society as a whole is nil.[11]

115. In this analysis, real resource costs are calculated as the sum of all capital, one-time, and operating costs associated with phasing-out the use of ODS in Article 5 countries. It is assumed that

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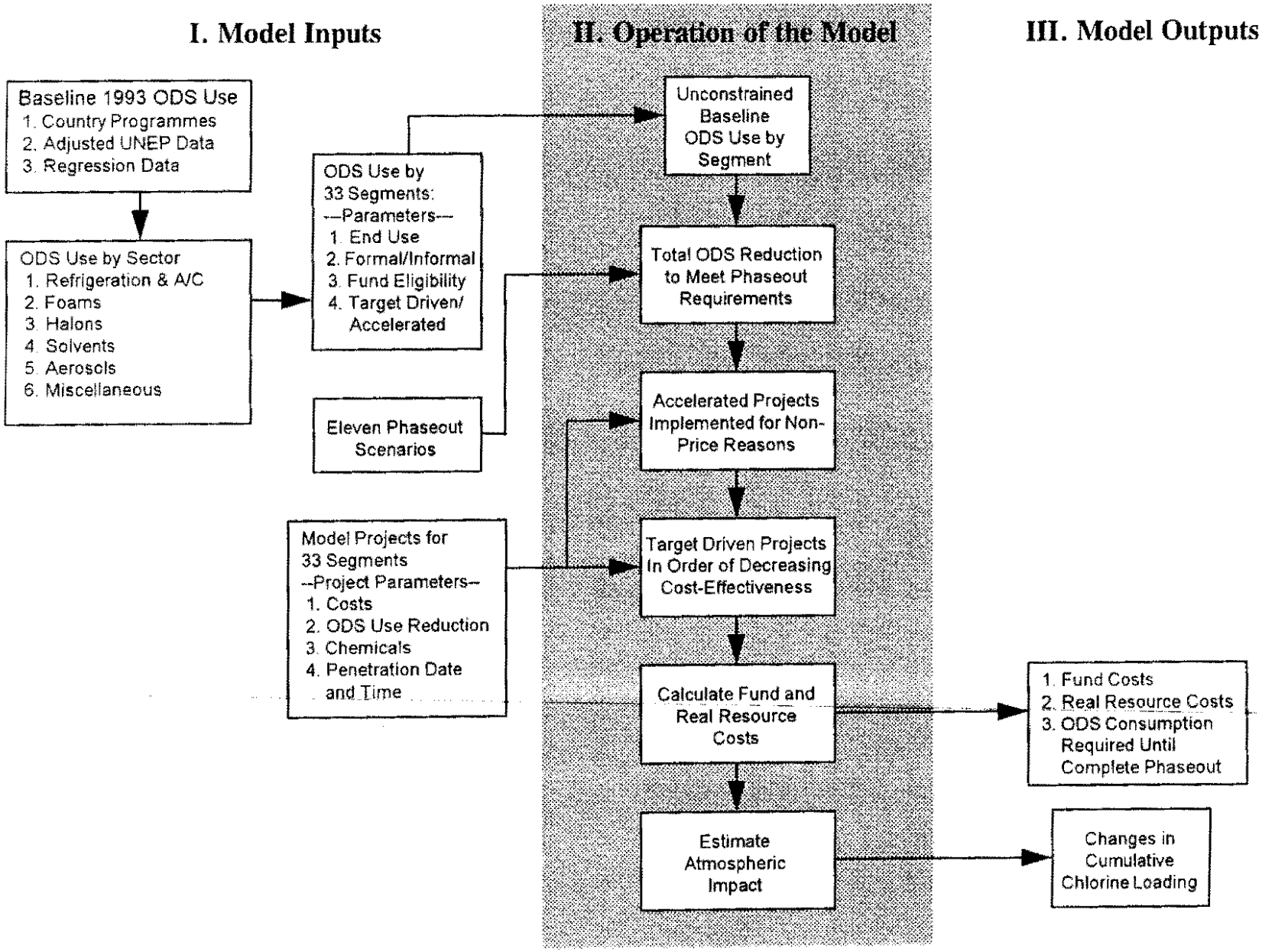
[10] For simplicity, this discussion assumes the tax does not decrease the amount of this commodity purchased by consumers.

[11] Of course, to the extent that consumers of ODS in Article 5 countries are transferring resources to producers of such chemicals in Article 2 or other Article 5 countries, then the economy of that country is worse off because resources are transferred to entities outside the country.

Exhibit 3-4: OVERVIEW OF THE MODEL



operating costs are incurred over the economic lifetime of each project, which, for the sake of consistency was assumed to be ten years. In addition, since ODS prices rise because the Protocol makes them scarce, and not because more resources are required to produce them, the chemical cost component of operating cost is calculated assuming pre-Protocol ODS prices. Real resource costs for each scenario are calculated for the period 1993 to 2030. Results are presented assuming a ten per cent discount rate in Article 5 countries, and sensitivity analyses are performed assuming discount rates of zero and five per cent. Zero per cent was chosen to provide an indication of the actual monetary transfers that would be required during the phaseout period, and five per cent was chosen to give an indication of the implications of assuming a relatively low discount rate for Article 5 countries.

3.4.2.2 Fund Costs

116. Fund costs are a measure of expected financial demand on the Multilateral Fund from projects eligible for reimbursement. The cost components included in the Fund costs were those specified in the document entitled "Indicative List of Incremental Costs" prepared by the Executive Committee. Key differences between the calculation of Fund and real resource costs include the fact that Fund costs (1) include up to only four years of operating costs for each project (this analysis assumes two years of operating costs in the base scenario and performs a sensitivity assuming four years of operating costs are reimbursable),[12] (2) assume rising ODS prices over time in the calculation of such operating costs, (3) do not include negative costs (or savings) for projects that are profitable without funding, and (4) are adjusted to reflect the fact that projects are not reimbursed for a percentage of their costs equal to their percentage foreign ownership. As a result of these major differences, real resource costs are typically higher than Fund costs.

117. Fund costs in this analysis are presented for the time period 1993 to 2030 and are presented assuming a discount rate of ten per cent in Article 5 countries. Sensitivity analyses are also performed for discount rates of zero and five per cent.

3.4.2.3 Annual Consumption of ODS

118. The model simulation estimates the total quantity of ODS used each year until the phaseout is complete across all Article 5 countries. Estimates of annual ODS use are divided by chemical class (i.e., CFCs, MCF, carbon tetrachloride, and halons) and by the quantity of chemical used in new equipment and the quantity used to service existing equipment. For tail scenarios, the model also reports the quantity of ODS required each year after the phaseout date to service existing equipment (and thereby avoid costly retrofits or early retirements).

3.4.2.4 Adjusted Stratospheric Chlorine Loadings

119. Given that the presence of chlorine and bromine in the stratosphere are considered to be the primary causes of ozone depletion, and that ODS compounds are the primary source of chlorine and/or bromine reaching the stratosphere, the impact of each scenario on adjusted stratospheric

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12 Nine of the eleven scenarios modeled in this analysis assume that the Fund will reimburse operating costs for two years. This period of time was calculated based on the average length of time that operating costs were included in projects presented at the Thirteenth meeting of the Executive Committee.

chlorine levels is a good indication of its potential harm to the ozone layer.[13] To assess the potential environmental impacts associated with each of the phaseout schedules for Article 5 countries, model runs were performed to estimate adjusted stratospheric chlorine levels under each scenario. For each scenario, total cumulative chlorine values are presented. Total cumulative Clx is reported as the area under the adjusted chlorine curve above 2.0 parts per billion from 1985 until the year adjusted chlorine concentrations return to 2.0 ppb.

3.4.3 Model Inputs

3.4.3.1 Baseline ODS Use in Article 5 Countries

120. The key inputs to the model related to baseline ODS use are total 1993 ODS use and the expected growth of this use in the absence of controls. The following four step process was used to estimate baseline.

121. First, ODS use estimates and expected growth rates were extracted from the 40 Country Programmes prepared for Article 5 countries to-date. The ODS use data and growth rates contained in these documents varied widely in terms of the years for which data were reported and the level of disaggregation of the data by chemical and end use. Estimates of 1993 ODS use by chemical were developed based on the most recent use estimate contained in the Country Programme and the expected growth rate. If growth rates were not included in a given Country Programme, then a weighted average value was used based on the growth rates contained in the other Country Programmes. If the Country Programme did not present ODS use disaggregated by chemical, then best professional judgement was used to disaggregate total ODS use for the country into use by chemical.

122. Second, if a Country Programme was not available for a given country, ODS use data reported by Article 5 countries to UNEP were obtained. Use data for an additional 22 Article 5 countries were obtained in this fashion. These data were always for the baseline year (1986 or 1989 depending on the ODS), and in some instances was also reported for 1990 or 1991. UNEP does not require countries to report data on expected growth in ODS use. As a result, use estimates by chemical for 1993 were developed based on (1) the most recent year for which data were reported to UNEP, and (2) a weighted average ODS growth rate for Article 5 countries developed based on the growth rates contained in the 40 Country Programmes noted above.

123. Third, if a Country Programme had not been prepared for a given country, and that country had not reported its ODS use to UNEP (i.e., it was out of compliance with the reporting requirements of the Protocol), then total ODS use was estimated using a regression analysis correlating ODS use in Article 5 countries with Gross Domestic Product (GDP) and population. This regression analysis correlated total weighted ODS use in 1993 in the 65 Article 5 countries for which use data were available from the Country Programmes or from UNEP with 1993 GDP and population estimates for the countries. The analysis showed a strong correlation between total weighted ODS use in a given Article 5 country and the GDP and population for that country. This correlation was

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[13] Adjusted stratospheric chlorine loading is defined as the concentration of chlorine in the stratosphere plus 40 times the concentration of bromine in the stratosphere. This calculation assumes that bromine molecules are 40 times more effective at destroying ozone than chlorine. Using adjusted chlorine levels is convenient because it provides a single measure of the concentration of chlorine and bromine in the stratosphere in chlorine equivalents.

then used to estimate total 1993 ODP weighted use for the remaining 26 Article 5 countries. Growth in ODS use for these countries was assumed to be the same as the average ODS growth rate across the 40 countries for which Country Programmes were available.

124. Fourth, total ODP-weighted use in each Article 5 country was divided into the following six broad sector categories: refrigeration and air conditioning, foams, halons, solvent cleaning, aerosols, and miscellaneous uses (sterilization and tobacco expansion). The division of total ODP-weighted ODS use by sector was accomplished as follows:

(1) Estimates of ODS use by sector were developed for the 40 Article 5 countries with Country Programmes based on the sector level data contained in these studies. The level of disaggregation and definition of sectors varied widely in the Country Programmes, and therefore best professional judgement was often used to divide the use into the six sectors defined for this analysis.

(2) Sector level data were not available for countries whose total ODS use had been estimated based on the UNEP data or the regression analysis. Total weighted ODS use for these countries was divided into the six sectors using the average division of use by sector across the 40 countries with Country Programmes.

The end result was baseline ODP-weighted ODS use across all Article 5 countries by sector and chemical from 1993 to 2030. Total ODP weighted ODS use in 1993 for all Article 5 countries was estimated to be 235,000 tonnes and this use was assumed to grow at a rate of 8.9 per cent per year until the base year for reduction was reached when growth was frozen.

3.4.3.2 Mapping of Baseline Use in Article 5 Countries into Use Segments

125. The next step in developing the model inputs was to map ODP weighted ODS use in each of the six sectors into 33 distinct use segments across all six sectors. These 33 segments differ in terms of four key parameters that the Study Team believed are critical to determining the types of controls implemented in Article 5 countries in each sector, the rate at which such controls are implemented, the total real resource costs of the controls, and the potential costs of the controls to the Multilateral Fund.

126. The four key parameters that are used to divide total ODP weighted ODS use by sector into 33 use segments are defined as follows:

- End Use: ODP weighted use in each sector was divided according to the following end uses within each sector:

  -- Refrigeration End Uses: Mobile air conditioners (MACs), commercial refrigeration (defined to include retail food, cold storage, industrial process refrigeration, and refrigerated transport), domestic refrigeration, and commercial air conditioning.

  -- Foams End Uses: Flexible foam, packaging foam, domestic and commercial refrigeration foams, and other foams (including all other insulating and non-insulating foams).

-- Halon End Uses: Streaming and total flooding applications.

-- Solvent Cleaning End Uses: CFC-113 containing equipment, methyl chloroform containing equipment, and carbon tetrachloride containing equipment.

-- Aerosol End Uses: The aerosol sector was not divided into any end uses. This is because ODS use in this sector does not need to be further divided to characterize the controls to be used in it.

-- Miscellaneous End Uses: This sector was divided into sterilization and tobacco expansion.

The definition of these end uses within each sector is necessary because the types of controls available to replace ODS use differ by end use as does their potential rate of implementation and cost.

- Formal or Informal Use: Within each sector, total ODS use was divided according to the fraction of use consumed by formal enterprises and the fraction of use consumed by informal enterprises. Formal enterprises were defined as large, well-organized, capital intensive entities, and informal enterprises were defined as small, unorganized, and labor intensive entities. This distinction is important because it was assumed that informal enterprises would implement control options more slowly than formal enterprises and at a higher cost, as discussed in Chapters 4 and 5.

- Can the Use Result in a Financial Demand on the Multilateral Fund: Total ODP weighted use was also divided according to whether it could potentially result in a financial demand on the Multilateral Fund. It is expected that the cost of phasing out the vast majority of ODS use in Article 5 countries could potentially be eligible for support from the Multilateral Fund. The major exception identified by the Study Team was new refrigeration equipment (MACs, commercial and domestic refrigeration equipment) manufactured in an Article 2 country that is imported into an Article 5 country. The higher cost of the new refrigeration technology to the consumer is unlikely to be reimbursed by the Fund given the difficulty of crafting an investment project to reimburse consumers. In other words, the use of new refrigeration equipment in Article 5 countries that is imported from Article 2 countries was assumed to result in no burden to the Fund because of the difficulty of reimbursing such costs.[14]

- Is the Implementation of Controls in a Given End Use Undertaken to Meet a Target (i.e., Price Driven) or is its Implementation Accelerated for Non-Price Reasons: Total ODS use in each sector was also divided according to whether the control technologies available to replace it would be implemented to achieve a target or in

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[14] It is possible that an enterprise in an Article 5 country importing non-ODS containing refrigerators from an Article 2 country could develop a project seeking reimbursement for the incremental cost of purchasing such refrigerators. This possibility was not considered in this analysis because no such projects have been submitted to the Fund to-date. In addition, such a project would likely raise a number of policy issues that would need to be resolved by the Fund prior its approval.

an accelerated fashion due to non-target driven reasons. Reasons that projects could be accelerated include (1) multinationals phasing out ODS use in enterprises in Article 5 countries because they have adopted a corporate policy to do so as quickly as possible and/or to preserve export markets to Article 2 countries, (2) domestic enterprises phasing out early so that they can continue to export products to Article 2 countries, and (3) aggressive national ODS phaseout strategies implemented by Article 5 countries.

The methodology used to map ODP weighted use for the six sector categories into the 33 use segments was as follows:

127. First, because the four key parameters all impact the availability, rate of implementation, and cost of control technologies, the Study Team felt it was critical to map groups of Article 5 countries with similar characteristics with respect to these four parameters in the same fashion. It was decided that GDP would be a good proxy for mapping like groups of countries according to the four key parameters. This variable was selected because it was felt that countries with low GDP would tend to have their ODS use concentrated in refrigeration end uses, and would be unlikely to implement controls in an accelerated fashion. Countries with a high GDP, on the other hand, were assumed to have a more industrialized economy that would employ ODS in all the major end use sectors, would have a large proportion of formal industries, and would be more likely to implement controls in an accelerated fashion.

128. Second, to group Article 5 countries, a graph was prepared plotting each Article 5 country for which a Country Programme had been prepared according to its GDP and total ODS use. The result was that most countries clustered into one of three groups according to the following definition of GDP:

- Group I -- Low GDP (i.e. below $3.5 billion)
- Group II -- Medium GDP (i.e., between $3.5 billion and $20 billion)
- Group III -- High GDP (over $20 billion)

It was found that four countries did not fall into any of these three clusters -- Brazil, China, India, and Mexico. These countries were then each treated as a separate group (i.e., Groups IV through VII) because they represent such a large portion of global use and because good information was available.

129. For each of the seven groups, the Study Team then mapped the use in each sector according to the remaining four parameters. This was done based on data collected during the country visits and from the fax questionnaires, data available from existing studies, and best professional judgement. The result was that for each of the seven groups of countries, a mapping protocol was developed that further divided use in each end use according to the remaining four parameters. This resulted in the 33 distinct use segments.

3.4.3.3 Definition of Model Projects

130. For each of the 33 use segments defined above, model projects were developed that characterized the control technologies available to eliminate this ODS use in each segment. A total of 98 model projects inclusive of retrofit and recycling controls were developed as part of this analysis. Model projects were characterized according to the following parameters:

- Capital cost;
- Operating cost per year including chemical, energy, labor, and all other annual costs;
- ODS use avoided each year;
- Identification of baseline and substitute chemicals used;
- Date of earliest availability;
- Maximum estimated market penetration, which is defined as the maximum fraction of the total ODS use in a given segment that can be replaced by a project. The sum of all the market penetrations across all projects in a given use segment must sum to 100 per cent; and
- Time required to achieve maximum penetration.

131. The model projects were developed and parameterized based on (1) a review of an array of investment projects approved by the Multilateral Fund to-date, (2) the control technologies identified as likely to be used in the eight Article 5 countries visited by the Study Team, (3) information on control technologies contained in the 13 responses to the fax questionnaires, (4) input from the Technical and Economic Assessment Panel, and (5) the professional judgement of the Study Team.

132. The primary source of data for developing estimates of the cost and ODS use reduction was a set of 62 investment projects that have been approved by the Fund. For each approved investment project that matched a given model project in an end use, data were extracted on the capital and operating costs of the project and the ODS use avoided. If there were multiple investment projects for a given model project, then the average of the values across the investment projects were used in parameterizing the model project.

133. If there were no approved investment projects that matched a given model project, then the Study Team used its best professional judgement in developing estimates of the cost and use avoided by the project. This approach was undertaken for all recycling and retrofit model projects, and a number of additional projects for which there were no approved investment projects. In all cases, these estimates were informed by the Team's extensive experience in analyzing phaseout costs and evaluating project proposals.

134. Assumptions regarding the date of availability of the control, its time required to achieve maximum penetration, and maximum market penetration were also developed based on data collected during the course of the country visits, data contained in the responses to the fax questionnaires, and the experience of the Study Team in modeling the penetration of ODS substitute control technologies.

135. It is important to note that the time required to achieve maximum penetration and cost of a model project was assumed to be significantly different between the formal and informal sectors. Specifically, it was assumed that it would take approximately twice as long for a given model project to penetrate the informal sector as compared to the formal sector, and that the cost of implementing the project in the informal sector would be 2.5 times that of implementing it in the formal sector.[15]

136. Finally, the rate of penetration of model projects that are implemented in an accelerated fashion for non-price driven reasons were assumed to be the same as that for enterprises operating in Article 2 countries. The rationale behind this assumption was that Article 5 enterprises

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[15] These estimates are based on the Study Teams visits to and experience working in Article 5 countries.

accelerating their phaseout usually do so because they are part of a larger multinational corporations and/or they are exporting to markets in Article 2 countries. As a result, their phaseout schedule is likely to be approximately the same as that for enterprises in Article 2 countries.

3.4.4 Operation of the Model

137. The algorithm used to estimate the real resource and Fund costs can be summarized as follows:

(1) Estimate total baseline ODS use across all Article 5 countries in the absence of controls.

(2) Calculate the total reduction in ODS use that must be achieved each year to comply with the phaseout targets specified in a given scenario. This is simply the difference between unconstrained use and the total use allowed under the scenario through time.

(3) Simulate the implementation of the model projects that are assumed to be undertaken in an accelerated fashion and estimate the total reductions achieved by these projects.

(4) Calculate the remaining reductions in total weighted ODP use required to meet the target. To achieve these additional reductions, determine the sequence of target driven model projects that must be implemented. The model determines this sequence by implementing model projects in order of decreasing cost-effectiveness use. The cost-effectiveness of each project is measured using the real resource unit abatement cost.

(5) Once the model has determined the sequence of model projects that must be implemented over time to achieve the targets, it calculates the Fund and real resource costs.

(6) For tail scenarios, instead of implementing retrofits or early retirements to achieve a given target, the model estimates the total size of the ODS tail required to avoid such retrofits and early retirements in the refrigeration and air conditioning sectors. The total size of this tail is reported over time, and no retrofit or early retirement costs are included in the Fund or real resource cost estimates.

(7) Based on the ODS use estimates developed for each scenario, the impacts of emitting this ODS consumed on stratospheric chlorine were calculated using the Atmospheric Stabilization Framework.

The remainder of this section describes each of these steps in greater detail.

3.4.4.1 Estimate Baseline ODS

138. The methodology used to develop estimates of baseline ODS use across all Article 5 countries was described in section 3.4.2.1. It is important to note that the model does not track ODS use at the individual Article 5 country level. Instead, the model tracks total ODS consumption by the 33 use segments across all Article 5 countries.

3.4.4.2 Total ODS Reduction Required to Meet the Target Each Year

139. Given an estimate of baseline ODS use through time, and the phaseout target specified by a given scenario, the model calculates the total ODS reduction required to achieve the target each year. This is calculated simply as the difference between forecasted use and the total use allowed under the scenario in that year.

3.4.4.3 Simulation of Implementation of Non-Price Projects

140. As described previously, the analysis assumes that model projects in a number of use segments are implemented in an accelerated fashion for non-price reasons. The early implementation of projects is assumed to be due to the corporate policies of multinational corporations mandating the phaseout as soon as possible at all of its enterprises worldwide, multinational or domestic enterprises phasing out to protect their export markets in Article 2 countries, or enterprises phasing-out because of aggressive national policies. This can be seen from the fact that (1) the phaseout schedule for Article 5 countries does not begin to restrict ODS use until 1999, and yet Article 5 countries are seeking support from the Fund now to implement ODS reduction projects that will reduce ODS use well before 1999 (such as solvents projects), and (2) to protect their export markets often without the impetus of a rise in prices.

141. In the modeling framework, accelerated projects are implemented as soon as they are available and reach maximum market penetration as soon as feasible. These are assumed to occur before any target driven (or price based) projects are implemented.

3.4.4.4 Sequencing of Target Driven (Price-Based) Model Projects

142. After implementing the non-price controls, the model calculates the additional ODS use reductions required each year to achieve the target. The model then implements additional model projects to meet the target each year in order of decreasing cost-effectiveness. The cost-effectiveness of controls are measure using the real resource unit abatement cost (UAC). The real resource UAC is calculated as the sum of the annualized capital costs plus the first year operating costs divided by the first year ODS reductions. In calculating operating costs from the real resource perspective, baseline prices for ODS are used (instead of rising prices). This is because, as explained previously in Section 3.4.2.1, the rise in ODS prices are not assumed to impact real resource costs because the cost of manufacturing the ODS has not increased. Instead, the price rise is due to the scarcity of ODS that results in a transfer of resources from the user of the chemical to the producer of the chemical.

143. Using the real resource UAC to sequence the order of the model projects means that projects will be implemented in the most cost-effective fashion from the societal perspective. Given that one of the purposes of the Multilateral Fund is to implement the phaseout in a cost effective fashion, employing a methodology that assumes that projects will be sequenced in such a fashion across all Article 5 countries seems appropriate.

3.4.4.5 Estimation of ODS Prices Over Time

144. It is necessary to develop estimates of the rise in ODS prices likely to occur under each scenario in order to estimate the Fund phaseout costs. The Study Team initially intended to obtain

estimates of future ODS prices from chemical manufacturers worldwide. This proved to be infeasible, because manufacturers felt they could not give credible estimates.

145. A number of factors make price forecasting difficult. First, the global production of ODS is currently in a state of flux with industrialized producers phasing out their production and certain Article 5 producers continuing to produce or even increasing their production. This makes it difficult to estimate the likely supply of ODS in the next few years, and ODS supply is a key determinant of price. Second, the activities of the Multilateral Fund tend to invalidate the standard microeconomic model for pricing in the context of a phaseout. Normally, ODS prices should rise to reflect the marginal cost of control at a given time. As ODS becomes scarce, users bid up the prices to avoid the need for control measures. No user will pay more than the UAC of their alternative. Therefore, the standard model assumes that the price is set by the UAC of the most expensive controls required to meet a phaseout target each year. However, the Fund breaks this connection by reimbursing the costs of projects. This effectively makes user costs zero and removes the force that drives prices in the standard model.

146. Despite the difficulties described above, the Study Team recognized the importance of having a price forecast and decided to use real resource UACs as a base for estimating price increases over time. In each scenario prices for each chemical were assumed to increase linearly from the base price of that chemical to the UAC of the most expensive control between 1993 and the phaseout year.

3.4.4.6 Estimation of Fund Costs

147. Once the model has determined the sequence and timing of the implementation of each of the model projects required to achieve a given target in a given year, the total Fund costs in each use segment are calculated as the product of the total cost of the model project from the perspective of the Fund and the total number of model projects that must be implemented in that use segment to achieve a given target each year. The total number of projects that can potentially be implemented in any give use segment is calculated as the total ODS use in that segment each year divided by the quantity of ODS use eliminated by a given model project.

148. In calculating the total cost of a given model project from the perspective of the Fund, the Indicative List of Incremental Costs approved by the Executive Committee was used to define the allowable incremental costs. Key assumptions underlying the calculation of Fund costs are explained in Section 3.4.2.2.

149. It is assumed that the cost of each model project decreases at a rate of 2 per cent per year over time. This is designed to capture continuing technological development and innovation that are likely to occur in the future. This is appropriate because given the time period over which the study addresses, it is reasonable to assume that there will be technological developments related to alternative technologies. These developments should reduce the cost of the alternative technologies and lead to a wider array of feasible options.

150. The model assumed that methyl chloroform projects in the solvent sector would not be funded if their UAC was above US $100/kg. This is based on the direction of the Sub-committee for the

Report as specified in the minutes of the July 24 meeting with the Study Team (see Attachment 1 of this report).[16]

151. Fund costs are discounted at a rate of ten per cent in the base scenario and sensitivity analyses are performed assuming a discount rate of zero and five per cent.

3.4.4.7 Estimation of Real Resource Costs

152. Real resource costs are estimated using the same methodology as that described above for Fund costs except that the cost of each model project is calculated based on its real resource cost. The real resource cost of such projects are calculated as the sum of the capital, one-time, and operating costs associated with it. The operating cost component of real resource costs are calculated (1) over the lifetime of the model project that is implemented to reduce or eliminate the ODS use, and (2) assuming that ODS prices remain constant over time at their baseline level. As with Fund costs, the real resource cost of each model project is assumed to decrease at a rate of 2 per cent per year. Again, this is designed to capture technological innovation that will reduce the cost of alternative technologies over time. Section 3.4.2.1 presents additional details on the process used to estimate real resource costs.

3.4.4.8 Tail Scenarios

153. In analyzing tail scenarios, the modeling framework estimates the quantity of ODS required each year to avoid potentially costly retrofit and early retirement controls in the refrigeration and air conditioning sector. In conducting this simulation, it is assumed that model projects to replace ODS use in new refrigeration and air conditioning equipment are implemented in the year that they become cost-effective. This means that the simulation does not attempt to implement such model projects as soon as they are technically feasible so as to minimize the size of the tail. As a result, the size of the tail is larger than it would be if ODS use in new equipment were replaced as soon as it is technically feasible to do so regardless of the cost.

3.4.4.9 Simulation of Atmospheric Impacts

154. The purpose of the atmospheric analysis is to provide a comparative measure of the environmental impact of each of the proposed phaseout schedules for Article 5 countries. It is beyond the scope of this study to perform a full scale atmospheric, human health, and environmental impact assessment for each scenario. However, as a proxy for a more detailed study, the Study Team used an existing simplified model, the Atmospheric Stabilization Framework (ASF), to estimate the impact of each phaseout schedule on stratospheric chlorine loading.

155. The ASF is a "consensus" model developed by a committee of prominent atmospheric scientists in government, academia, and private consulting firms. It was designed to approximate the behavior of more sophisticated two- and three- dimensional physical models without requiring the computing power needed for physical simulations. It has been used extensively to support the U.S. government in evaluating the atmospheric implication of both domestic and international policy measures. Additional information of the ASF can be found in the National Aeronautical and Space Administration Conference Publication 3023, An Assessment Model for Atmospheric Composition.

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16 It is important to note that the Subcommittee to the Report's admonition to the Study Team that "this assumption is for the purpose of this study alone and should not be interpreted as Executive Committee policy."

156. Since chlorine in the stratosphere is the principal cause of ozone depletion, the impact of each scenario on chlorine levels is a good indication of the potential harm to the ozone layer. As a result, chlorine loading is used to compare the atmospheric impact of each scenario. The analysis involved the following steps:

- Estimate Article 5 emissions from the use estimates developed in Section 3.3.4.1 with baseline emissions estimates from the developed world to create a global emissions scenario for each proposed phaseout schedule;

- Calculate adjusted stratospheric chlorine levels for each emissions scenario using the ASF, and report chlorine levels integrated over time.

157. Total adjusted chlorine loading estimates for each proposed scenario were used as a proxy for the potential damage to the ozone layer from each scenario. Total cumulative Clx is defined as the sum of the area under the Clx curve above 2.0 parts per billion during the period from 1985 until Clx returns to 2.0 ppb.

3.4.5 Model Limitations

158. The modeling framework tracks ODS use and implements projects in global sectors. However, the ODS use restrictions mandated by the Montreal Protocol apply to each Article 5 country individually. This is an important limitation for two reasons: First, compliance with global targets does not necessarily mean that individual countries meet their targets. For instance, if one country is below its target in one year, another country can violate its target while still maintaining global compliance. This error tends to underestimate phaseout costs.

159. Second, the model implements projects across global sectors in order of decreasing cost effectiveness. As a result, all projects of a given kind are typically implemented together. This introduces an error since different countries have different sector profiles. For example, if the model meets its first target by implementing inexpensive solvent projects, it misses the more expensive projects that must occur in countries without solvent sectors. This error tends to underestimate costs by delaying (therefore discounting more) some expensive projects while expediting (therefore discounting less) a corresponding number of inexpensive projects.

160. The costs of the model projects were largely developed based on the financial data contained in the 62 approved investment projects reviewed for this study. Relying on this data will tend to bias upwards the cost of the model projects relative to those actually implemented in the marketplace because the Fund does not see projects that are cost-effective. In other words, because the Fund does not provide assistance to projects that are currently cost-effective, the model projects developed based on the projects approved by the Fund will tend to be overestimates.

161. In culling financial data for use in the model projects from the 62 projects, The Study Team relied solely on the documentation provided to the by the Secretariat to the Team about each of the investment projects. This documentation varied widely in terms of the level of disaggregation and detail provided in support of the operating costs contained in the projects. This often made it difficult to divide the operating costs into its components (i.e., chemical costs, labor costs, cost of materials) for inclusion in the modeling framework. In addition, the data presented in the projects at times appeared contradictory or inconsistent. As a result, the Project Team used its best

judgement in interpreting the data contained in the investment projects for inclusion in the model.[17]

162. The modeling framework does not assume that recycled ODS are banked prior to the phaseout date for use after this date. If such a bank were assumed to be created, it could potentially significantly reduce the cost of the phaseout in Article 5 countries, particularly in those scenarios that do not provide for a tail to service existing refrigeration and air conditioning equipment after the phaseout date.

163. Finally, as mentioned above, there are severe limitations in ODS price forecasting. There are good reasons to believe that, because of these limitations, this methodology overestimates future chemical prices, and hence overestimates the chemical savings in the Fund cost calculation for some projects.

3.5 ESTIMATION OF COSTS TO PHASE OUT ODS PRODUCTION

164. This section describes the methodology employed by the Study Team to estimate the costs associated with the phaseout of ODS production in Article 5 countries. Following a brief overview of this approach, the primary elements of the approach are presented.

3.5.1 Overview

165. Enterprises in several Article 5 countries produce significant quantities of ozone depleting substances. As the global phaseout proceeds, these producers will be required to retire ODS production capacity and may, depending on country-specific decisions, choose to invest in capacity to produce alternative chemicals. The "Indicative List of Categories of Incremental Costs" provides that several of the associated costs are eligible for reimbursement by the Multilateral Fund. Because of the capital-intensive nature of chemical production and the number and of size of production facilities in Article 5 countries, the demands on the Fund for financial support could be considerable.

166. Any attempt to estimate such financial demands must, however, recognize substantial uncertainties. First, definitive policy guidelines on the calculation of eligible incremental costs in the production sector have not yet been finalized. Consequently, several issues are unresolved including, but not limited to, choice of substitute chemicals for each producing country, incorporation of country specific preferences for domestic production versus imported supplies, level of new production capacity to be supported for each country, avoiding double-counting when allocating grants to both users and producers in the same country, treatment of market uncertainties such as the demand for and profitability of substitute chemicals, and calculating certain cost elements such as lost profits on ODS production. Second, accurate and comprehensive data on the universe of production facilities in Article 5 countries is not readily available. While much information is available, collection of plant-by-plant data is very resource-intensive and beyond the scope of this study. Third, because production costs are critically dependent on the specific chemical being produced and the quantity produced, prediction of the mix and volume of alternative chemical production capacity is a

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[17] The Study Team considered approaching the Implementing Agencies or individuals who prepared the investment projects to clarify any questions. It was determined, however, that undertaking such a task would have been too time-consuming given the time frame for the analysis and the resources available.

prerequisite to estimating likely demands on the Multilateral Fund. Efforts to make such predictions in a sophisticated, microeconomic framework can quickly become very complex.

167. Believing strongly that analytic methods should reflect the quality of the underlying data, the inherent uncertainties in predicting complex future events, and the degree of precision in the available policy frameworks, the Study Team devised a relatively simple approach to estimating the likely demands on the Multilateral Fund associated with addressing ODS production. The Team compiled a profile of ODS production plants in Article 5 countries, developed a method for calculating conversion costs based on chemical prices, and applied the method to the profile to compute global costs. Two different assumptions about the global quantity of production capacity to be addressed and four approaches for computing grants from the Multilateral Fund were combined to yield eight different estimates. The resulting estimates should be regarded as no more than a very rough indicator of the range of potential demands on the Fund.[18] In addition, the Study Team could not develop a simple approach to determine when these costs would be incurred; thus, the estimate of production phaseout costs is independent of the calculation of phaseout costs for ODS use and does not vary across the eleven phaseout scenarios described in Chapter 2.

3.5.2 Profile of ODS Production in Article 5 Countries

168. The Study Team developed a profile of ODS production plants in Article 5 countries based on a variety of sources. Written materials that were reviewed included Country Programmes, the reports of Team staff who visited producing countries, and documents prepared by the implementing agencies. In addition, interviews were conducted with representatives of multiple chemical manufacturers from both developed and developing countries. Data were often incomplete and occasionally contradictory; best professional judgment was used to finalize the profile.

169. The Study Team believes that ODS are produced in at least eight Article 5 countries, including Argentina, Brazil, China, India, Mexico, Romania, the Republic of Korea, and Venezuela. The number of production plants is thought be around 90, with 70 in China, nine in India, and the remainder in the other six countries. While ODS production plants in some Article 5 countries are already being closed or converted, it appears that, in at least one country, ODS production capacity is currently being increased. Ten plants are believed to be owned, in part or in whole, by foreign, non-Article 5 enterprises. Because grants from the Multilateral Fund are typically reduced by the fraction of foreign ownership, the production and capacity estimates in the profile were appropriately adjusted downward. As shown in Exhibit 3-5, actual production, at present, appears to be far below production capacity.

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[18] This approach is consistent with the Sub-Committee's instructions to the Study Team regarding the production sector to "use a reasoned approach and readily available technical information to estimate the cost of conversion on a global scale and not on a country or plant basis." See Executive Committee Document, 13/39/Add.1, 25 July 1994.

3.5.3 Estimation of Cost to the Multilateral Fund to Address ODS Production

170. In order to estimate the Fund cost associated with phaseout of ODS production, the Study Team used a five step approach.

- First, the Team developed a method for inferring the capital and operating cost associated with each ODS and the leading alternative chemicals based on their prices.

- Second, "equilibrium" prices, free of the effects of market distortions caused by the phaseout and reflective of the true costs of chemical production were estimated.

Exhibit 3-5
Estimated ODS Production and Capacity in Article 5 Countries
(Adjusted to reflect foreign ownership)

Chemical	Quantity Produced (MT/yr) In Latest Year Data Available	Production Capacity (MT/yr)
CFC 11/12	58,000	152,000
CFC 113	<1,000	1,600
Halon 1211	6,500	10,000
Halon 1301	Negligible	600
Methyl Chloroform	<1,000	4,300
Carbon Tetrachloride: Non-Feedstock	4,200	6,400

- Third, "pathways" were defined to describe the specific substitutes into which ODS production will be converted (e.g., from CFC-12 to HFC-134a) and the global quantities of each ODS on each pathway were estimated.

- Fourth, for each combination of an ozone depleting chemical and a substitute (i.e., for each pathway), the incremental capital and operating costs per kilogram were estimated.

- Finally, the incremental costs per kilogram derived in Step 4 were multiplied by the global quantities predicted in Step 3 and combined with assumptions about Multilateral Fund grant calculations to yield a range of estimated Fund costs.

More detail on these steps is presented below.

171. Step 1 entailed allocation of a chemical's price among three types of costs: recovery of the initial capital investment, returns to the investors in the form of profit, and the ongoing operating costs associated with chemical production. The approach is based upon microeconomic theory suggesting that, in a competitive and unconstrained market, market prices will settle at the marginal cost of production. It is possible to roughly allocate this marginal cost among the three cost types based on the capital intensity of an industry and the returns demanded by investors in that industry. To do so, the Study Team used values for two financial parameters that are typical of large firms in the organic chemical industry that operate globally. A typical sales to assets ratio of 1.6 and a profit to asset ratio of about 0.15,[19] were used to compute a typical profit to sales ratio of 0.091, meaning that about 9.1 per cent of a chemical's price represents a return to investors. Moreover, based on the sales to assets ratio and an expected plant lifetime of 15 years, about 4.2 per cent of price represents recovery of capital investment. The remainder, or about 86.7 per cent of the price, is thus used to cover operating costs.

172. Step 2 entailed estimation of "equilibrium" prices for key chemicals, which are defined as the prices that will prevail in competitive markets unaffected by market disturbances such as supply constraints resulting from policies like the Montreal Protocol. Such prices are sufficient to cover capital and operating costs while not being so high as to convey to investors a return beyond that typical for the industry. Equilibrium prices are needed for the analysis to ensure correct allocation among the three cost types (i.e., capital recovery, operating costs, and profits). For ODS chemicals, the Study Team used pre-Protocol prices from the 1985 to 1987 era. These prices were then adjusted upward to reflect inflation, but not the scarcity caused by the Protocol. For ODS substitutes already in widespread production, current prices were used. Finally, for "new" chemicals only just beginning to be produced in significant quantities, conversations were held with chemical producers to predict the price at which a producer could cover all capital and operating cost and offer investors an industry-accepted profit margin.

173. Step 3 entailed first defining the "pathways" that ODS use will follow as it is switched into alternatives. Examples of pathways would include CFC-11 being replaced by methylene chloride, CFC-12 being replaced by HFC-134a, and so on. The quantity of ODS following each pathway across all end uses was then estimated based on the modeling framework described earlier in this chapter and which was used to predict the total cost of the various phaseout scenarios.[20]

174. Step 4 entailed calculating the incremental cost per kilogram for each pathway based on the results of Steps 1 and 2. The calculation for the switch from CFC-11 to HCFC-141b provides an illustrative example. The equilibrium prices per kilogram for these two chemicals are US $1.70 and US $3.08 respectively. Thus, the total incremental cost for this pathway is US $1.38 per kilogram.

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19 See "Annual Statement Studies: 1990," Robert Morris Associates, page 83.

20 Because of the negligible impact on global cost estimates and to simplify the analysis, ozone depleting substances for which total Article 5 country production capacity is less than 5,000 MT per year were excluded from the analysis. Chemicals consequently not analyzed include CFC-113, Halon-1301, and methyl chloroform.

Of this amount, US $0.06 can be allocated to capital recovery, US $1.20 to operating costs, and the remainder (US $0.12) to profits for investors.

175. Step 5 entailed computation of Multilateral Fund grants under several scenarios which are defined by three different parameters.

- First, because of the large discrepancy between actual production and reported capacity in Article 5 countries, Fund costs were estimated for both quantities to yield an upper and lower bound.

- Second, the Team evaluated two assumptions about the reimbursement of operating costs. For the first, it was assumed that only capital costs would be funded; in the second, it was assumed that four years of operating costs would be funded in addition to the capital cost.

- Finally, situations where savings are expected from a shift to a chemical with a lower price than the one it replaces were addressed in three alternate ways. First, it was assumed that the savings would not be used to offset the increased cost of other chemical switches. Second, the alternative assumption was also evaluated; that is, cost savings were netted against cost increases, thereby lowering the overall demand on the resources of the Fund. In both cases, no Fund monies were assumed to be used to offset lower profits associated with the replacement chemical. Accordingly, a third assumption was evaluated that entailed payment of four years of lost profits.

The combination of these three parameters thus produces a total of twelve scenarios for which Fund costs were estimated.

176. When considering this approach to estimating the cost of the ODS production phaseout, several factors should be kept in mind. First, in order to avoid the problem of "double-counting," the real resource cost for the phaseout of ODS production has not been estimated as a quantity distinct from the cost for the phaseout of ODS use. If chemical producers incur higher costs in the production of ODS substitutes, then their customers (i.e., ODS users) will ultimately face higher prices as a result. As such, these higher prices are reflected in the real resource cost estimates produced by modeling framework described in Section 3.3 above. It is, of course, a policy matter for the Executive Committee to determine how to compensate chemical producers whose customers may also be receiving Fund support to cover the cost of purchasing ODS substitutes.

177. Second, by virtue of the methodology used, the capital costs associated with current production of ODS have been subtracted from the capital cost of the ODS alternatives. This has the effect of reducing the potential grant from the Multilateral Fund under all scenarios evaluated.

178. Third, a key implication of the Study Team's approach is that the financial and technical parameters associated with production of ODS and chemical substitutes in Article 5 countries are similar to those for the developed countries. A more refined analysis of this assumption was not possible within the time and resources available for this Study.

179. Finally, this analysis is a global, rather than country or plant, level analysis. As such, it does not involve development of a production phaseout strategy for each country. Issues such as the optimal number and size of plants for each country and the distribution of Fund grants among and

within Article 5 countries are not addressed. Instead, the approach implicitly assumes that production of ODS alternatives will be set at a level dictated both by the predicted demand for various ODS alternatives and by existing production capacity for ODS. National preferences for more in-country production or for smaller capacity plants may lead to higher costs for the Multilateral Fund than estimated by the Study Team.

3.6 ESTIMATION OF NON-INVESTMENT COSTS

180. In addition to the costs associated with investments in projects to phaseout both use and production of ODS, the Multilateral Fund is also used to finance other activities including the support activities of the Implementing Agencies, the operations of the Secretariat and the Executive Committee, institutional strengthening grants for Article 5 governments, and the information clearinghouse functions. In order to estimate the total cost to the Multilateral Fund of the various phaseout scenarios, therefore, it is important to include these non-investment costs. Because these costs are relatively small compared to the other demands made upon the Fund, the Study Team took a simple approach to their estimation.

181. The clearinghouse function, institutional strengthening, operation of the Secretariat and Executive Committee are assumed to cost US $11.5 million per year. These estimates are based on an analysis conducted during the replenishment of the Multilateral Fund in 1993.[21] This cost was assumed not to vary over time or across the various phaseout scenarios analyzed.

182. The cost of support activities performed by the Implementing Agencies were not estimated as a constant amount per year. Rather, because the scope of the investment projects to be done in any year may vary widely as a function of the phaseout scenario being analyzed, a different approach was used. The approach entailed applying a 13 per cent support fee to all investment projects. This reflects the practice of two of the implementing agencies and was, for the sake of analytic expedience, assumed to applicable to the work of other implementing agencies. In sum, then, in any given year, non-investment costs are assumed to be US $11.5 million plus 13 per cent of the combined cost of all investment projects conducted that year.

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21 See "Proposed Three-Year Plan and Budget of the Multilateral Fund (1994-1996)," UNEP/OzL.Pro/ExCom/10/40, Annex II.

CHAPTER 4

OVERVIEW OF DATA COLLECTED BY STUDY TEAM

4.1 INTRODUCTION

183. This chapter presents the data collected by the Study Team that respond to the specific items requested by the Terms of Reference (TOR) for this study. The TOR asked the Study Team to take into account the factors addressed in this chapter in examining alternative phaseout schedules for Article 5 countries. As such, the chapter provides a descriptive overview of data collected and is organized around the TOR. Analysis and interpretation of these data have, for the most part, been reserved for Chapters 5 and 6. In addition, Section 4.11 discusses the feedback received from Article 5 countries on the feasibility of the various phaseout schedules being evaluated under this study. Attachment 1 of the report presents the TOR as well as the minutes of the May 23-24 and July 25-27 meetings.

4.2 ACTUAL AND APPROVED TRANSFER OF RESOURCES (TOR item 1-a-ii-1)

184. Data to assess the transfer of Fund resources to Article 5 countries were obtained from the Fund Secretariat and are extracted from the database of projects approved by the Executive Committee.[22] Exhibit 4-1 presents two tables of information regarding the number, size and status of Multilateral Fund projects as of the conclusion of the 13th meeting of the Executive Committee. The first is based on the number of projects while the second reflects the cost of these projects. Projects for which funds have been approved are grouped into the following categories: investment, institutional strengthening, project preparation, training, and other projects. This latter category includes country programme (CP) preparation, demonstration projects, and technical assistance activities.

185. As Table 1 of Exhibit 4-1 shows, of the 685 projects approved by the Executive Committee as of the 13th meeting, 197 projects have been completed. The highest project completion rate is associated with training projects (56 per cent), which, by their nature, tend to be of a shorter duration and less resource intensive than other projects. In contrast, about four per cent of all investment projects submitted to date have been completed. Finally, no institutional strengthening has been completed because institutional strengthening projects typically represent a three-year commitment of funds to Article 5 countries and none were approved more than three years ago.

186. The Study Team also looked at the cost of projects to see what insights the data offer. Table 2 of Exhibit 4-1 presents the cost of projects approved, completed, and to be completed. A total of 29 per cent of all approved projects have been completed while five per cent of total funds allocated for projects have been transferred.

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22 This database contains information on all projects approved by the Executive Committee, including: a title and description of each project; the project's category (e.g., investment, training); the lead Implementing Agency; the amount of funds allocated for the project; and the status of the project.

Exhibit 4-1
Actual and Approved Transfer of Resources

Table 1 - By number of projects

Type of Project	Number Approved by ExCom	Number Completed	Number Not Yet Completed	Percentage of Projects Completed
Investment	197	7	190	4%
Institutional Strengthening	43	0	43	0%
Project Preparation	139	47	92	34%
Training	81	45	36	56%
Other	225	98	127	44%
Total	685	197	488	29%

Table 2 - By cost of projects

Type of Project	Cost of Projects Approved by ExCom	Final Cost of Completed Projects	Cost of Projects Not Yet Completed*	Percentage of Funds Disbursed
Investment	US $141,741,842	US $2,280,016	US $139,473,461	2%
Institutional Strengthening	8,772,467	0	8,772,467	0%
Project Preparation	17,357,990	3,894,449	11,477,377	22%
Training	7,019,932	2,069,783	2,943,440	29%
Other	23,626,652	2,619,159	17,470,958	11%
Total	US $198,518,883	US $10,863,407	US $180,137,703	5%

* The numbers across columns do not sum to totals due to differences between the amount of funds allocated and funds actually disbursed.

Source: Data from the Inventory of Approved Projects, provided by the Fund Secretariat in August 1994.

187. To distinguish between projects recently approved and those that were approved some time ago, the Study Team divided uncompleted projects according to the Executive Committee at which they were approved. The two tables in Exhibit 4-2 show the breakdown by Executive Committee meeting of projects (by number and size) that have been approved but not yet completed. The tables include the number of months that have passed between the specific Executive Committee meeting at which the projects were approved and the thirteenth Executive Committee meeting. This information indicates that a significant number of projects that were approved prior to the tenth Executive Committee meeting remain to be completed: 160 projects approved prior to the tenth meeting remain to be completed. Of these, investment projects account for the largest portion, with 50 projects remaining to be completed. Investment projects account for the vast majority of the funds remaining for projects not yet completed that were approved prior to the tenth meeting.

188. Two important points should be kept in mind when interpreting these data. First, for some projects (particularly CP preparation, project preparation, and a few investment projects), funds have been allocated at more than one meeting for the same project. For example, if a project approved at one meeting received an additional allocation at a subsequent meeting, the project would be counted twice in the data provided--once for each meeting at which funds were allocated. As a result, the actual number of approved projects is less than the numbers presented in Exhibits 4-1 and 4-2. The total cost of projects, however, is not affected. Second, the funds allocated for approved projects do not include the 13 per cent of a project's cost that UNDP, UNIDO, and UNEP receive on top of the funds allocated for a project to cover overhead costs. In contrast, the World Bank receives an allocation to cover its overhead costs separately from projects it submits for approval. These allocations are accounted for under project preparation.

4.3 RELATIONSHIP BETWEEN AVAILABILITY OF ODS AND RATE OF IMPLEMENTATION ACTIVITIES (TOR item 1-a-ii-2)

189. Data from the eight country visits and the 13 fax questionnaires were examined to evaluate the relationship between the availability of ODS and the rate of implementation of phaseout activities. The Study Team did not look at CPs for this TOR item because they would not indicate the status of actual phaseout activities to date. The Study Team reviewed the country visit reports and the responses to question 6 of the fax questionnaire concerning changes in prices of ODS and their effect on phaseout rate.[23] These data sources provide the most current information on this factor.

190. The eight Article 5 countries visited report no actual supply constraints for CFC-11 or CFC-12, but some of the eight countries have experienced reduced supply of other chemicals. For example, one country that was visited reports a constraint in the supply of the refrigerant R-502, which contains CFC-115. The constraint has caused a rapid decline in consumption of R-502 and a halt in the purchase and installation of refrigeration equipment designed for use with R-502. The constraint seems to be caused by the rapid phaseout in production of CFC-115 taking place in industrialized countries, which supply CFC-115 to the country.

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[23] Question 6 reads as follows: "Have the prices of ODS gone up or down significantly in the last 12 months? To what extent have rising ODS prices led to phaseout projects irrespective of government policy or Multilateral Fund support?"

Exhibit 4-2
Breakdown of Actual and Approved Transfer of Resources by Executive Committee Meeting

Table 1 - By number of projects

Type of Project	Number of Projects Not Yet Completed	For projects not yet completed, number approved by ExCom meeting (and number of months from 13th ExCom meeting)				
		13th (0 months)	12th (3 months)	11th (7 months)	10th (12 months)	Before 10th (16-36 months)[24]
Investment	190	55	33	23	29	50
Institutional Strengthening	43	6	6	4	9	18
Project Preparation	92	9	38	12	9	24
Training	36	3	4	6	8	15
Other	127	21	39	20	9	38
Total	488	94	120	65	64	145

Source: Data from the Inventory of Approved Projects, provided by the Fund Secretariat in August 1994.

[24] Based on the first meeting at which projects were approved (i.e., the fourth meeting of the Executive Committee).

Exhibit 4-2 (continued)
Breakdown of Actual and Approved Transfer of Resources by Executive Committee Meeting

Table 2 - By cost of projects

Type of Project	Cost of Projects Not Yet Completed	For projects not yet completed, funds approved by ExCom meeting (and number of months from 13th ExCom meeting)				
		13th (0 months)	12th (3 months)	11th (7 months)	10th (12 months)	Before 10th (16-36 months)[25]
Investment	US $139,473,461	US $42,376,524	US $15,653,187	US $15,864,550	US $20,933,700	US $44,645,500
Institutional Strengthening	8,772,467	839,975	824,910	716,500	1,956,810	4,434,272
Project Preparation	11,477,377	1,235,000	4,366,510	956,000	1,374,000	3,545,867
Training	2,943,440	125,000	766,800	306,000	451,200	1,294,440
Other	17,470,958	1,788,000	3,761,100	3,705,476	1,957,110	6,259,272
Total	US $180,137,703	US $46,364,499	US $25,372,507	US $21,548,526	US $26,672,820	US $60,179,351

Source: Data from the Inventory of Approved Projects, provided by the Fund Secretariat in August 1994.

25 Based on the first meeting at which projects were approved (i.e., the fourth meeting of the Executive Committee).

191. In another country visited, although there is no actual supply constraint for ODS, many large ODS consumers and producers of ODS-consuming equipment perceive that the supply of CFCs is limited. The current perception of supply limitations, regardless of the actual current supply, is partially responsible for motivating these enterprises to accelerate the transition to non-ODS technologies. In addition, the system instituted by the country to control ODS imports seems to have successfully deterred "dumping" of ODS at extremely low prices into the country from other countries while ensuring that ODS continues to be available.

192. Four countries reported supply constraints for halons, particularly halon 1301. The drastic reduction in available halon in one country has caused prices to increase more than 30 times over the prior year's prices. As a result, all new fire fighting systems use substances other than halons and some existing systems are being switched in phases.

193. Of the countries that responded to the fax questionnaire, any constraints or surpluses in supply of ODS were deduced from data provided on changes in ODS prices over the past 12 months. Of the 13 countries that responded, four reported significant price increases in ODS, which may indicate reduced availability of ODS in-country. In one of these countries, however, the price increase for ODS was due to the country's high rate of inflation rather than any limitations in the supply of ODS. For another country, the price increase was due both to a currency devaluation and an increase in the cost of carbon tetrachloride for production of ODS.

194. Another five countries responding to the fax questionnaire indicated some increase in prices but did not characterize it as significant, which indicates that the countries are not facing significant supply shortages. One country reported that ODS prices have remained steady over the past year. Another country indicated that, while CIF prices[26] for ODS had increased by 30 per cent to 50 per cent (depending on the substance in question), market prices in U.S. dollars have not changed significantly.

195. In sum, the availability of ODS appears to differ across the countries visited or that responded to the fax questionnaire, as well as by chemical. For those countries that have experienced significant ODS supply limitations, some phaseout activity has been observed.

4.4 RATE OF TRANSFER AND IMPLEMENTATION OF LOW- AND NON-ODS TECHNOLOGIES TO OR FROM ARTICLE 5 COUNTRIES (TOR item 1-a-ii-3)

196. Data to assess the rate of transfer and implementation of low- and non-ODS technologies to or from Article 5 countries were drawn from the eight country visit reports. The Study Team reviewed the data for evidence of shop floor-level phaseout experience in the eight countries, including Fund-financed projects and projects implemented independent of the Fund. The data indicate that the implementation of low-and non-ODS technologies in Article 5 countries varies considerably across ODS-use sectors and across countries. This section summarizes the extent of implementation of low- and non-ODS technologies by sector.

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[26] CIF stands for cost, insurance, and freight, i.e., the landed cost of an import on the dock or other entry point in the receiving country. CIF price excludes any charges after the import touches the dock and all domestic tariffs and other taxes or fees.

197. The phaseout implementation has progressed the farthest in the aerosols sector. Three of the eight countries visited have already phased out all ODS use in this sector. In three other countries, at least 50 per cent phaseout has occurred, and in two countries, initial phaseout activities have commenced. Complete phaseout is expected in all countries by 1996. Three of the countries visited instituted early legislation banning ODS use in this sector, but the phaseout process in all eight countries has been largely driven by the economic advantages of using hydrocarbon as a propellant. In some of the large countries, however, the non-availability of high-quality hydrocarbon has limited the phaseout in certain applications, such as perfume sprays and room fresheners. Some phaseout in applications such as insecticide sprays has occurred in these countries with the use of destenched liquified petroleum gas (LPG).

198. In the flexible foams sector, replacement of ODS blowing agents by methylene chloride, water and HCFC blends is rapidly occurring in most countries visited. The early acceptance of substitute technology, its low cost, and the availability of Fund financing have driven this phaseout process. The switchover in this subsector is complete in four of the eight countries visited and is well underway in another country. Enterprises in a sixth country have phased out as well, with the exception of two enterprises that use continuous process equipment designed for CFC-11. In the two remaining countries, most enterprises are also actively involved in the phaseout process and are at various stages of project preparation and implementation.

199. The transfer of technologies for ODS replacement in the blowing of rigid foams has been comparatively limited in all the countries visited. The lag is due to the relatively recent maturing of substitute technologies for this end-use. Projects for phaseout are only now being developed in many of these countries. Most of these projects are based on cyclopentane or HCFC-141b technologies. Rapid phaseout in at least four of the countries is expected on the basis of these projects.

200. In four of the eight countries visited, no halon phaseout implementation has occurred to date. Two of these countries are producers of Halon 1211, and a third is in the process of developing a strategy for phasing out halons. In the other four, Halon 1211 is being substituted by dry powder, water, carbon dioxide and foams in many applications, excluding sensitive applications such as computer systems, telecommunications, and refineries. In at least two of the countries, all new fire control equipment uses substitutes. The phaseout of Halon 1301 presently has not progressed much, although a few installations in some of the eight countries visited have adopted FM200 systems. Halon recycling centers have been installed in three of the countries visited, and two other countries are in the process of preparing a recycling plant project. A halon banking plan is being implemented in a sixth country.

201. In the domestic refrigerator sector, no substitute refrigerant projects have yet been completed in any of the countries visited. However, HFC-134a projects are at various stages of project preparation and implementation in all the countries. In three of the countries, enterprises are also evaluating hydrocarbons and/or HCFC/HFC blends as alternative refrigerants. Most enterprises expect to complete phaseout implementation by 1998, though servicing and/or retrofitting of residual stock is expected to continue as long as allowed. Refrigerator manufacturers have shifted to low-ODS foam blowing in only one country. Projects for shifting to either HCFC-141b or cyclopentane are underway in five other countries, and evaluation of alternatives is in progress in two countries.

202. Low-ODS technologies have been implemented in the commercial refrigeration and air conditioning sectors in all the countries that were visited. The eight countries have traditionally used HCFCs in these sectors to varying degrees. In addition, the Montreal Protocol has provided an

impetus to CFC-using enterprises to shift to HCFCs as new equipment is installed and old equipment replaced. As a result, new commercial air conditioning equipment in the eight countries is almost completely based on HCFCs or HCFC/HFC blends, with the exception of chillers. Installation of new equipment using HCFCs and HCFC/HFC blends for large commercial refrigeration units also is rapidly increasing in all eight countries.

203. The implementation of non-ODS technologies has been relatively fast in the MACs sector for the manufacture of new MACs. ODS phaseout projects are at various stages of implementation in all the countries that manufacture MACs. The fact that most manufacturers of MACs are either multinational or joint venture companies has played a key role in the adoption of HFC-134a technology. In contrast, no conversion of existing MACs to alternative technologies is taking place in the eight countries visited. This situation is a result of the high price of MACs retrofits.

204. Phaseout implementation in the solvents sector varies considerably across the eight countries visited. In two countries, substantial progress has already been made, largely because of the export orientation of the enterprises that used ODS as solvents. Another two countries expect to phase out a large fraction of ODS use in this sector, although little if any progress has occurred to date. In another country, most multinational companies (MNCs) have already phased out, but very little phaseout has occurred in local enterprises. In this country, the phaseout of ODS for export-oriented electronics cleaning is almost complete. By comparison, phaseout has been relatively limited in metal cleaning for domestic use. In other countries, the diversity of ODS uses in the solvents sector and the relatively low amounts of ODS used by individual enterprises have constrained phaseout implementation.

4.5 TRANSFER OF NON-ODS TECHNOLOGIES BETWEEN ARTICLE 5 COUNTRIES (TOR item 1-a-ii-4)

205. The Study Team reviewed the eight country visit reports for any evidence of technology transfer occurring between Article 5 countries. Technology transfer can refer to actual non-ODS technology currently in place on the shop floor of enterprises in Article 5 countries or to the transfer of skills and know-how.

206. At present, no actual transfer of non-ODS technologies between Article 5 countries has been observed in any of the eight countries visited. However, some transfer of skills and knowledge related to non-ODS technologies between Article 5 countries has been observed in certain sectors. Experts and consultants from some Article 5 countries are assisting governments, implementing agencies and enterprises in other Article 5 countries in technology selection for the foams and aerosol sectors.

207. It appears likely that, in the future, the transfer of non-ODS technologies between some Article 5 countries could occur. For example, one of the countries visited has developed non-ODS compressors for domestic refrigerators and can export the compressors to other Article 5 countries as they phase out ODS refrigerants in domestic refrigerators. In addition, a number of enterprises in Article 5 countries export ODS-using products (e.g., refrigerators and foam systems) to other Article 5 countries, and would be expected to export non-ODS using products after they adopt substitute technologies. Furthermore, the experience with technological adaptation in at least four of the countries visited has resulted in the development of locally adapted technology. This technology could be exported to other Article 5 countries with similar needs, particularly in the solvents and aerosol sectors.

4.6 CURRENT PLANS OF ARTICLE 5 COUNTRIES AS ARTICULATED IN COUNTRY PROGRAMMES (TOR item 1-b)

208. Section 4.6 addresses the current plans of Article 5 countries as articulated in the CPs submitted to date. To respond to this TOR item, the Study Team reviewed the 40 CPs approved by the Executive Committee to identify the phaseout schedules currently planned by Article 5 countries. In addition, planned investments in Article 5 countries were measured by collecting the estimated social costs and funds requested from the 40 CPS. Data on both phaseout schedules and planned investments were then aggregated and analyzed to better understand the current plans of Article 5 countries.

209. Each CP details the country's phaseout schedule for the four groups of ozone-depleting chemicals: CFCs, halons, carbon tetrachloride, and methyl chloroform. As currently written, the Montreal Protocol binds all Article 5 signatories to a 2010 phaseout schedule for the first three chemical groups and a 2015 date for methyl chloroform. Many countries with CPs in place, however, have adopted accelerated phaseout schedules for all four groups. Exhibit 4-3 presents the distribution of phaseout dates by chemical group for those countries with a CP.[27] The graphs indicate that, if countries adhere to the phaseout schedules articulated in their CPs, they will, roughly speaking, phase out during either of two timeframes: the first group will phase out between 1994 and 2001 and the second group between 2005 and 2010.

210. If the phaseout date for each country is weighted according to the ozone-depletion potential (ODP) of its consumption of a particular chemical group, a weighted average phaseout date for each chemical group can be calculated. Those weighted average dates for countries with CPs are as follows: 2007 for CFCs, 2008 for halons, 2009 for CCl_4, and 2001 for MCF. Although the weighted phaseout schedule for MCF represents a 14-year acceleration compared to the Protocol date, the accelerated dates for the other chemicals represent only small advances in the Protocol dates. Exhibit 4-4 shows the effect of considering CP-planned phaseout schedules in light of both ODS consumption in each country and variations in ODP across chemical groups. These data confirm that, despite the plans of many countries to accelerate the phaseout, most ODP-weighted consumption will not be phased out until late in the next decade under current CP plans.

211. The analysis presented above reflects only the 40 Article 5 countries with approved CPs. There are another 51 countries for which CPs have yet to be approved. Of the total ODP-weighted consumption of 235,623 MT per year, countries with CPs are thought to consume about 158,709 MT or 67 per cent of the total. If countries without CPs are assumed not to accelerate the phaseout and instead adhere to the Protocol schedule, the graph shown in Exhibit 4-4 can be adjusted to reflect all Article 5 countries. Exhibit 4-5, which depicts the schedules for all Article 5 countries, illustrates again that the majority of the phaseout is planned to occur between 2008 and 2010.[28]

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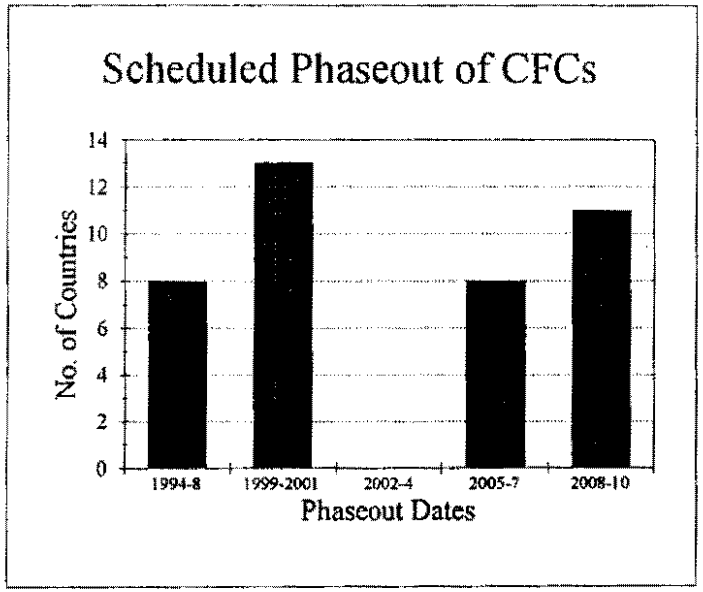
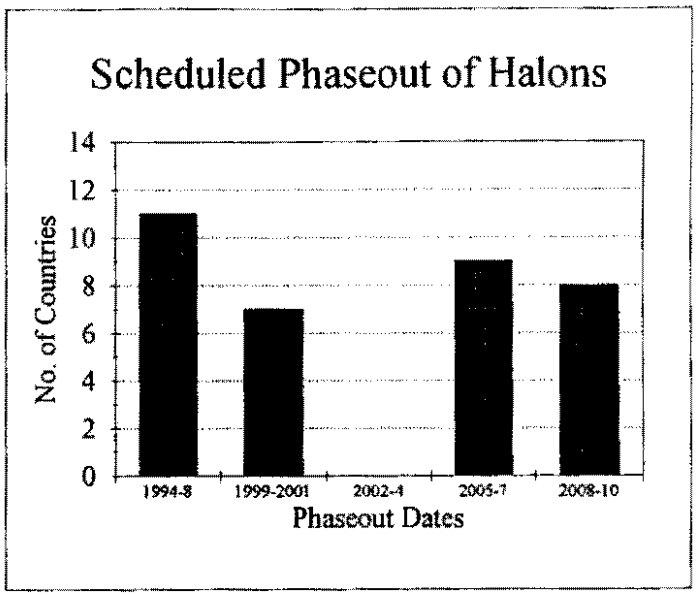
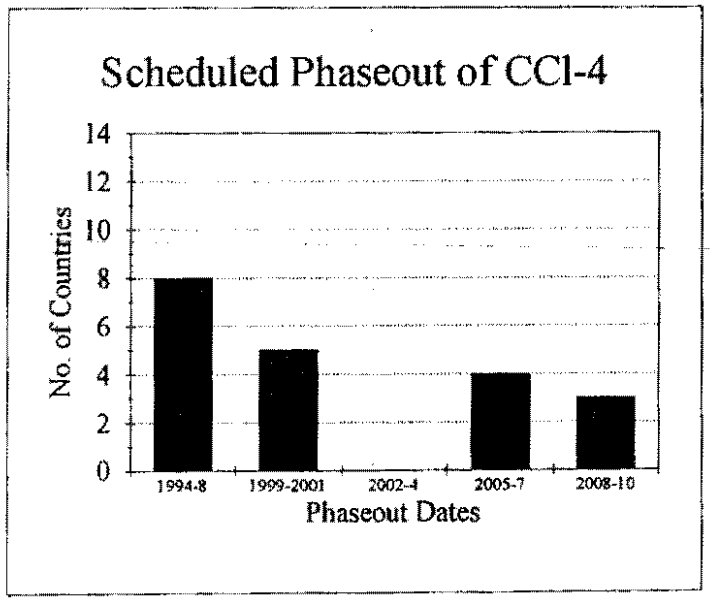
[27] The number of countries varies among the four graphs in Exhibit 4-3 because not all countries have set a phaseout date for each chemical group.

[28] It is important to note that CPs may not offer the definitive statement on the likelihood of acceleration of the phaseout schedule. Section 4.11 describes the responses of Article 5 countries to specific questions regarding the potential for acceleration.

Exhibit 4-3


Scheduled Phaseout of CFCs
No. of Countries
0
2
4
6
8
10
12
14
1994-8
1999-2001
2002-4
2005-7
2008-10
Phaseout Dates


Scheduled Phaseout of Halons
No. of Countries
0
2
4
6
8
10
12
14
1994-8
1999-2001
2002-4
2005-7
2008-10
Phaseout Dates


Scheduled Phaseout of CCl-4
No. of Countries
0
2
4
6
8
10
12
14
1994-8
1999-2001
2002-4
2005-7
2008-10
Phaseout Dates

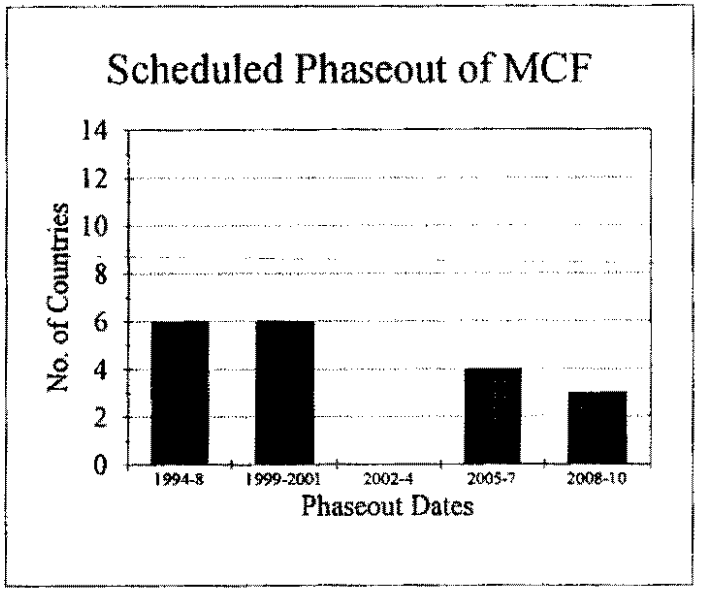

Scheduled Phaseout of MCF
No. of Countries
0
2
4
6
8
10
12
14
1994-8
1999-2001
2002-4
2005-7
2008-10
Phaseout Dates

Exhibit 4-4:
Planned Phaseout Schedule
for Article 5 Countries with CPs

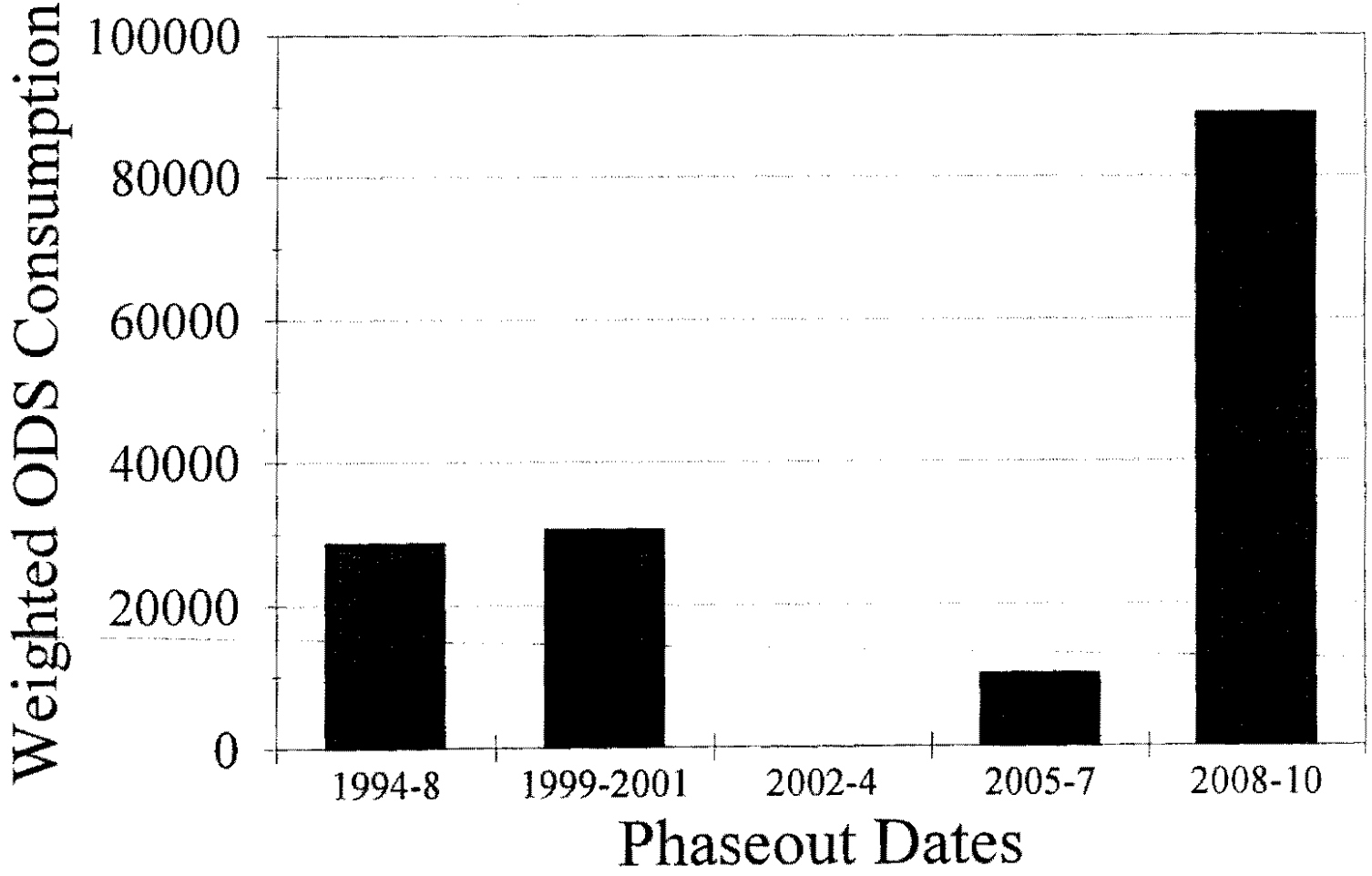
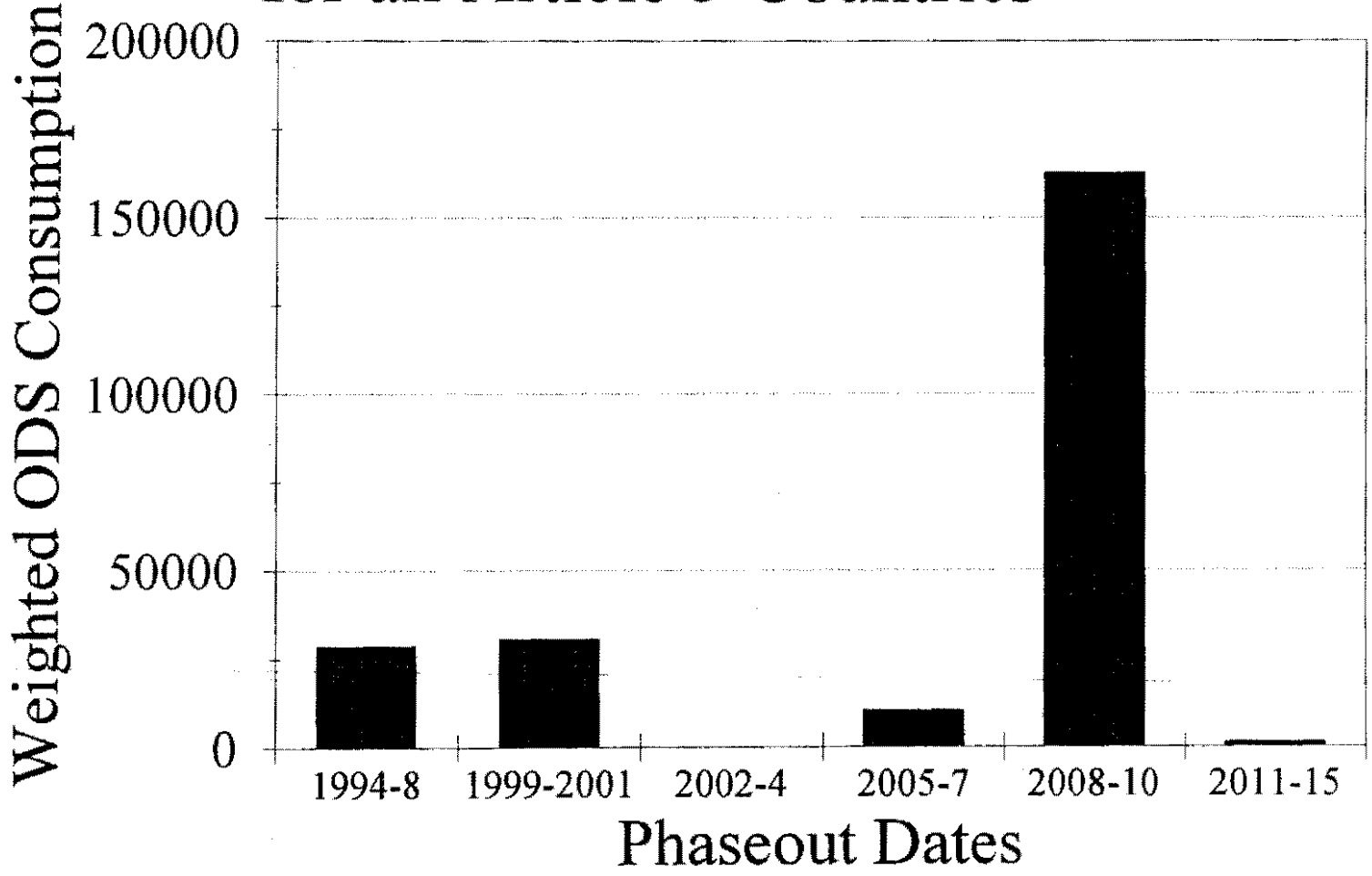


Exhibit 4-5:
Estimated Phaseout Schedule for all Article 5 Countries*



*Assumes that countries without CPs adhere to the Protocol-specified phaseout schedule.

212. Another perspective on the plans of Article 5 countries can be obtained by a review of the planned investments and spending associated with the phaseout. Such investment can be measured in terms of both the total incremental real resource cost to the country (i.e., the social cost) and the fraction of these social costs for which Multilateral Fund support will be sought. Most CPs include data on these social costs to the economy and the specific funding requests necessary to implement the country's action plan.

213. Based on these data, of the 32 CPs that provide social costs, the average social cost for all countries with CPs is estimated at US $208.6 million. In addition, of the 39 CPs that provide total amounts requested from the Fund, the average amount requested is US $97.85 million. Total social costs for all countries with CPs amounts to US $6.884 billion and total Funds requested to US $3.816 billion. To measure the cost-effectiveness of a CP, the social cost of the phaseout can be divided by the ODP-weighted consumption in a country. The resulting cost ratios vary widely from less than US $25 to greater than US $500 per kg of weighted consumption. The overall average ratio of social cost to ODP-weighted consumption is US$43.40 per kg of ODP-weighted consumption.

214. Given the extreme variations in these data, it is difficult to know how heavily to rely upon them when drawing inferences about global phaseout. First, there seems to be substantial variation across CPs in the method of calculation--both computationally and conceptually. Second, many CPs do not include an estimate of the full set of activities and investments for which Fund support will be sought. Third, differences across countries in the types of ODS use (e.g., aerosols versus halons) and in the overall quantity of ODS used have an effect on the estimated costs.

4.7 OPERATION OF THE FUND AND UPDATE OF UNEP DOCUMENT 10/40 ANNEX I (TOR item 1-c)

215. The TOR require the Study Team to take into account UNEP document 10/40, Annex I (Report on the Operation of the Financial Mechanism Since 1 January 1991) and to update pertinent information in the document. This document describes the Fund's mode of operation and the challenges it faced at the time it was prepared on 1 July 1993. The document consists of the following sections: the structure of the Multilateral Fund; the process for accessing funds; progress in Fund operations; and issues encountered, resolved, and outstanding. In addition, the document includes three appendices: the Report from the Treasurer on 1992 accounts; a description of the IAs; and a list of contributions and Fund disbursements (as of 24 June 1993).

216. At the May 23-24 meeting of the Sub-committee for the Report, the Study Team was instructed not to evaluate the operation of the Fund in its study. For this reason, the Study Team has not updated the sections of the UNEP document concerning the structure of the Fund nor Appendices I and III (Report from the Treasurer and Contributions and Fund Disbursements). Updated information on the funding process is incorporated in Chapter 5 of this report and progress to date is addressed in Section 4.1. Issues encountered, resolved and outstanding are addressed in both Chapters 4 and 5 of the report. Finally, Attachment 2 of this report includes updated descriptions of the project cycle for the four IAs (UNEP, UNIDO, UNDP, and the World Bank) to reflect changes in their operating procedures that have been instituted since UNEP document 10/40 Annex I was prepared.

4.8 PROGRESS MADE AND PROBLEMS ENCOUNTERED BY ARTICLE 5 COUNTRIES IN IMPLEMENTING COUNTRY PROGRAMMES (TOR item 1-d)

217. Issues concerning progress made and problems encountered by Article 5 countries in implementing their CPs are central to the study because of their impact on various phaseout schedules being considered. As such, this issue is directly addressed in a qualitative sense in Chapter 5 and in a quantitative manner in Chapter 6. For this reason, Section 4.8 is limited to a descriptive presentation of some specific pertinent data collected by the Study Team.

218. To respond to this TOR item, the Study Team took a two-pronged approach. First, the Study Team looked at qualitative data obtained from the eight country visits and the responses to the fax questionnaires to identify the factors impeding and those facilitating the phaseout. Second, to provide a quantitative measure of progress made by Article 5 countries in implementing their CPs, the Study Team examined data from those countries that were visited or responded to the fax questionnaires. From this group, the Team then selected those which have had a CP in place for over a year to mpare their estimated unconstrained ODS consumption with the latest ODS consumption figures reported to UNEP. (The Team assumed that problems and progress associated with a CP less than one year old would not be indicative of results over the long run.) Differences between reported and estimated consumption would provide one measure of any progress made in implementing CPs.

219. Several general themes emerged from the qualitative review of data obtained from 20 Article 5 countries. The factors cited by a number of countries as impediments to phaseout include:

a. Lack of awareness about the phaseout by enterprises in the country
b. Lack of information about alternative technologies
c. Lack of an OPU or recent establishment of OPU
d. Lack of funding/lack of capital for conversion to alternative technologies
e. Non-availability of alternative technologies
f. Complicated procedures for receiving Multilateral Fund assistance, particularly regarding funds disbursement

220. Factors facilitating the phaseout that were cited by more than one country include:[29]

a. Availability of cheaper substitutes (aerosols, flexible foams)
b. Foreign ownership of local ODS users or presence of MNCs
c. Multilateral Fund support
d. Awareness programs (both general and targeted)
e. High or rising ODS prices
f. Approval of investment projects

221. Of the twelve countries with a CP in place for at least one year, only seven reported complete ODS consumption data to UNEP in 1991 or 1992. These data were compared to CP estimates of

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[29] It should be noted that, in some cases, it was unclear whether the countries responding to the fax questionnaire were citing the factors they believe would facilitate the phaseout or those factors that are actually facilitating the phaseout in their countries. Nonetheless, the factors listed were specifically suggested by the Article 5 countries.

unconstrained demand for the same year.[30] Actual ODS consumption was lower than the unconstrained figures by an average of three per cent in four cases, but was on average 14 per cent higher in the other three countries. For all seven countries, total actual demand exceeded unconstrained demand by eight per cent. Although such data are clearly limited and may reflect differences in methods used to calculate consumption, they do suggest that the phaseout may not be progressing as rapidly as had been expected.

222. On an additional issue referenced by this TOR item, the Study Team employed data developed as model inputs to assess current per capita consumption and its likely future growth. As explained in Section 3.3 of the report, the Study Team developed an estimate of total weighted unconstrained ODS consumption in all Article 5 countries in 1993 from several data sources. Dividing this figure, 233,215 MT, into the Article 5 population of 4.066 billion yields a per capita consumption figure of approximately 0.06 kg per capita for all Article 5 countries.

223. In order to estimate the likely future growth of ODS consumption, the team employed other data gathered from the CPs as model inputs. The likely growth rates given for different ODS sectors in different Article 5 countries in their CPs were weighted and averaged across all countries and sectors to yield an annual average weighted growth rate for ODS consumption of approximately nine per cent. Therefore, in the absence of the phaseout program, the unconstrained ODS consumption in Article 5 countries might have grown to 993,643 MT in 2010.

4.9 LEGISLATION ENACTED IN ARTICLE 5 COUNTRIES (TOR item 1-e)

224. To evaluate the extent and impact of legislation enacted in Article 5 countries, the Study Team examined a number of data sources, including: the eight country visit reports; responses to question 9 of the fax questionnaires[31]; and relevant sections of 35 country programmes. These data sources account for 42 of the Article 5 countries. Information was collected regarding the types of legislation employed (e.g., import controls, use controls) in these countries. In addition, the Study Team deemed it useful to compare CPs to actual progress to determine if countries had enacted any legislative measures considered in their CPs. As such, for eleven countries which have had CPs in place for more than one year and for which a country visit report or fax questionnaire response existed, proposed legislative/regulatory policies described in the CP were compared against measures actually implemented by the country.

225. In considering the data, it should be remembered that interpretations of the terms "legislation" and "regulation" vary. In many countries, legislative action describes the lawmaking process conducted by elected representative bodies; regulatory action describes the implementation of legislative decisions, typically by administrative agencies through a rulemaking process. Since this is not the case in all Article 5 countries, the available data may not capture fully the level of "governmental activity" in facilitating the phaseout, if such activity did not require formal legislative or regulatory authority.

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30 Unconstrained demand is the consumption of ODS that would occur in the absence of the restrictions imposed by the Montreal Protocol and the London Amendments.

31 Question 9 reads as follows: "What domestic legislation/regulations have been enacted in response to the ODS phaseout? What effect have they had across ODS-consuming sectors? How well are regulations enforced?"

226. This situation is illustrated in cases where a country indicates in its CP its intention to rely "on existing legal structures" or "upon voluntary measures" while simultaneously noting that it will adopt import quotas. No legislative or regulatory action is required *per se*, but the government is acting in a formal capacity to facilitate the phaseout. Thus, data which suggest a country has not taken legislative or regulatory action or that it does not intend to do so, may not reflect the degree to which government authority and power have been exercised in support of the phaseout.

227. Several Article 5 countries acted early, beginning in 1989, to control aerosols, either through use bans, import controls, or manufacturing controls. Six of the 42 countries have aerosol controls in place. The data provide an insufficient basis on which to explain definitively why countries acted early to address aerosols, but several explanations are possible (in addition to the existence of the Montreal Protocol): the availability of cheaper substitutes; the presence of multinational ownership, creating early awareness and capacity to act; the export orientation of the country or the sector, requiring conversion in order to maintain markets; and greater acceptability of aerosol controls because industrialized countries proved that viable, cost-effective alternatives exist for aerosols.

228. Although a majority of Article 5 governments either have taken formal action to facilitate the phaseout or contemplate doing so in their CPs, actual legislative activity remains so far the exception rather than the rule. In countries where measures are actually in place, most of these measures address imports. Five countries are implementing or have implemented import controls. Imports are typically restricted through the use of quotas and administered under a permit system. Permit schemes are also facilitating data collection as required under the Protocol and supported by UNEP. A few countries have taken direct action, such as production and use controls and executive decrees that require implementation. Two countries have instituted production controls and another two countries have Executive Decrees in place.

229. Despite the scarcity of measures enacted so far, the overwhelming majority of countries have CPs which contemplate some legislative action. Only two countries explicitly have rejected or refused to contemplate legislative or regulatory responses, expressing intent to rely on a voluntary approach as a matter of policy. The paucity of legislative measures enacted to date may reflect the infancy of the issue, rather than express intent by Article 5 countries to reject a legislative/regulatory approach. In fact, many of the eleven countries that have had a CP in place for at least one year and that have stated their intent to enact legislative measures have now done so.

230. Given that many of the countries which have taken measures have had CPs in place for more than one year, the lack of legislative activity in other countries may be due to other factors, such as: incomplete information on which to evaluate and select options; insufficient institutional capacity for formulating legislative or regulatory responses; insufficient time in which to implement legislative measures; and interest in avoiding a formal legal regime until the effectiveness of information/awareness campaigns and voluntary agreements can be assessed.

231. The data suggest that, in general, laws and regulations follow rather than lead ODS phaseout in Article 5 countries. Presumably, if legal and regulatory actions were driving the phaseout, rather than merely facilitating it, many more legislative and regulatory responses would be in place. In the case of ODS phaseout in Article 5 countries, only a few types of controls have been enacted and those by only a handful of countries, despite the fact that 51 Article 5 countries have signed the Montreal Protocol and 40 have CPs showing how they intend to phase out ODS. This finding suggests that, at this time, economic and political factors in general are affecting the ODS phaseout in Article 5 countries more than laws or regulations.

4.10 MARKET DYNAMICS IMPACTING THE PHASEOUT (TOR item 1-f)

232. The Study Team reviewed the country visit reports and responses to fax questionnaires for data to identify the market dynamics impacting the phaseout in Article 5 countries. Seven major characteristics of the market dynamics in Article 5 countries have a significant influence on the phaseout. These are:

a. Prices: Market data on CFC-11 and CFC-12 prices reveal diverse trends in the countries that were visited and in those that responded to the fax questionnaires. The data indicate that prices were steady (in real terms) over the past year in countries with local CFC production. Changes in the import prices of inputs had corresponding impacts on prices: in one producer country, prices increased because of higher prices for imported carbon tetrachloride and devaluation of local currency. In the non-producer countries, regional trends in CFC prices are observed: prices increased in Africa and Latin America (with the increase being more significant in local currency than in dollars), and remained steady in Asia. Prices of halons, TCA, and some CFCs (particularly CFC-115 and to a lesser extent CFC-113) exhibit rapidly rising trends worldwide. Generally, there has been greater pressure to phase out ODS where prices are undergoing rapid increases.

b. Export Orientation: In countries or sectors with a preponderance of export-oriented enterprises, the phaseout has been accelerated. In three countries where export-oriented enterprises account for a significant fraction of the ODS usage in certain sectors, significant phaseout has already occurred because of the requirements in the importing countries. The necessity for rapid phaseout in these cases has discouraged many enterprises from accessing the Fund for phaseout costs. One of the countries visited has only recently prepared its CP, but significant phaseout has already occurred because of the export orientation of its aerosols and foams sectors.

c. Ownership of ODS-Using Enterprises: MNCs have been phasing out worldwide, including all the Article 5 countries visited. In one country, most MNCs have phased out ODS use in the solvents sector, but phaseout by local enterprises has been very limited. On the other hand, phaseout in some joint ventures with foreign partners has been impeded because the foreign principals and the local enterprise are reluctant to invest the component of phaseout costs deducted by the Fund on account of foreign ownership. In one country with state ownership of industry, all enterprises move together in response to centralized decisions regarding phaseout; phaseout progress is therefore uniform across a user sector.

d. Size and Formality of Enterprises, and Concentration Within Sectors: In five of the eight countries visited, the presence of a significant informal sector has impeded phaseout. In one country, the majority of ODS use has been phased out in the aerosol sector, but little progress has been made in implementing the phaseout of the remaining (comparatively small) use in the informal sector. At the other end of the size spectrum, large enterprises in the foams sector in all the countries have tended to phase out ODS use more rapidly than medium or small enterprises. They exhibit greater capability to select substitute technologies and negotiate with non-ODS technology vendors.

e. Size of Existing Capital Stock Requiring Ongoing ODS Use: A substantial fraction of total CFC usage goes towards recharge in the countries visited. All these countries are experiencing fairly rapid growth of products that use ODS (particularly domestic refrigerators), so the recharge requirement is large in all eight countries. To date, only one of the eight countries visited has a recycling facility. ODS requirements are expected to continue over the useful life of installed equipment. These requirements imply that ODS consumption will continue for an extended period of time. As an alternative, existing capital stock would have to be retrofitted in order to use non-ODS alternatives.

In sectors such as solvents and tobacco fluffing, the high investment in ODS-based capital plant and equipment also appears to constrain phaseout due to the high unit cost of abatement for some projects in these two sectors. For projects to eliminate methyl chloroform use, the low ODP of methyl chloroform increases the unit abatement cost and reduces the cost-effectiveness of the phaseout.

f. Local Production of ODS: Five of the six Article 5 countries that produce ODS were either visited or their response to a questionnaire was sought. One of these countries has entered into voluntary agreements with the producer enterprises to completely phase out ODS production for domestic consumption by 2000. Enterprises in all the other countries plan to produce ODS for domestic consumption and for export according to Protocol limitations. This has kept ODS prices generally steady in these countries.

The local availability of ODS and the accompanying low prices have tended to reduce the perceived signals for accelerated phaseout. In addition, ODS producers in the Article 5 countries are now exporting to other (non-producer) Article 5 countries as well. This has, to some extent, compensated for the decrease in supply (and the increase in prices) of ODS from non-Article 5 countries.

f) Flow of Information about Non-ODS Technologies: The IAs are a primary source of information about non-ODS technologies in many of the countries visited. Seminars and workshops by the IAs have been the first fora at which many ODS-using enterprises have learned about alternative technologies. However, many enterprises feel that the information provided at these seminars is non-specific, encouraging but not leading directly to phaseout. In at least one of the countries visited, the OPU has developed sectoral strategies and workplans in conjunction with enterprises and international consultants, with IA support. This approach has accelerated phaseout activities within sectors.

Most large and medium sized enterprises have obtained specific information from vendors of alternative chemicals and technologies. Most of these enterprises have existing links (through ownership, equity or license agreements) with non-Article 5 country technology vendors, and often prefer to adopt the technology adopted/developed by their foreign contacts. Large enterprises in all the countries visited have also carried out their own evaluation of substitute technologies. However, the lack of information on evaluation of alternative technologies, particularly to small and informal enterprises, has impeded phaseout in at least four of the countries visited.

In all the countries visited, information often did not penetrate to small ODS consumers who have only indirect linkages to the large chemical and technology suppliers at the national or international level. These small consumers have generally not received prior information about alternative technologies.

In one country with state ownership of industry, sectoral ministries coordinate information dissemination to enterprises. Technical personnel based in research institutes are the main conduits for information about alternative technologies to enterprises within the country. The research institutes undertake evaluation and demonstration programmes before proceeding with information dissemination to enterprises. As yet, no demonstration programmes have been completed, but it is expected that phaseout implementation in each enterprise would be rapid once a model has been developed for each end-use.

4.11 FEEDBACK FROM ARTICLE 5 COUNTRIES ON PHASEOUT SCHEDULES

233. Feedback from Article 5 countries on the feasibility of various phaseout dates was compiled from the 8 country visit reports and responses to the fax questionnaires received from 13 countries. Specifically, in both country visits and fax questionnaires, countries were asked whether they expected to have difficulty meeting the following phaseout schedules for Article 5 countries:

- phaseout by 2010
- phaseout by 2006, with a servicing tail[32]
- phaseout by 2006
- phaseout by 1996

234. Exhibit 4-6 summarizes the responses received from the 21 countries regarding the feasibility of the various phaseout schedules. All responding countries indicated that accelerating the phaseout date to 1996 for Article 5 countries would be infeasible. Some countries have a 1996 phaseout schedule for particular chemicals (e.g., CFC-113 or halons 1211 and 1301), but no country indicated it would be able to accelerate the phaseout in its country to 1996 across all ODS use sectors. One country has committed to accelerated phaseout schedules ranging from 1996 to 2010 for different sectors and end-uses. This country thought a 1996 phaseout across all sectors would be too abrupt because it would not allow time to reach small users and because of the large amount of domestic refrigerators that could not easily be replaced.

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[32] Servicing tail refers to an allowance for continued ODS production after the phaseout date to meet the service needs of existing equipment. The purpose of a service tail is to eliminate the need for expensive retrofitting and early retirement. For example, a 2000 phaseout with service tail would prohibit ODS use in equipment manufactured on or after the year 2000, but would allow continued ODS production after 2000 so long as it is used to service equipment.

Exhibit 4-6
Summary of Feedback From Article 5 Countries on Phaseout Schedules

Phaseout Schedule	Feasible	Not Feasible	Unknown[33]
2010	21	0	0
2006 with servicing tail	16	2	3
2006	9	11	1
1996	0201		

235. Approximately half of responding countries thought that phaseout by 2006 would be feasible and 89 per cent indicated that they considered phaseout by 2006 with a servicing tail feasible. Since many countries thought phaseout by 2006 would not be feasible, it seems reasonable to infer that many countries would also find phaseout by 2000 infeasible, and some countries did in fact state that they could not meet such an accelerated phaseout schedule. It should be noted that there are 91 Article 5 countries[34] and that the countries included in Exhibit 4-6 represent about 62 per cent of total ODS consumption.

236. Most countries seemed to be in favor of the servicing tail concept. A few countries did point out some practical difficulties they foresaw in implementing the concept. Specifically, one country noted that logistical difficulties may arise for the informal sector, which consists of small and dispersed users. Two countries felt that there could be difficulties enforcing the prohibition on use of ODS in equipment manufactured after 2006 if ODS continues to be available for servicing existing equipment. Administration and monitoring of ODS usage to ensure that it is not diverted to new equipment will be required, particularly in the informal sector. Another country stated that ensuring the availability of adequate quantities of ODS at reasonable prices would be key for the success of the service tail concept.

237. In many Article 5 countries, concerns over accelerated phaseout schedules centered around the issue of the impact of such an accelerated phaseout on the refrigeration and air conditioning sectors. Many countries have a large stock of installed equipment, both commercial and domestic, and a significant amount of CFC consumption goes towards servicing of this existing capital stock. For this reason, the servicing tail concept drew favorable comments from many of the 21 Article 5 countries that were questioned. One country observed that equipment and appliances in Article 5 countries tend to be used over long periods of time, so the cut-off dates for the service tail would need to be carefully defined to cover such long lifetimes.

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33 Unknown: no answer was given and/or it is unclear from the answer provided whether the phaseout schedule is feasible.

34 Of these countries, 31 are temporarily categorized as operating under Article 5 paragraph I of the Montreal Protocol.

238. It should be noted that the two countries that did not think phaseout by 2006 with a servicing tail was feasible did not commit to any accelerated schedule. In addition, some countries expressed interest in a phaseout by 2010 with a servicing tail. The countries that favored such a schedule have committed to the 2010 phaseout for Article 5 countries as described in the London Amendments. Finally, several countries stated that even their current phaseout schedules (whether accelerated or not) were contingent upon timely receipt of funds and technology.

4.12 CONCLUSION

239. This section presents the principal conclusions of this chapter. To date, few investment projects approved by the Executive Committee have been completed. In addition, the greatest number of projects not yet completed that were approved prior to the tenth meeting of the Executive Committee are investment projects. These findings indicate that investment projects have significantly lagged other types of projects in terms of completion rate. Other types of projects (such as training projects) have a higher rate of completion.

240. Based on the countries studied, some shortages of ODS were observed but there were differences across countries, as well as by chemical. For those countries studied that have experienced significant ODS supply limitations, some phaseout activity appears to have occurred as a direct result.

241. Implementation of low- and non-ODS technologies in Article 5 countries varies considerably across ODS-use sectors and across countries. In general, phaseout implementation has progressed farthest in the aerosols and flexible foams sectors, but is just getting underway in domestic refrigeration and, to a lesser extent, rigid foams. In the halons and solvents sectors, phaseout implementation is highly dependent on the situation faced by individual countries, such as whether halon is produced in-country and the export orientation of the solvents sector. Finally, for the MACs sector, although implementation has been rapid in the manufacture of non-ODS-consuming MACs, no retrofits of existing MACs have been observed.

242. Although no actual transfer of non-ODS technologies between Article 5 countries has been observed in the countries visited, transfer of skills and knowledge related to non-ODS technologies has occurred in some sectors. As Article 5 countries progress further in their phaseout efforts, it is likely that actual transfer of non-ODS technologies could begin to occur.

243. Despite the plans of many Article 5 countries (as articulated in their CPs) to accelerate the phaseout, the data from approved CPs indicate that most ODS-weighted consumption will not be phased out until late in the next decade under current CP plans.

244. For several countries for which complete data on ODS consumption were available for the years 1991 and 1992, total actual consumption exceeded unconstrained demand projections provided in their CPs. Some countries did, however, show some reductions.

245. Factors cited by a number of countries as impediments to phaseout generally concerned lack of resource flows (e.g., information, alternative technologies, funding, OPU) as well as the complicated procedures for receiving Multilateral Fund assistance. Factors facilitating phaseout included various parameters of market dynamics (e.g., foreign ownership, ODS prices, availability of cheaper substitutes) as well as the impact of Multilateral Fund-supported activities.

246. Although a majority of Article 5 governments either have taken formal action to facilitate the phaseout or contemplate doing so in their CPs, actual legislative activity so far remains the exception rather than the rule. This situation may reflect the infancy of the issue, because the longer a country had a CP in place the more likely it was to have enacted legislative measures.

247. The following characteristics of the market dynamics in Article 5 countries seem to have a significant influence on the phaseout: ODS prices; export orientation of ODS-using sectors; foreign ownership of ODS-using enterprises; size and formality of enterprises and their concentration within sectors; size of existing capital stock requiring recharge; whether there is local ODS production; and the flow of information about non-ODS technologies.

248. Feedback received from a number of Article 5 countries indicates that a phaseout date of 1996 would be infeasible. Similar feedback was received regarding a 2000 phaseout. Some countries thought phaseout by 2006 would be feasible, and most thought phaseout by 2006 with a servicing tail would be feasible.

CHAPTER 5

POLICY AND INSTITUTIONAL FACTORS THAT AFFECT ALTERNATIVE ODS PHASEOUT SCHEDULES

5.1 INTRODUCTION

5.1.1 Overview

249. The challenge of ODS phaseout is not the same in all Article 5 countries. A wide variety of policy and institutional factors determine when and in which industrial sectors each country will be able to end its use of ODS. In any given country, these factors may include market dynamics, the presence and operation of the Montreal Protocol Multilateral Fund, domestic government policy actions, the current state of economic, technological, and institutional development, and a range of additional issues.

250. Examining the particular determinants and thus the feasibility of ODS phaseout in each Article 5 country is not within the scope of this study. This chapter, therefore, presents a full range of policy and institutional factors that encourage or inhibit the rate of technology transfer among the countries visited and surveyed by the Study Team. Following presentation of these factors, the chapter briefly revisits the implications for the ODS phaseout of the diversity among Article 5 countries. The chapter then draws summary conclusions about the overall feasibility of the phaseout scenarios described in Chapter 2 based on these policy and institutional issues.

251. The results presented in this chapter reflect application of the analytic framework described in Section 3.2 to the data collected during this study, as are summarized in Chapter 4. The analytic framework provides a means for identifying critical factors that affect the rate of technology transfer by considering the various stages of technology transfer and the key actors who have the potential to affect success at each of those stages. Exhibit 5-1 summarizes these stages and the key actors considered in this analysis.

252. To the degree possible, these conclusions are incorporated in the quantitative simulation of costs, technology transfer, and atmospheric impact presented in Chapter 6. Many of the qualitative issues discussed in this chapter are, however, impossible to reflect in that quantitative analysis. Accordingly, these issues must be considered along with the quantitative results when evaluating the various ODS phaseout scenarios.

5.1.2 Introduction to Primary and Secondary Impacts on the ODS Phaseout

253. Some of the policy and institutional factors identified, such as market dynamics and the industrial structure within individual Article 5 countries, directly and unambiguously affect the feasibility of various phaseout scenarios in the countries where they are operative. Each of these primary factors has a potential impact of several years on the final phaseout date. Section 5.2 summarizes these primary factors.

Exhibit 5-3
Summary of Stages of Technology Transfer and Key Actors Involved

Summary Stages of Technology Transfer

- ODS consuming enterprises decide to switch to new technologies
- Low or non-ODS technologies are evaluated and specific options are selected
- A project is designed and financing is obtained
- The new technology is acquired, installed, and used

Key Actors Involved

- The ODS-consuming enterprises in Article 5 countries
- Vendors of non-ODS and low-ODS technologies
- Donor country governments
- Article 5 country governments, including Ozone Protection Units (OPUs)
- The Executive Committee of the Multilateral Fund
- The Secretariat of the Montreal Protocol Multilateral Fund
- The implementing agencies, including bilateral aid agencies
- Local financial intermediaries and financial agents in Article 5 countries
- Non-government organizations

254. Other policy and institutional factors in any given country, such as the Multilateral Fund project review process and the capacity of enterprises to manage technological change, may affect the rate of any particular technology transfer project by several months or one to two years. While having this impact on individual projects, these secondary factors do not necessarily or directly affect the overall ODS phaseout schedule. However, under certain circumstances they may indirectly do so in at least two ways. First, several of these secondary factors may combine to slow work in one country or industry and therefore confuse and discourage local actors, thereby disrupting the entire phaseout process. Second, individual or groups of enterprises who believe that these factors increase the uncertainty or risk surrounding phaseout projects may delay their projects until a future time when the uncertainty or risk subsides, thereby also delaying the phaseout. Alternatively, some of these factors may speed the phaseout in comparison to what would have occurred without their influence. The Study Team witnessed all these circumstances during the data collection effort. In these ways, these secondary factors, which Section 5.3 summarizes, may have a significant impact on the feasibility of alternative phaseout schedules similar to the primary factors.

255. The analysis throughout this chapter highlights the fact that technology transfer and ODS phaseout projects may occur with or without the assistance of the Multilateral Fund. This chapter presents a wide range of significant policy and institutional factors that either encourage or impede technology transfer, some of which are determined by the Multilateral Fund and others of which are entirely independent. Section 5.4 summarizes how all these factors play out differently in some Article 5 countries and similarly in others. Section 5.5 then offers final policy and institutional conclusions for the global phaseout.

5.2 PRIMARY FACTORS DIRECTLY AFFECTING THE PHASEOUT SCHEDULES

256. The Study Team identified four primary factors that directly affect the feasibility of alternative phaseout schedules. These factors are market dynamics, the Montreal Protocol and the Multilateral Fund, actions by Article 5 country governments, and the time necessary for societal transition. This section elaborates each of these four primary factors.

5.2.1 Market Dynamics

257. The first primary factor affecting the phaseout relates to the markets for ODS technologies and the associated alternatives. Various market forces drive enterprises to stop using ODS. These include, for example, international and domestic trade pressures and the prices of alternative technologies. The nature and direction of these forces play an important role in the feasibility of alterative phaseout schedules. Foremost, factors which impede the market for non and low-ODS technologies inhibit the ODS phaseout, and factors which facilitate that market help accelerate the phaseout. This section reflects the data on these market dynamics that is presented in Section 4.9.

5.2.1.1 Industry Structure in the Article 5 Countries

258. The foremost determinant of the rate of ODS phaseout in any country, beyond the Montreal Protocol itself, is the nature and structure of local industry in each ODS consuming sector. ODS phaseout actions are fundamentally affected by the export orientation, ownership structure, and size and formality of ODS consuming enterprises, and by the size of the existing capital stock requiring constant ODS use. These four factors and considerations about how governments or the Multilateral Fund may influence them, if possible, are discussed below.

Export Orientation of ODS Consuming Industries and Enterprises

259. Enterprises and industries that sell products on the international market are generally much more active in phasing out ODS than industries which concentrate on domestic markets in Article 5 countries. This is especially true in sectors that export to developed countries which have additional or more accelerated phaseout requirements. The trade provisions of the Montreal Protocol also encourage ODS phaseout by export-oriented enterprises in many circumstances. In addition to these direct pressures fostered by the export markets, industries claiming significant exports also demonstrate access to more information about new technologies than sectors with no international linkages.

Ownership Structure of ODS Consuming Enterprises

260. Full or partial ownership of an enterprise by a government or multinational corporation plays a strong role in driving and facilitating that enterprise's ODS phaseout plans. Multinational enterprises often accelerate their phaseout plans, for example, in order to maintain world-wide technological consistency in their products. They may also do so to promote their public images as vendors of environmentally conscious and protective products. The export orientation of many of these enterprises contributes to the pressure to eliminate ODS use as well. Multinational access to information, technologies, and skilled support often helps smoothen these technology transfer efforts.

261. With relation to multinational companies and international partnerships, however, the phaseout is sometimes delayed partially as a result of Multilateral Fund rules. These rules reduce funding for enterprises that are foreign owned. Some Article 5 country enterprises have reportedly postponed the ODS phaseout because they cannot obtain full incremental cost funding from either the Multilateral Fund or their foreign partners. Regardless of whether this is consistent with broader Multilateral Fund objectives, it does affect the feasibility of some phaseout efforts.[35]

262. Government control of enterprises may also affect the ODS phaseout. In at least three cases, for example, government control of certain enterprises has helped accelerate the transition to non-ODS technologies. In one example, the government enterprise is so dominant within a particular sector that its ODS phaseout actions are expected to prompt private sector enterprises in the sector to act as well. The government actions will demonstrate new equipment and facilitate the flow of information about alternatives. In another country, the government agency responsible for ozone issues maintains enough authority to direct some enterprises or industries to stop using ODS. Finally, in countries with a state-run economy, government policy makers rather than enterprise managers may make the key phaseout decisions.

Size and Formality of Enterprises

263. Based on data collected for this study, the phaseout is proceeding much more slowly in the smaller and more informal portions of various industrial sectors. Many small and informal enterprises are diffuse, lacking in technical sophistication , and not linked to formal financial institutions, large technology suppliers, or the government. As a result, these enterprises tend to be less informed about the phaseout to begin with, less likely to initiate phaseout activities on their own, more difficult for technology suppliers, OPUs, and implementing agencies to identify, more difficult to provide information to, and more difficult to organize for Multilateral Fund projects. Furthermore, the available alternative technologies in some sectors, such as aerosols, are sometimes too large in scale for very small enterprises in some countries to use cost-effectively.[36] Various parts of this chapter reference these important difficulties regarding small and informal enterprises.

Size of Existing Capital Stock Requiring Constant ODS Use

264. A substantial fraction of equipment in many sectors requires constant ODS use. One obvious example is refrigeration equipment that carries an ODS charge for several years. Use of many of these types of equipment, such as domestic refrigerators, is growing in many Article 5 countries, including those visited by the Study Team.[37] Furthermore, as the existing phaseout schedule in many countries requires that much of this equipment be either replaced or serviced with ODS that are provided through local reclamation and recycling facilities or through an ODS servicing tail, an accelerated schedule would further compel these actions. Since widespread and comprehensive

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35 Section 5.3.2 discusses Multilateral Fund rules in more detail.

36 The non-ODS technologies may require too many or complicated resources or facilities to operate, and in some circumstances they can function only on a large scale with high output that is too much for small or informal enterprises to handle.

37 There are press reports in at least one Article 5 country suggesting that the local government is developing policies to increase the flow of ODS-consuming equipment into their country in order to sustain the market for local ODS producers and to achieve a higher baseline relative to later anticipated cutbacks.

equipment retrofits are generally thought not to be feasible by some representatives of the Multilateral Fund and by managers of several enterprises in Article 5 countries, extensive recovery and recycling projects or a servicing tail to provide ODS supplies for existing equipment seem to be important for any accelerated phaseout schedule.[38]

5.2.1.2 Production, Supply, and Cost of ODS Technologies and Alternatives

265. The direct costs of ODS versus non-ODS technologies play a significant role in helping drive the phaseout in some countries.[39] According to generally accepted economic principles, enterprises will eventually phase out if ODS costs are higher than alternatives, and they will phase out sooner if the difference in costs becomes larger. Furthermore, ODS cost is partially a function of supply, such that a supply reduction would drive up prices, thus supporting the phaseout. Additionally, these same cost or price incentives will help encourage research, development, and production of new alternatives. High ODS prices, potentially but not necessarily linked to ODS supply, should therefore be considered as one factor that can contribute to the phaseout. An important consequence of high ODS prices, of course, is that they shift a larger portion of the phaseout burden to the local consumers.

266. All but one of the ODS producing Article 5 countries visited by the Study Team plan to continue producing ODS at current or accelerated rates under the provisions of the Montreal Protocol. This continued production will most likely dampen upward pressure on ODS prices and potentially undermine the power of market forces to promote the complete phaseout in these countries and in their ODS export markets. On the other hand, international demand for ODS by other non-producing Article 5 countries may drive up prices and stimulate some phaseout actions.

267. These price and supply issues warrant special attention during the consideration of the final years of the phaseout and during consideration of ODS production for a servicing tail. These issues relate to the typical economies of scale seen at ODS production facilities. First, current large CFC producers may be reluctant to produce at low levels unless production subsidies were offered. Second, if these producers generate large enough supplies to make their operations cost-effective without subsidies, they will probably need to produce surplus ODS that could not be absorbed by the servicing tail, resulting perhaps in widespread low ODS prices which might become an incentive for other enterprises to continue or start using CFCs again.

5.2.1.3 Information Flow: Prices, Alternative Technologies, and Available Financing

268. The operation of the market is affected by the level and quality of information available to technology producers, suppliers, and consumers. Many market forces will not contribute to a timely ODS phaseout if these critical actors do not receive certain information, including:

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38 Managers of several large Article 5 country enterprises that use refrigeration equipment said that logistically they would not be able to coordinate the replacement of equipment in all their facilities for many years, even if the financing were available.

39 "Technologies" are assumed to include equipment as well as the chemical itself.

- Clear near-term and long-term price signals for ODS technologies and alternatives;
- Authoritative data on the availability and technical and financial details of alternatives;
- Data for technology producers and suppliers on potential projects in Article 5 countries, to encourage them to market their products and services; and
- Information about the availability of financing for phaseout projects.

269. The data collected by the Study Team demonstrate that this information is not flowing openly in many Article 5 countries. ODS prices in some sectors and countries do not appear high enough to play a role in rapidly stimulating the alternatives markets, and the Multilateral Fund and other institutions are generally not providing a wide distribution of this information at the enterprise level.[40] Similarly, the majority of enterprises interviewed lacked complete information about the impending ODS phaseout and their options for dealing with it. Furthermore, enterprises often doubt, sometimes justifiably, the credibility of information they do have about the viability of alternative technologies or the reality of the phaseout. These problems are generally exacerbated in the small and informal sectors, where there are fewer international ties or connections to large chemical suppliers and trade associations. The Study Team even encountered two specific cases where enterprises resisted clearly profitable investments in alternative technologies because they did not realize or understand the business opportunities. This delay in technology transfer is a factor of poor information flow.[41]

270. Information flow would become even more important with any accelerated phaseout schedule. Unless ODS prices seen by consumers rise drastically, significant market interventions would be required in most countries to facilitate the flow of phaseout, price, alternatives, and financing information. Without reliable data of this type and with no other incentives, few enterprises can be expected to make potentially costly and disruptive changes in their processes.

5.2.2 The Montreal Protocol and the Multilateral Fund

271. The second primary factor affecting the phaseout is the existence of the Montreal Protocol and the Multilateral Fund. These institutions provide powerful incentives for countries to stop using ODS. The Montreal Protocol itself, as a high profile global agreement endorsed by governments and including distinct obligations for signatory countries, provides the international focal point and legitimacy that drives the entire phaseout effort. Furthermore, the trade restrictions and other provisions contained in the Montreal Protocol affect markets for ODS technologies and their alternatives in a way that clearly helps guide phaseout planning by enterprises and governments.

272. The existence of the Multilateral Fund as part of the Montreal Protocol is also extremely important at this point in time. The Multilateral Fund is the institutional mechanism for covering the

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40 As noted in the previous section, this may be partially related to local ODS production.

41 These two opportunities were for enterprises venting significant amounts of ODS in the solvents cleaning and mobile air conditioning sectors.

incremental costs of the phaseout in Article 5 countries. The Multilateral Fund facilitates information flow around the world and provides powerful incentives for enterprises to implement ODS phaseout projects. At a field level, if enterprises believe the global phaseout will occur, they see the Multilateral Fund as a mechanism for eliminating or lowering their portion of cost of technology transition. In many circumstances this has proven to be a powerful incentive to encourage enterprises to initiate phaseout projects. Additionally, the Multilateral Fund is able to use these information and financial mechanisms to encourage projects in certain sectors and countries where action would not otherwise be occurring for many years. Furthermore, some countries stated explicitly in their Country Programmes and through interviews that they will not be able to achieve a phaseout by the target dates without assistance from the Multilateral Fund, signaling the symbolic and practical importance of this institution.

273. Current uncertainty among individuals that the Study Team interviewed about future replenishment of the Multilateral Fund seems to have several counteracting effects. Some Article 5 governments are accelerating their efforts to implement projects under the Fund in order to secure a large portion of the available resources before those resources are potentially exhausted. On the other hand, uncertainty about available funding (and about the overall funding process) has discouraged some enterprises from initiating projects with the implementing agencies. In a related manner, the fact that some donor countries have at times fallen behind in their contributions has contributed to these signals of funding uncertainty to some Article 5 countries and may have threatened, though not necessarily affected, the timely implementation of certain projects.

5.2.3 Article 5 Country Governments: Policy Actions and Establishment of the OPU

274. The third primary factor affecting the phaseout is actions taken by the Article 5 country governments. This includes establishment of a functioning OPU and implementation of policies that directly affect ODS production, consumption, and commerce. Without a functioning OPU of even a minimal size, the Secretariat and the implementing agencies cannot effectively provide resources and services to the country. This is especially relevant in countries that have no domestic resources to promote the ODS phaseout, including many small countries and/or countries with other dominant social priorities. Furthermore, the basic existence of the OPU is even more critical under accelerated phaseout scenarios, where the Multilateral Fund becomes more important than now in achieving the global ODS elimination. While Section 5.3.4 discusses additional aspects of OPU structure that may speed up or slow down technology transfer efforts, such as the number and skills of OPU staff, the fundamental point here is OPUs are critically necessary -- regardless of their deeper structure -- in order for the Multilateral Fund to operate effectively.

275. In addition to establishing responsive OPUs, direct policy actions by domestic governments could also significantly affect the feasibility of phaseout scenarios in some Article 5 countries. This may include, for example, import quotas, voluntary or mandatory ODS use or production controls, ODS or technology taxes or subsidies, or any other type of domestic policy mechanism. Evidence of the clear impact of such policies is limited since few Article 5 countries have pursued much of this type of action to date. In at least one Article 5 country, however, quotas and use and production restrictions have clearly set the stage for an early national phaseout, and in others some of these actions have facilitated if not enhanced the movement to eliminate ODS use.

276. In these limited cases, these actions facilitate the phaseout in two distinct ways. First, they prompt the flow of authoritative information regarding ODS and alternatives between enterprises and industries, as those businesses react to try to understand the full implications of the global phaseout

and to look for alternatives. Second, the voluntary and mandatory use restrictions where they are in place are fairly effective at eliminating waste and increasing ODS use efficiency. The import quota systems may also be effective in controlling ODS flows into a country, although they mostly been used for data gathering rather than for a control role as of yet. There also exists at least one case where an Article 5 country is planning to subsidize import of ODS technologies in the short term, with obvious implications for the feasibility of a quick phaseout.

5.2.4 Time Required for Societal Transition

277. The fourth and final primary factor affecting the phaseout relates to the time inherently required for this scale of global industrial transition. Agencies and individuals responsible for complying with the Montreal Protocol face a complex challenge. With limited resources, the majority must foster difficult technological transformations in diverse economic sectors. To do so successfully, they must overcome an intricate array of technical, institutional, economic, and political constraints at the national and international levels. Furthermore, they must do so amidst many additional constraints and complications. This may include, for example, priority given to other critical social policies, varying levels of regulatory support, limited institutional capacity, sparse technical and economic data, or lack of local experts familiar with the latest developments in non-ODS technology.

278. Several individuals interviewed by the Study Team drew comparisons of the Article 5 phaseout to the time taken by developed countries to phase out ODS. It was noted that many such countries began the phaseout with CFC controls in aerosols in the late 1970s, and will complete the phaseout at the end of 1995, about eighteen years later. While the comparison is not a perfect one -- ODS alternatives in most applications have been developed in just the last few years -- it is important to keep in mind the complexity and enormity of the phaseout task in Article 5 countries, and the remaining need for technological development to meet the distinct circumstances in many of those countries. There was broad consensus among those interviewed that, for these reasons alone, a firm phaseout date of 1996 or 2000 for all Article 5 countries would be extremely difficult or impossible to achieve.

5.3 SECONDARY FACTORS POTENTIALLY AFFECTING PHASEOUT SCHEDULES

279. As explained in Section 5.1, the following factors may slow or accelerate the rate of technology transfer and thus affect the feasibility of alternative phaseout schedules in several ways. They may combine or interact in some countries or industrial sectors to cause ODS phaseout gridlock. They may also contribute to the uncertainty or risk surrounding phaseout projects perceived by ODS consuming enterprises, causing those enterprises to delay their phaseout efforts. Alternatively, some of them may act as catalysts to make technology transfer projects happen sooner than they would have otherwise.

5.3.1 The Process of Identifying, Evaluating, and Selecting Non-ODS Technologies at the Project Level

280. The overall rate of technology transfer is affected by the fundamental choices that prompt enterprises to stop using ODS and by factors that influence how enterprises identify, evaluate, and select replacement technologies. These factors may include, in addition to the major incentives and impediments described above, the institutional capacity of the individual enterprise and the involvement of other actors such as equipment vendors and implementing agencies in the firm's

decision making. Success in this process will result in an efficient enterprise-level ODS phaseout, while failure can lead to delay in phaseout decision making and to project abandonment during or after installation of the new technologies. This may occur, for example, if those technologies do not meet the actual local needs or are not sustainable with local resources. This section presents additional information on these factors.

5.3.1.1 Limits on Currently Available Technologies

281. Alternative technologies are not always available in a form or scale appropriate to certain Article 5 country enterprises. For example, some non-ODS alternatives from developed countries do not function in humid climates, various technologies require constant water or electricity supply or quality that are not available to enterprises in particular areas, and others require maintenance and upkeep by skilled technicians who often do not exist in a particular country or who are not readily available. Furthermore, the country reports for this study discussed two enterprises who have not been able to identify any suitable non or low-ODS alternative as of yet. As noted earlier, non-ODS technologies may also be designed to function on too large of a scale to match the needs and abilities of certain small or informal enterprises.

5.3.1.2 Uncertainty About Alternative Technologies

282. Uncertainty and lack of credible information about the performance and efficiency of non-ODS technologies and about potential future regulation of equipment that uses HCFCs (because of their ODP), HFCs (because of global warming potential), and other greenhouse gases sometimes confuse enterprises. On a global scale these enterprises prefer to continue using known technologies that carry low risks, and therefore they are reluctant to replace their current ODS-consuming processes until they know that the alternative they are investing in will perform at acceptable quality levels and will not need to be replaced again in the near future. This causes many enterprises to continue using their ODS-consuming processes even when assistance is available for conversion to new technologies.

5.3.1.3 Capacity of the Enterprise to Manage the Technological Change

283. The process of identifying, evaluating, selecting, installing, and maintaining new technologies often requires significant resources and skills. Many enterprises and certain entire industrial sectors in various countries do not have the capacity to manage this process. They often do not have access to comprehensive or detailed information, skilled technical and financial staff, laboratory or engineering facilities, or other necessary resources. In this situation, enterprises become confused and cannot manage the information they do have about alternative technologies and about the ODS phaseout. This problem is enhanced by the scarcity of local engineering consultancy capabilities in some countries. These problems are often exacerbated further in some small and informal sectors where average technical education tends to be low.

5.3.1.4 The Willingness and Ability of Outside Actors to Assist the Enterprise

284. The assistance of actors outside the enterprise has often helped resolve these problems, especially when that assistance is provided on an ongoing basis:

- *Equipment vendors'* marketing efforts, when they exist, often include provision of information about alternatives and sometimes include offers to modify equipment to meet local circumstances;

- *Chemical Vendors*, especially large ones, frequently provide information about various non-ODS technologies or about vendors of non-ODS technologies to their customers and others;[42]

- *Implementing agencies under the Multilateral Fund* provide partial or complete assistance with technology identification, evaluation, and selection; and

- *Non-government organizations* can influence the technical and political range of non-ODS options at the international level and at the national or local level within certain countries.

285. One problem associated with assistance from these actors is that enterprises still do not always receive complete, accurate, or unbiased information. Data from this study suggests that the technology and chemical vendors and the implementing agencies sometimes prefer certain technology options for given ODS applications. Enterprises that recognize these biases remain confused and are sometimes unwilling to act. Enterprises that do act on uncertain information run the risk of obtaining inappropriate or inadequate technologies which they may later discard, possibly inducing a return to ODS consumption.[43] Regardless of these points, however, many enterprises say that outside assistance, specifically ongoing assistance provided by the implementing agencies and by technology and chemical suppliers, has been critically important in their ability to make technology decisions and move ahead with phaseout plans.

5.3.1.5 Market Exploitation by Owners of Proprietary Technologies

286. Another factor that delays the rate of technology transfer is the unwillingness of some private sector technology owners to supply Article 5 countries. Limited cases suggest that this problem exists because the supplier wants to avoid creating competition for their own products in the international or Article 5 country market. The World Bank's Ozone Operations Resource Group (OORG) Report Number 4 discusses this situation relative to chemical producers when Article 5 country enterprises would receive the technology at price subsidized by the Multilateral Fund.[44] The Study Team was also told about technology suppliers who fear that their intellectual property rights will not be protected and their technologies will therefore be replicated without permission in some countries. Additionally, in at least one of the countries visited for this study, a developed country supplier insisted on forming a joint venture with the Article 5 country enterprise before granting the rights to use the non-ODS technology. This raised the perceived costs to the local enterprise, in terms of

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42 Efforts by equipment and technology vendors are usually enterprise-specific, thus helping the particular enterprise they are in contact with but not providing broad-based dissemination of information.

43 Return to ODS consumption is a concern particularly in recovery and recycle projects where technicians can easily revert to venting the ODSs and in other projects with low levels of chemical dependent capital investment.

44 Technical Considerations for Chlorofluorocarbon Alternatives Production in Developing Countries, The World Bank, Ozone Operations Resource Group Report Number 4, October 1993.

absolute price and control over their business, and they backed away from the technology transfer deal.

5.3.2 The Terms of Project Financing for Article 5 Country Enterprises

5.3.2.1 Multilateral Fund Incremental Cost Rule and Principles of Reimbursement to Enterprises

287. The Study Team received various comments regarding the Multilateral Fund rule that only the incremental costs of conversion to low or non-ODS technologies will be financed. These comments included statements concerning the actual utility of this operating principle for promoting the phaseout, as well as expressions of peoples' confusion over how the rule operates. Foremost, this incremental cost rule has limitations in terms of the incentives it provides for enterprises to stop using ODS.[45] Depending on levels of uncertainty and risk, with incremental costs fully subsidized an enterprise may still be indifferent between its current and the alternative technologies. Additional incentives of some kind are often necessary to induce the enterprise to switch, such as international market pressures or the distribution of authoritative information about the long term viability of the alternatives. Grants provided under the Montreal Protocol which do not fully cover all the incremental costs from the enterprise's perspective, therefore, provide even less incentives for an enterprise to phase out. This may be the case with projects where cost calculations truncate operating costs, projects that use current ODS nominal prices rather than pre-Protocol prices, and with enterprises that are partially foreign owned where the foreign equity partner or the enterprise will not pay a related fraction of the costs.

288. On a related topic, the Multilateral Fund's unwillingness to pay for technology conversions which will apparently result in increased profits for the enterprise sometimes results in the continued use of ODS-consuming technologies. This is true when the flow of technical and financial information to enterprises is incomplete and the enterprises do not realize or believe the benefits of switching to the non-ODS process.[46] They therefore will not do so without outside financial assistance, or without receiving significant information about their non-ODS alternatives that authoritatively demonstrates the benefits of conversion. Implementing agencies cited limited examples where visits by their technical experts and consultants did facilitate this information flow and induce enterprises to change to non-ODS processes without further assistance from the Multilateral Fund.

289. The perceived lack of consistency, clarity, and precision in administering some of the Multilateral Fund rules, especially regarding project content and cost requirements, has reportedly also slowed the process of project formulation and approval by the Executive Committee and the implementing agencies. Loose rule definition and discretion in applying rules does permit flexibility and provide a mechanisms for achieving consensus at times. Confusion regarding the rules, however, also leads to perhaps unnecessary iterative efforts by the Secretariat, implementing agencies, OPUs, local financial intermediaries, and enterprises as they debate how to proceed in preparing and presenting projects for approval.

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45 This section analyzes only the incentives and impediments to ODS phaseout generated by the reimbursement principles of the Multilateral Fund. This section does not consider other Multilateral Fund objectives that these principles may serve, such as conserving scarce Fund resources.

46 Section 5.2 cites examples of this situation.

5.3.2.2 Financing for ODS Phaseout Projects from Non-Multilateral Fund Sources

290. Data collected for this study indicate that enterprises in many Article 5 countries have a difficult time obtaining financing for ODS phaseout projects from sources other than Multilateral Fund. While private sector or non-Fund financing has sometimes been obtained in circumstances where other strong incentives are present, such as export pressures, ODS phaseout projects in general are not profitable and thus firms in some countries without large cash or capital reserves have had difficulty obtain financing in commercial markets.

5.3.3 The Governance Structure and Operation of the Multilateral Fund

291. Several distinct aspects of the Multilateral Fund's structure and operations affect the rate of technology transfer. Foremost, as highlighted at the beginning of this chapter, the basic existence and operation of the Multilateral Fund is an enormous incentive that promotes the ODS phaseout in many ways at the enterprise, national, and global levels. The comments in this section regarding relative rates of technology transfer must be considered within that broader context. It is important to note that this section again focuses narrowly on the rate of technology transfer and does not consider how these factors relate to other Multilateral Fund objectives.

5.3.3.1 Perceived Mission and Overlapping Roles Amongst Multiple Agencies and the Executive Committee

292. Differing and confusing priorities and objectives sometimes emerge between the Executive Committee and the implementing agencies -- including cost effectiveness, technical criteria, safety criteria, and development criteria -- slowing technology transfer efforts by requiring frequent repetition of tasks or redesign of projects. The involvement of multiple agencies for administering the Multilateral Fund also sometimes fosters confusion and delay in project implementation. Specifically, confusion or disagreement over some specific roles between the Secretariat, implementing agencies, OPUs, and local financial intermediaries leads to perhaps unnecessary repetition or duplication of tasks at the project design, review, approval, and funding stages. Projects can get reviewed for technical and financial features, for example, two or three times within a country (by the enterprise, OPU, and local financial intermediary), twice or more by the implementing agency, and once by the Secretariat prior to submittal to the Executive Committee. While this definitely serves some purposes, it also fosters numerous opportunities for disagreement and confusing contradictory statements.

293. Conversely, multiple agencies operating simultaneously tend to produce variety and creativity in project design. Multiple agencies may also be able to put forward a larger total number of projects than fewer agencies could, even if their specific roles, or the tasks within their roles, are not always well defined.

5.3.3.2 Operating Procedures of the Implementing Agencies

294. This study specifically does not evaluate the relative merits of the operating procedures of the various implementing agencies. Some common components of those operating procedures are worth mentioning, however, because they were highlighted multiple times during the data collection effort as affecting the rate of technology transfer:

- *Procurement and fund disbursement procedures*: The rate of technology transfer is sometimes affected by complex preparation, technical review, negotiation, and contracting procedures for international procurements. This reflects, for example, dealing with equipment suppliers in multiple countries and coordinating between technical reviewers, especially when these reviewers have overlapping roles.

- *The degree of active coordination between the multiple actors involved in project implementation*: During project implementation, equipment and resources must move among many actors, including technology suppliers, recipient enterprises, OPUs, implementing agency contracting staff, implementing agency administrative staff, customs offices, shipping companies, and others. Projects where a central coordinator manages these interactions generally experience fewer delays than projects without such a coordinator.

- *The degree to which mechanisms are put in place to ensure the sustained use of the non-ODS technologies*: Some tension exists between the need for rapid project implementation and the need to ensure the capacity and incentives for enterprises to use the non-ODS technologies in the long term. This may include, for example, ensuring long term parts supply and maintenance support. This is especially relevant in cases where discouraged enterprises could easily revert to their previous ODS-emitting procedures, such as with refrigerant recovery and recycling projects.

295. The rate of technology transfer under the Multilateral Fund can be enhanced or diminished depending on how the implementing agencies handle each of these operational factors. These issues also clearly relate to the sometimes overlapping roles of the multiple agencies involved under the Multilateral Fund, as discussed above. Also, OPUs report that it takes months and sometimes years to learn the different operating procedures of the different implementing agencies. It also takes a long time to forge effective working relationships with agency staff, whose occasional replacement prior to project completion sometimes further delays projects.

5.3.4 The Structure and Operation of OPUs in Article 5 Countries

296. Section 5.2.3 discusses the primary and fundamental roles of Article 5 country governments, including OPUs, in affecting the feasibility of alternative phaseout schedules. This section presents additional observations, drawn from the Study Team's data collection effort an analysis, on how OPUs affect the rate of technology transfer in secondary ways that may affect the overall phaseout.

297. The structure and operation of OPUs varies tremendously among the Article 5 countries. This in turn affects the rate of technology transfer. Some OPUs are autonomous organizations while others are part of larger government agencies, such as the national ministries responsible for environment, development, industry, finance, or health. Some OPUs have multiple staff dedicated solely to ozone protection issues, others have only one staff person whose primary responsibilities in the agency have little to do with ozone, and other countries do not even have anyone actually working on this issue. Similarly, some OPUs are intimately involved in all stages of project development and implementation while others play a passive role.

298. Differing social priorities, political priorities, levels of available resources, institutional capacities, as well as the skills, talents, and personalities of individuals in the OPUs, account for these variations. The critical factors that affect rates of technology transfer include:

- *Whether the OPU has the authority and capacity to coordinate with the implementing agencies.* As discussed in Section 5.2.3, a fundamental OPU function is to provide a local coordinating point for implementing agencies. Without someone to fulfill this role in a country, even if it is a single individual in some agency who accepts no other ozone phaseout responsibilities, the Fund cannot operate.

- *Whether the OPU's institutional capacities are sufficient to support the roles and responsibilities they adopt.* Some OPUs do not have the technical skills, time, or other resources to conduct certain tasks. When such OPUs accept responsibility for those tasks, like technology research or coordinating or facilitating all meetings between implementing agencies and enterprises, the phaseout process may become bogged down in that country.

- *Whether the OPU adopts a role that is duplicative of the Secretariat, the implementing agencies, local financial intermediaries, or enterprises.* Some OPUs have adopted responsibility for tasks that are duplicative of implementing agencies' or other entities' responsibilities. In some situations, this may include technical review of projects, central coordination of projects, and many other tasks. Duplication, while perhaps serving other objectives, may cause conflict and usually slows the technology transfer process. This suggests again that all agencies and individuals responsible for projects should carefully coordinate with each other and perhaps explicitly agree on their mutual roles.

- *Who directs the OPU.* OPU effectiveness in carrying out different roles varies depending on the personalities, training, and experience of the OPU's staff. Traits that affect the success of technology transfer efforts include staff organization, aggressiveness, political savvy, and willingness and ability to deal with other national and international actors in the public and private sectors.

299. OPU actions around the world that seem to have been particularly successful in promoting technology transfer, as long as individual OPU institutional resources are sufficient to support these activities, include:

- Direct policy actions, when they have occurred, to affect ODS supply and consumption, such as voluntary agreements with industry, import quotas, consumption restrictions, and other similar actions;

- Information dissemination to industry specifically regarding the ODS phaseout and available financing, and information dissemination to implementing agencies about potential projects;

- Strategic planning in coordination with industrial groups for entire industrial sectors;

- Coordination of the responsibilities and actions of multiple implementing agencies that are operating within the country;

- Providing information to implementing agencies about local technical, economic, political, and cultural circumstances that will affect projects; and

- Advocating specific projects during Executive Committee deliberation.

300. OPU actions that have at times slowed the rate of technology transfer under the Multilateral Fund generally relate to OPU desire to control projects or to be involved at all stages, even when this duplicates the responsibilities of other agencies or is beyond the OPU institutional capacity. While each independent party to the Montreal Protocol can clearly organize their phaseout efforts in the manner they believe is most appropriate, agencies operating under the Multilateral Fund do maintain certain distinct responsibilities, and OPU involvement in these same tasks without careful coordination or agreement can slow down the process. Limited examples of these types of OPU actions include:

- technical involvement during engineering reviews;
- involvement during equipment procurement; and
- involvement in all meetings between implementing agencies and enterprises.

301. The impact of all issues of task duplication and limited institutional capacity, or of the match or mismatch between institutional capacity and adopted roles, is expected to be more pronounced if the rate of technology transfer and project implementation increases in the future. There is perhaps a linkage between the degree of OPU involvement in these activities now, even if they are duplicative of other agencies' actions, and the institutional strengthening effect in the longer term. Given that the ODS phaseout is a one-time effort, however, it is uncertain how much long-term institutional capacity and capability needs to be created in Article 5 countries to support this objective.

5.4 CONSEQUENCES OF DIVERSITY AMONG COUNTRIES FOR THE PHASEOUT

302. As the Study Team assessed alternative phaseout scenarios, it quickly became clear that the prospects for ODS phaseout are affected by different combinations of factors in different countries. Rates of ODS consumption and technology transfer in each country, for example, reflect the unique local interplay of all the factors presented in Sections 5.2 and 5.3. The net result of the varying relative influence of these factors is that the ODS phaseout in some countries is occurring almost as quickly as in the developed world, while at the other extreme, the phaseout to date in other countries has been extremely limited.

303. Variations in the significance of these factors is rooted in these countries' diverse economic, technological, political, and cultural circumstances. The gross domestic product (GDP) in some Article 5 countries is less than US$2 billion, for example, while in others it is more than US$300 billion. Economic systems and structures, technological development, and the level of international economic activity vary tremendously among countries. Political systems and levels of institutional capacity for dealing with this issue are also highly diverse. These circumstances and others result in ODS consumption in Article 5 countries ranging from less than 20 tonnes per year in some to more than 15,000 tonnes per year in others.

304. In the context of the existing Protocol with a single target phaseout date for Article 5 countries, the logical consequence of these differences is that the feasibility of a global phaseout scenario is determined by the countries that eliminate ODS last, rather than by those that will phase out sooner. Delayed phaseout may occur through deliberate planning or an unfortunate confluence

of circumstances in particular countries. Either way, the implication for determining a global phaseout schedule is that particular attention must be paid to the interplay of the specific primary and secondary factors as they apply to each country, or at least to groupings of similar countries. The feasibility of distinct phaseout scenarios in different countries, for example, may be evaluated by considering the role of international market dynamics, information flow, current technological development, the operation of the Multilateral Fund, and other factors within each individual country or within groups of relatively similar countries.

305. The Study Team's analysis of available country data suggests three general groupings of Article 5 countries in terms of ODS consumption and phaseout feasibility, as well separate consideration of a small set of particularly distinct individual countries. The first grouping includes countries with relatively low GDPs, usually less than US $3.5 billion, that are fairly isolated economically and in which most ODS is used for servicing rather than manufacturing purposes. The second grouping includes countries with GDPs in the size of US $3.5 to US $20 billion that may have a small amount of international economic activity and that demonstrate higher levels of institutional capacity than the first group. The third grouping includes countries with larger GDPs that have significant manufacturing activity and more international linkages. The individual countries with particularly distinct ODS consumption circumstances includes those with very high relative GDPs, high rates of ODS consumption, domestic ODS production capacity, large manufacturing sectors that service both domestic and international markets, and perhaps large informal sectors. These groupings have been carried over for use in the modeling framework in Chapter 6 as well, because of the relatively consistent ODS consumption and technology transfer traits that they exhibit.

5.5 CONCLUSIONS

306. To recap, the Study Team used a structured policy analysis framework to sift through the data collected for this project. The Study Team assessed policy and institutional factors with the potential to impact alternative phaseout schedules by evaluating each stage of the technology transfer process and the roles of key actors at each of those stages. It was determined that factors affecting the phaseout within any given country can be classified either as primary, with a potential impact of several years, or secondary, with an impact on the order of several months to one or two years.

307. Four primary factors that do affect the feasibility of phaseout scenarios in specific countries, and thus the global phaseout, were identified:

- Market dynamics;
- The Montreal Protocol and the Multilateral Fund;
- The actions of Article 5 Country governments; and
- The time required for societal transition.

308. Four secondary factors that may affect a particular country's phaseout were also identified:

- The process of identifying, evaluating, and selecting non-ODS technologies at the project level;

- The terms of project financing for Article 5 country enterprises;
- The structure and operation of the Multilateral Fund; and
- The structure and operation of OPUs in Article 5 countries.

309. Based solely on its assessment of these policy and institutional factors, the Study Team determined that successful implementation of the phaseout in all Article 5 countries by 1996 would be impossible and that phaseout by 2000 would be extremely difficult. This conclusion is rooted in the fact that tens to hundreds of phaseout projects, often taking more than a year each to complete, have to be implemented in each of approximately ninety countries. This time frame alone makes the 1996 date unattainable. In addition, the physical, technological, and institutional capacities of the implementing agencies, the Article 5 country governments and enterprises, and the world's technology suppliers would be severely tested by a 2000 phaseout date. Furthermore, many Article 5 country governments have spent several years constructing policy frameworks based on target dates well after 2000, even to the point of encouraging ODS consumption now, while others have taken little policy action as of yet. A 2000 phaseout would therefore first require prompt and definitive policy action by a large number of the Article 5 country governments, and then determined efforts to lead their industries through a very accelerated phaseout.

310. The feasibility of phaseout dates beyond 2000 cannot be ruled out strictly by policy and institutional factors. However, the possibility of meeting these targets may depend in part on the implementing agencies' abilities to provide support and interventions based on the unique interplay of factors that affect ODS consumption and phaseout within each country or group of similar countries. The feasibility of global phaseout for these scenarios also remains dependent, of course, on the actions of specific Article 5 country governments.

311. For all scenarios with phaseout dates beyond they year 2000, these results and conclusions must be considered along with the quantitative results from Chapter 6 and the data from Chapter 4. Each of these chapters carries distinct implications for the feasibility of alternative phaseout scenarios. Chapter 7 summarizes and integrates the conclusions from each of these chapters into a final assessment of the phaseout scenarios.

CHAPTER 6

RESULTS OF SIMULATION OF COSTS AND ATMOSPHERIC IMPACTS

6.1 MODEL RESULTS FOR TOTAL PHASEOUT COSTS AND ATMOSPHERIC IMPACTS

312. This chapter presents estimates of the total costs and atmospheric impacts of each of the phaseout scenarios. Total phaseout costs include the costs of (1) investment projects to reduce ODS use, (2) conversion of ODS production capacity, and (3) non-investment project activities. In the results that follow, the cost of investment projects to reduce ODS use and non-investment costs are presented by scenario, and are compared to the atmospheric impacts of each scenario. The costs of phasing out ODS production at production plants are presented in a separate exhibit at the end of this chapter. These results are presented separately because of the wide range of potential costs associated with the phaseout of production plants and because these results do not vary by phaseout scenario.

6.2 COSTS OF INVESTMENT PROJECTS TO REDUCE ODS USE AND OF NON-INVESTMENT ACTIVITIES

313. Exhibits 6-1 and 6-2 present Fund costs and real resource costs for investment projects to reduce ODS use and for non-investment activities. The costs of projects to eliminate ODS use in new equipment are divided into capital, non-chemical operating, and chemical operating costs. The costs of projects to eliminate ODS use in existing equipment are divided into recycling costs and retrofit costs. Non-investment costs are presented separately. A number of conclusions can be drawn from these exhibits:

314. First, results are not presented for a 1996 ODS phaseout. A 1996 phaseout was found to technically infeasible in Article 5 countries because technologies to replace ODS use in new equipment could not penetrate the market fast enough to achieve the phaseout. A 2000 phaseout was found to be technically feasible, but resulted in costs of $6.7 billion to the Fund and $7.9 billion real resource costs. These costs were primarily retrofit costs. All other phaseout scenarios were determined to be technically feasible and involved relatively minor or no retrofit costs.

315. Second, the total Fund costs are less than the total real resource costs for each of the scenarios. As explained in Chapter 3, there are four reasons for this: (1) the Fund reimburses up to four years of operating costs, while real resource costs include operating costs through the entire life of the project, (2) the Fund cost calculation assumes rising ODS prices, while real resource costs are based on pre-Protocol ODS prices, (3) the Fund reduces the total cost of a project by its percentage of foreign ownership, while real resource costs ignore foreign ownership, and (4) the Fund does not consider cost saving projects, while cost saving projects do reduce overall real resource costs.

316. Third, the scenarios generally show significant chemical cost savings over time. This is largely due to inexpensive alternatives implemented in the aerosols, foams, and solvent sectors (i.e., hydrocarbons, cyclopentane, methylene chloride, chlorinated solvents, etc.). These cost savings exceed the cost increases associated with the use of more expensive alternatives such as HCFCs and HFCs.

Exhibit 6-1

Fund Phaseout Costs by Type

($US Millions, Discounted at 10%)

Phaseout Scenario	Investment Projects for Non-ODS Using Technologies					Non-Investment	Total
	New Equipment			Existing Equipment			
	Non-Chemical						
	Capital	Operating	Chemical	Recycling	Retrofit		
1: 2000	382	219	(199)	70	5,416	821	6,709
2: 2010	370	213	(92)	170	62	186	909
3: 2010 w/Tail	262	93	(153)	219	0	163	584
4: 1996	--	--	--	--	--	--	--
5: 2006	346	209	(95)	145	117	176	897
6: 2006 w/Tail	256	114	(166)	184	0	157	545
7: Fast	451	227	(237)	66	0	160	667
8: 2010 w/Accel.Tail	367	201	(144)	181	0	181	787
9: 2006 w/Accel.Tail	340	195	(161)	158	0	171	704
10: 2000 w/4 year	279	381	(268)	40	5,416	816	6,665
11: 2010 w/4 year	300	374	(110)	104	62	187	917

Exhibit 6-2

Real Resource Phaseout Costs by Type

($US Millions, Discounted at 10%)

Phaseout Scenario	Investment Projects for Non-ODS Using Technologies					Non-Investment	Total
	New Equipment			Existing Equipment			
	Non-Chemical						
	Capital	Operating	Chemical	Recycling	Retrofit		
1: 2000	783	1,301	(614)	198	5,416	821	7,905
2: 2010	612	1,128	(319)	232	62	186	1,901
3: 2010 w/Tail	501	670	(479)	312	0	163	1,167
4: 1996	--	--	--	--	--	--	--
5: 2006	674	1,172	(360)	225	117	176	2,004
6: 2006 w/Tail	581	812	(459)	301	0	157	1,392
7: Fast	884	1,358	(637)	194	0	160	1,960
8: 2010 w/Accel.Tail	624	1,119	(443)	261	0	181	1,742
9: 2006 w/Accel.Tail	675	1,142	(437)	261	0	171	1,812
10: 2000 w/4 year	783	1,301	(614)	186	5,416	816	7,888
11: 2010 w/4 year	612	1,128	(319)	220	62	187	1,890

317. Fourth, Scenario 7 (fastest economically feasible phaseout) results in a phaseout of ODS use in new equipment by 2002 and a phaseout of virgin ODS use in existing equipment by 2011. Under this scenario, recycled ODS is used to continue to service existing equipment until 2018.

318. Fifth, accelerated tail scenarios exhibit higher total costs than regular tail scenarios. This is as expected given that the accelerated tail requires that ODS use in new equipment be phased out in 1999 while the regular tail scenario allows ODS use in new equipment up until the phaseout date.

319. In a few scenarios the Fund costs appear to be counter-intuitive. For example, the Fund capital costs for the 2000 and 2010 phaseout scenarios change when the period that operating costs are reimbursed increases from two to four years. In addition, the Fund costs for the 2006 phaseout scenarios are less than the Fund costs for the 2010 phaseout scenarios, which seems implausible since the 2006 schedule is more stringent. These results are explained by the fact that Fund costs exclude consideration of cost-effective projects. In the first case, reimbursement of four years of operating costs makes cost-effective some projects that had incremental costs when only two years of operating costs were considered. These projects are not eligible for reimbursement, and their capital costs are no longer included in total Fund costs. In the second case, ODS prices rise more quickly in 2006 phaseout scenarios than they do in 2010 phaseout scenarios. This has the twofold effect of (1) reducing chemical operating costs across all projects in the 2006 phaseout scenario and (2) making some projects cost-effective under the 2006 phaseout scenario that were not cost-effective under the 2010 phaseout scenario. Again, the cost-effective projects are ineligible for funding and their costs drop out of the Fund cost estimates for 2006 phaseout scenarios.

6.3 COSTS BY SECTOR

320. Exhibits 6-3 and 6-4 present the Fund and real resource costs of undertaking investment projects to reduce ODS use and non-investment activities by use sector. In reviewing the costs by sector, it is apparent the majority of costs occur in the refrigeration and air conditioning sector across all phaseout scenarios.

321. Exhibit 6-3 also indicates that the aerosol sector will require no support from the Fund to achieve the phaseout. This result is driven by the significant operating cost savings that are simulated to occur in the aerosol sector due to the use of inexpensive chemicals like hydrocarbons and compressed gas. The Study Team is aware that aerosol projects have received assistance from the Fund to-date, and that this conclusion appears inconsistent with the aerosol projects submitted to the Fund. It is our belief that this result arises because (1) of the ODS chemical forecasts used by the Study Team over time; and (2) because at least some of the investment projects approved by the Fund to-date in the aerosol sector have not considered the operating cost savings associated with converting to these alternatives.

322. Seventh, in some sectors Fund costs are zero or positive and real resource costs are negative. This result arises because some projects have cost savings and are ineligible for Fund support. These projects result in savings from a real resource perspective, but not from the perspective of the Fund. This is particularly apparent in the solvents sector where cost-effective chlorinated solvents projects produce significant real resource savings.

Exhibit 6-3

Fund Phaseout Costs by Sector

Discounted at 10%

($US Millions)

Phaseout Scenario	Aerosol	Foam	Halon	Refrig	Solvent	Other	Total
1: 2000	0	8	57	6,556	43	45	6,709
2: 2010	0	41	96	701	60	11	909
3: 2010 w/Tail	0	45	106	345	69	19	584
4: 1996	--	--	--	--	--	--	--
5: 2006	0	32	89	715	44	17	897
6: 2006 w/Tail	0	36	101	331	51	26	545
7: Fast	0	20	61	445	57	86	667
8: 2010 w/Accel.Tail	0	42	81	580	65	18	787
9: 2006 w/Accel.Tail	0	34	83	515	48	25	704
10: 2000 w/4 year	0	0	67	6,550	16	31	6,665
11: 2010 w/4 year	0	16	104	778	12	7	917

Exhibit 6-4

Real Resource Phaseout Costs by Sector

Discounted at 10%

($US Millions)

Phaseout Scenario	Aerosol	Foam	Halon	Refrig	Solvent	Other	Total
1: 2000	(122)	121	(40)	7,977	(138)	108	7,905
2: 2010	(86)	78	21	1,971	(113)	31	1,901
3: 2010 w/Tail	(96)	90	31	1,213	(116)	47	1,167
4: 1996	--	--	--	--	--	--	--
5: 2006	(97)	78	12	2,021	(60)	50	2,004
6: 2006 w/Tail	(99)	92	24	1,369	(59)	66	1,392
7: Fast	(128)	133	(45)	1,865	(16)	150	1,960
8: 2010 w/Accel.Tail	(96)	87	(21)	1,848	(121)	45	1,742
9: 2006 w/Accel.Tail	(99)	90	(20)	1,839	(62)	64	1,812
10: 2000 w/4 year	(122)	120	(39)	7,965	(141)	106	7,888
11: 2010 w/4 year	(86)	73	22	1,974	(123)	31	1,890

6.4 IMPACT ON ODS USE AND CHLORINE LOADING

323. Exhibit 6-5 presents yearly weighted ODS use under each scenario from 1993 to 2025. This exhibit indicates the quantity of ODS required each year for new and existing equipment prior to the phaseout date and the quantity required to service existing equipment after the production phaseout date. Of note is the fact that the 2000 and 2010 phaseouts show ODS use until 2004 and 2014 respectively. This is because of the London Amendment's 2005 phaseout date for methyl chloroform. Exhibit 6-5 also presents totals for ODS use before and after the phaseout date. ODS use after the phaseout date is a measure of the size of the tail required to service existing equipment in each tail scenario.

324. Exhibit 6-6 presents the impact on adjusted cumulative chlorine associated with each of the of the phaseout scenarios. The exhibit also presents the change in adjusted cumulative chlorine for each of the scenarios relative to the levels calculated for the 2010 London Amendments phaseout schedule for Article 5 countries (i.e., scenario 2). As discussed in Chapter 3, adjusted cumulative chlorine is a measure of the total area under the Clx curve above 2.0 parts per billion during the period from 1985 until Clx returns to 2.0 ppb.

6.5 SUMMARY OF RESULTS

325. Exhibit 6-7 compares the Fund and real resource costs at a discount rate of ten percent to the (1) total adjusted chlorine loading, and (2) the percent change in total chlorine loading relative to the levels estimated under the 2010 London Amendments phaseout schedule for Article 5 countries (i.e., scenario 2).

326. Exhibit 6-8 presents a sensitivity analysis showing the Fund and real resource costs at discount rates of zero percent and five percent, respectively. Of particular interest are the Fund costs at a zero percent discount rate. These are estimates of the Fund requirements in nominal dollars for each of the scenarios.

6.6 PRODUCTION PHASEOUT COSTS

327. As explained in Chapter 3, the costs of phasing out ODS production were roughly estimated under a variety of different assumptions about the quantity of production capacity to be addressed and the rules under which the Fund would make grants for production projects. Twelve scenarios were considered based on the following parameters:

- First, because of the large discrepancy between actual production and reported capacity in Article 5 countries, Fund costs were estimated for both quantities to yield an upper and lower bound.

- Second, the Team evaluated two assumptions about the reimbursement of operating costs. For the first, it was assumed that only capital costs would be funded; in the second, it was assumed that four years of operating costs would be funded in addition to the capital cost.

Exhibit 6-5

Weighted Virgin ODS Consumption by Scenario
(Millions of Kilograms)

Scenario	1 2000	2 2010	3 2010 Tail	4 1996	5 2006	6 2006 Tail	7 FAST Tail	8 2010 Accel. Tail	9 2006 Accel. Tail	10 2000	11 2010
1993	221.0	221.0	224.0	N/A	221.0	224.0	206.9	224.0	224.0	221.0	221.0
1994	204.7	215.2	224.1	N/A	215.2	224.1	168.6	224.1	224.1	204.7	215.2
1995	107.8	208.5	225.2	N/A	208.5	225.2	135.8	225.2	225.2	107.8	208.5
1996	78.9	202.5	229.5	N/A	202.5	229.5	94.0	229.5	229.5	78.9	202.5
1997	36.0	196.5	233.3	N/A	196.5	233.3	69.2	233.3	233.3	36.0	196.5
1998	18.2	189.3	236.6	N/A	189.3	236.6	47.7	236.6	236.6	18.2	189.3
1999	14.5	159.9	206.5	N/A	159.9	206.5	40.7	147.1	147.1	14.5	159.9
2000	1.5	155.3	208.2	N/A	155.3	208.2	35.0	142.6	142.6	1.5	155.3
2001	1.4	152.5	209.9	N/A	152.5	209.9	31.2	138.2	138.2	1.4	152.5
2002	1.4	126.4	188.3	N/A	126.4	188.3	27.6	117.0	117.0	1.4	126.4
2003	1.4	122.9	177.6	N/A	122.9	177.6	24.3	102.0	102.0	1.4	122.9
2004	1.4	119.4	178.3	N/A	44.8	65.5	20.8	98.2	43.1	1.4	119.4
2005	0.0	97.9	107.3	N/A	37.0	57.3	17.2	39.0	34.9	0.0	97.9
2006	0.0	94.0	104.0	N/A	0.0	49.4	13.5	34.5	27.0	0.0	94.0
2007	0.0	37.4	72.9	N/A	0.0	44.6	9.6	26.7	22.2	0.0	37.4
2008	0.0	33.8	68.0	N/A	0.0	39.8	6.0	21.8	17.3	0.0	33.8
2009	0.0	30.8	63.2	N/A	0.0	34.9	3.2	18.1	13.6	0.0	30.8
2010	0.0	1.6	38.6	N/A	0.0	30.0	1.1	11.5	9.9	0.0	1.6
2011	0.0	1.6	34.6	N/A	0.0	26.0	0.8	8.6	7.0	0.0	1.6
2012	0.0	1.6	29.9	N/A	0.0	21.3	0.0	5.0	3.4	0.0	1.6
2013	0.0	1.6	25.2	N/A	0.0	16.6	0.0	3.8	2.2	0.0	1.6
2014	0.0	1.6	20.9	N/A	0.0	13.5	0.0	2.7	1.1	0.0	1.6
2015	0.0	0.0	15.8	N/A	0.0	10.0	0.0	0.7	0.7	0.0	0.0
2016	0.0	0.0	12.3	N/A	0.0	6.4	0.0	0.2	0.2	0.0	0.0
2017	0.0	0.0	8.7	N/A	0.0	2.9	0.0	0.0	0.0	0.0	0.0
2018	0.0	0.0	5.1	N/A	0.0	1.9	0.0	0.0	0.0	0.0	0.0
2019	0.0	0.0	1.5	N/A	0.0	0.9	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	2.5	N/A	0.0	0.3	0.0	0.0	0.0	0.0	0.0
2021	0.0	0.0	1.1	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.6	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2023	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2024	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Virgin ODS Consumption Before and After the Phaseout Date											
Pre-PO	688.1	2,371.4	2,906.3	N/A	2,031.7	2,466.6	953.4	2,267.9	2,099.7	688.1	2,371.4
Post-PO	0.0	0.0	247.3	N/A	0.0	317.9	0.0	22.2	102.4	0.0	0.0

Exhibit 6-6

Impact on Cumulative Adjusted Chlorine Loading

Name	Cumulative Adjusted Chlorine [1] (ppb-years)	Change in Cumulative Adjusted Chlorine [1,2] (ppb-years)	Change in Cumulative Adjusted Chlorine [1,2] (percent)
1: 2000	87.98	-10.66	-12.1%
2: 2010	98.64	0.00	0.0%
3: 2010 w/Tail	103.03	4.39	4.3%
4: 1996	--	--	--
5: 2006	96.40	-2.24	-2.3%
6: 2006 w/Tail	100.62	1.98	2.0%
7: Fast	89.32	-9.32	-10.4%
8: 2010 w/Accel.Tail	97.67	-0.96	-1.0%
9: 2006 w/Accel.Tail	97.08	-1.56	-1.6%
10: 2000 w/4 year	87.98	-10.66	-12.1%
11: 2010 w/4 year	98.64	0.00	0.0%

1. Cumulative Adjusted Chlorine Loading is the integral of chlorine and chlorine-equivalent bromine concentrations above 2.0 ppb.

2. Change in cumulative adjusted chlorine is expressed off a London Amendments baseline (scenario 2).

Exhibit 6-7

Sensitivity of Investment Costs to Discount Rate

($US Millions)

Scenario	Fund			Real Resource		
	10%	5%	0%	10%	5%	0%
1: 2000	6,709	9,023	12,384	7,905	10,598	14,579
2: 2010	909	1,177	1,680	1,901	2,449	3,391
3: 2010 w/Tail	584	828	1,311	1,243	1,993	3,802
4: 1996	--	--	--	--	--	--
5: 2006	897	1,183	1,701	2,004	2,609	3,582
6: 2006 w/Tail	545	758	1,145	1,392	2,129	3,607
7: Fast	667	772	928	1,960	2,428	3,145
8: 2010 w/Accel.Tail	787	1,024	1,400	1,742	2,433	3,673
9: 2006 w/Accel.Tail	704	921	1,263	1,812	2,527	3,718
10: 2000 w/4 year	6,665	8,968	12,314	7,888	10,577	14,554
11: 2010 w/4 year	917	1,199	1,723	1,890	2,437	3,378

Exhibit 6-8
Summary of Results

Scenario	Fund Costs (US$ Mil)	Real Resource Costs (US$ Mil)	Cumulative Adjusted Chlorine [1] (ppb-years)	Change in Cumulative Adjusted Chlorine [1,2] (percent)
1: 2000	6,709	7,905	88.0	-10.8%
2: 2010	909	1,901	98.6	0.0%
3: 2010 w/Tail	584	1,167	103.0	4.5%
4: 1996	--	--	--	--
5: 2006	897	2,004	96.4	-2.3%
6: 2006 w/Tail	545	1,392	100.6	2.0%
7: Fast	667	1,960	89.3	-9.4%
8: 2010 w/Accel.Tail	787	1,742	97.7	-1.0%
9: 2006 w/Accel.Tail	704	1,812	97.1	-1.6%
10: 2000 w/4 year	6,665	7,888	88.0	-10.8%
11: 2010 w/4 year	917	1,890	98.6	0.0%

1. Cumulative Adjusted Chlorine Loading is the integral of chlorine and chlorine-equivalent bromine concentrations above 2.0 ppb.

2. Change in cumulative adjusted chlorine is expressed off a London Amendments baseline (scenario 2).

- Finally, situations where savings are expected from a shift to a chemical with a lower price than the one it replaces were addressed in three alternate ways. First, it was assumed that the savings would not be used to offset the increased cost of other chemical switches Second, the alternative assumption was also evaluated; that is, cost savings were netted against cost increases, thereby lowering the overall demand on the resources of the Fund. In both cases, no Fund monies were assumed to be used to offset lower profits associated with the replacement chemical. Accordingly, a third assumption was evaluated that entailed payment of four years of lost profits.

328. Exhibit 6-9 presents the results of the production cost analysis. These results should be added to the Fund costs presented above. As discussed in Chapter 3, real resource costs were not estimated for the production phaseout to avoid double counting.

Exhibit 6-9
Production Phaseout Costs

Fund Reimbursement Rule	Undiscounted Cost (US $ Million) to Phaseout Production Based on:	
	Current Production	Existing Capacity
Savings Netted from Grant: Capital Cost Only	4.2	64.5
Savings Netted from Grant: Capital Cost + 4 Years Operating Cost	27.8	422.7
Savings Set Equal to Zero: Capital Cost Only	78.2	201.2
Savings Set Equal to Zero: Capital Cost + 4 Years Operating Cost	511.8	1,317.9
Lost Profits Paid in Lieu of Savings: Capital Cost Only	121.3	281.1
Lost Profits Paid in Lieu of Savings: Capital Cost + 4 Years Operating Cost	555.0	1,397.8

CHAPTER 7

CONCLUSIONS

329. The fundamental purpose of this study was to assess the feasibility of alternative phaseout schedules for Article 5 countries. The Study Team examined seven such scenarios, as presented in Chapter 2, from a variety of technological, institutional, and policy perspectives. In addition, the Study Team considered variations of several of those scenarios. This chapter reports the major conclusions of this assessment. (Note that all costs in this chapter are presented on a discounted basis using a 10 per cent discount rate.)

330. At the outset, it is important to consider that, in the context of the current Protocol with its single phaseout schedule for all Article 5 countries, the feasibility of any scenario is determined not by the prospects for phaseout in countries that will act first, but rather by the situation in those countries that will phase out last.

331. Phaseout by 1996. The Study Teams concluded that global phaseout by 1996 is not feasible. None of the CPs target such a phaseout and every country that provided feedback for this study stated that it could not meet a 1996 phaseout target. For this phaseout date to be met, tens to hundreds of field level projects would have to be implemented in approximately ninety countries within the next sixteen months. Article 5 governments, ODS-consuming enterprises, and technology suppliers do not have the capacity to complete a global transition within this time frame. Only four per cent of the Multilateral Fund-supported investment projects initiated to date have been completed and market forces and Article 5 government actions cannot be expected to change enough to drive an immediate ODS phaseout. The quantitative modeling results support this assessment by showing that targets for 1996 phaseout could not be met.

332. Phaseout by 2000. Global phaseout by 2000 would be extremely difficult, if not impossible. Although more than twenty Article 5 countries anticipate in their CPs that they can phase out by 2000, the remainder either specify later dates in their CPs or have yet to even finalize a CP with firm targets. Additionally, the time required for alternative technologies to completely penetrate certain informal sectors is six to seven years, effectively ruling out the 2000 target date. Furthermore, the capacities of implementing agencies, Article 5 governments and enterprises, and technology suppliers would be severely tested by this phaseout date. Many Article 5 governments, for example, have spent several years constructing policy frameworks based on targets well after 2000. Changing these targets would require immediate and definitive action by a large number of Article 5 countries, along with determined efforts to lead their industries through a very accelerated phaseout. If a 2000 phaseout is politically and institutionally possible, the quantitative modeling results show total Fund costs of US $6.7 billion and real resource costs of US $7.9 billion.

333. Phaseout by 2006. The Study Team concluded that a 2006 phaseout is feasible depending on how a significant number of policy and institutional constraints are dealt with. Approximately thirty CPs, or 75 per cent of those submitted to date, indicate the country's intention to eliminate ODS use near 2006. It is important to point out, however, that some of the higher ODS-consuming countries have some of the latest phaseout dates. The number of years until 2006 also is sufficient to allow

for complete penetration of alternative technologies in all sectors. The primary constraint, therefore, is whether the government, the Multilateral Fund, and the private sector in each Article 5 country can implement phaseout plans by 2006 that are based on the specific factors that drive local ODS consumption. As Chapter 5 highlights, these factors vary considerably between countries due to economic, technological, political, and cultural diversity. While it may be possible to group most Article 5 countries into three or four sub-categories, based on their gross domestic product and generalized ODS consumption and technology patterns, achieving a 2006 phaseout would probably still require distinct and deliberate actions to address the specific factors that affect each of these sub-groups. The feasibility of the 2006 and earlier phaseout scenarios also depends, of course, on the time it takes the parties to the Montreal Protocol to agree to the revised date. The quantitative modeling estimates total Fund costs of US $897 million and real resource costs of US $2 billion for this scenario.

334. Phaseout by 2006 with a Servicing Tail. The only difference between this and the previous scenario, 2006 without a servicing tail, is that the servicing tail avoids the need for a significant portion of equipment retrofits, effectively lowering costs but delaying the actual ODS phaseout by approximately 10 years, to 2016. A number of countries that provided feedback on the issue stated that they could meet this phaseout date. For this scenario, Fund costs are estimated at US $545 million and real resource costs at US $1.4 billion.

335. Phaseout by 2010. This scenario is feasible. All forty countries with CPs expect to phase out by this date, and the technology, policy and institutional constraints described above are less binding, though still important. The interplay of specific factors affecting phaseout in each individual country would still need to be addressed. For this scenario, the model estimates total Fund costs of US $909 million and real resource costs of US $1.9 billion.

336. Phaseout by 2010 with a Servicing Tail. A servicing tail under the 2010 phaseout scenario would eliminate all need for equipment retrofits, thereby lowering the costs of the phaseout and delaying ultimate phaseout to 2016. As such, costs of this phaseout are estimated at US $584 million for Fund costs and US $1.2 billion for real resource costs.

337. Phaseout as Fast as Cost-Effectively Possible. The Study Team estimated the fastest possible phaseout, subject to a cost effectiveness constraint that equipment retrofits would never be required. Under this scenario, new ODS using equipment need not be installed anywhere as of 2002. Based on the modeling results, virgin production of ODS can then be halted in 2011, with demand for ODS in existing equipment met through the year 2019 by recycling. This phaseout scenario produces total Fund costs of US $667 million and real resource costs of about US $2 billion.

338. Variations on these scenarios. In the quantitative modeling exercise the Study Team conducted sensitivity analyses regarding accelerated servicing tails and the duration of operating costs to be covered by the Multilateral Fund. An accelerated servicing tail indicates that ODS produced for the servicing tail could only be used for equipment manufactured prior to 1999. The results of these analyses are that an accelerated tail increases the speed of phaseout only in certain parts of the refrigeration sector and also increases the costs of the phaseout slightly. For the 2006 target date the accelerated phaseout costs projected in the quantitative model are US $704 million for Fund costs and US $1.8 billion for real resource costs. A 2010 phaseout with accelerated tail yields estimated Fund costs of US $787 million and real resource costs of US $1.7 billion. The impact of a variation in the duration of operating costs to be covered by the Multilateral Fund depends on the scenario being evaluated. For a 2000 phaseout, the Fund cost associated with reimbursing 4 years of operating

cost instead of two years is about US $44 million less, while for the 2010 target, the difference is about US $8 million more.

339. In summary, the earliest feasible phaseout date among those considered is 2006. Servicing tails lower costs by avoiding the need for equipment retrofits but do not affect the ultimate feasibility of any target date.

ATTACHMENT 1

1. TERMS OF REFERENCE FOR THE REPORT UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

2. REPORT OF THE SUB-COMMITTEE FOR THE REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL (May 23-24, 1994)

3. REPORT OF THE SUB-COMMITTEE FOR THE REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL -- Addendum (July 24, 1994)

Enclosure 1

TERMS OF REFERENCE FOR THE REPORT UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

1. The review referred to in paragraph 8 of Article 5, taking into account Section II, paragraph 4 of Decision IV/18, shall cover the following terms of reference:

a. Consider the schedule of control measures applicable to Article 5 Parties and the possible need for revision of the existing schedule of control measures after examining alternative scenarios. The following factors shall be taken into account in examining alternative schedules of control measures for Article 5 countries:

i. The financial implications of various phase-out strategies including comparisons in achieving the targets set in the London and Copenhagen amendments;

ii. The actual transfer of resources and technology to Article 5 countries and their absorption thereof taking into account the operation of the Fund to-date and determine, inter alia:

(1) the actual and approved transfer of resources to Article 5 countries,
(2) the relationship between the availability of controlled substances and the rate of implementation of activities for their phase-out in Article 5 countries,
(3) the rate at which low- and non-ozone-depleting-substance (ODS) technologies are being transferred to or developed by Parties operating under Article 5, including the actual implementation of these technologies, and
(4) the transfer of non-ODS technologies between Article 5 countries; and,

iii. The technological feasibility of a change in the control measures based on the reports of and discussions with the chairmen of the Scientific Assessment Panel and the Technology and Economic Assessment Panel; and,

iv. The feasibility of achieving the greatest possible reduction as soon as possible.

The review should also take into account:

b. The current plans of Article 5 Parties as articulated in their country programmes;

c. Document UNEP/OzL.Pro/ExCom/10/40, Annex I (Report on the Operation of the Fund adopted at the Tenth Meeting of the Executive Committee) updating the pertinent information; and,

d. The progress made and problems encountered by Article 5 Parties in implementing their country programmes and determine, based on the country programmes approved by the Executive Committee, the current status of ODS technologies used in Article 5 countries and the current per capita consumption and the likely growth in consumption of ODS in Article 5 countries.

The review should also: -

e. Provide information on legislation being enacted in Article 5 countries in consonance with the strategies and action plans included in the country programmes; and,

f. Describe market dynamics impacting the phase-out of controlled substances in Article 5 countries including the determination of the background of the industrial structure of Article 5 countries and the impact of ODS phase-out on the small scale and informal industrial sector.

Modalities

2. The report should be prepared by a well-qualified consulting firm with experience in working in Article 5 countries. The Secretariat is requested to invite consulting firms to tender bids based on this terms of reference as soon as possible so that bids will be received before 1 May 1994.

3. A sub-committee membership of six with equal representation of Parties operating under Article 5 and Parties not so operating should be established with oversight responsibilities for the study. The Sub-committee shall examine, with the assistance of the Fund Secretariat, the bids offered, select the consulting firm, approve its work programme, provide guidance, review the draft report, and any subsequent modifications to the report.

4. According to Decision V/11, the Committee's report must be submitted to the Open-ended Working Group through the Ozone Secretariat by 31 December 1994. To accommodate this directive from the Parties, a preliminary draft report will be submitted to Sub-committee members and the Fund Secretariat two weeks in advance of a September meeting of the Executive Committee. The Sub-committee will meet the day before a September meeting.

5. Also, to accommodate Decision V/11, the consulting firm's draft report should be submitted to the Fund Secretariat no later than 1 November 1994 to allow time to circulate it to Executive Committee members before an anticipated December meeting of the Executive

Committee. This meeting will enable the Committee to approve the report in time for the end of the year submission to the Open-ended Working Group.

6. Representatives of the consulting firm shall establish contacts with the Chairmen of the Scientific Assessment Panel and the Technology and Economic Assessment Panel to address the technological feasibility issue raised above in paragraph 1 and visit a representative sample of Article 5 countries taking into account a regional distribution and per capita consumption to be identified by the Sub-committee. The consulting firm will also have ongoing discussions with bilateral donors, members of the Executive Committee, the Ozone Secretariat, the Fund Secretariat and the implementing agencies.

7. Following the Committee's approval of the report in December 1994, the Fund Secretariat will invite Parties to comment on the report, compile the comments received, and submit the comments to the Open-ended Working Group and/or the Meeting of the Parties, if so requested.

8. Per Decision V/11, the selected consulting firm will continue work in 1995. Following the completion of the Committee's Report and its submission to the Open-ended Working Group, the consulting firm will prepare an addendum to the Report no later than three months before the Seventh Meeting of the Parties to be held in 1995 which will address all comments received in addition to updating the December 1994 report of the Committee.

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the Multilateral Fund for the
Implementation of the Montreal Protocol

Thirteenth Meeting
Montreal, 25-27 July 1994

REPORT OF THE SUB-COMMITTEE FOR THE REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

(May 23-24, 1994)

1. Pursuant to a decision of the Executive Committee at its Twelfth Meeting, the Sub-Committee for the Report on the Review under Paragraph 8 of Article 5 of the Montreal Protocol was convened in the offices of the Fund Secretariat in Montreal from 23 to 24 May 1994. The meeting was chaired by Mr. John Whitelaw, Australia, and was attended by representatives from Brazil, Denmark, India, United States of America, and Venezuela.

2. Following a brief closed session of the Sub-Committee, representatives from the four firms, ICF, TERI, CETEC, and CGC, representing the study team (the Consultant) were invited into the meeting. The Chairman of the Sub-Committee gave a presentation on the overall objectives of the study which was followed by an overview and task by task discussion of the study elements. A copy of the meeting agenda is included as Annex I.

3. The Sub-Committee agreed with the Consultant on the following issues:

(a) Phase-out schedules to be considered in the study:
  (i) London amendments for Article 2 countries
  (ii) London amendments for Article 2 countries plus 10-year grace period

(iii) London amendments for Article 2 countries plus 10-year grace period plus a tail for existing equipment
(iv) Copenhagen amendments for Article 2 countries
(v) Copenhagen amendments for Article 2 countries plus 10-year grace period
(vi) Copenhagen amendments for Article 2 countries plus 10-year grace period plus a tail for existing equipment
(vii) Maximum possible cost-effective reductions as soon as possible with a servicing tail
(viii) Scenario that develops as a result of the Consultant's study (if one arises) (will discuss in July)

(b) The amount of ODS used each year for each phase-out schedule should be specified.

(c) A decision on the precise manner of incorporation of HCFCs and methyl bromide will not be made until the July meeting of the Sub-Committee. The Consultant will meet with the co-chairs of the Technology and Economic Assessment Panel before the July Sub-Committee meeting to discuss this issue. It was understood that the modelling will include HCFC substitutes for CFCs but not substitutes for HCFCs or methyl bromide.

(d) The review of the Financial Mechanism to be undertaken in accordance with decision V/12 and this study on Article 5 country phase-out schedules should be kept distinct. The Consultant should make the data collected for this study available for the review of the Financial Mechanism.

(e) Analysis of technology transfer should focus on the time it has taken to implement projects on the shop floor. It should also take into consideration changes in the rate of technology transfer and resource transfer to the shop floor.

(f) Tail scenarios shall be defined as follows:

(i) Sensitivity analysis will be conducted of tail scenarios which includes an ending date of 1999 for the production of new ODS-using equipment. This sensitivity will apply to phase-out schedules in paragraph 3(a)(iii) and (vi) above.
(ii) Production and consumption of ODS continues only to service existing equipment. The practical implication is that no retrofits are required.

(g) The Consultant will not make recommendations concerning the phase-out schedules but will indicate if a particular schedule is not feasible and why.

(h) The Consultant will not evaluate the operation of the Fund.

(i) The Consultant will not prepare an original forecast of ODS prices, but the Consultant will assemble a consensus forecast of prices based on materials provided by chemical manufacturers, users, and distributors. The Consultant will inform the Sub-Committee about obtaining forecasts and discuss any issues that arise in that regard. The Consultant will consider in addition to multinational chemical producers, indigenous chemical producers.

(j) The Consultant will not provide analyses, summary information, or recommendations on a country-specific basis.

(k) Selected environmental organizations will be contacted during the data collection phase of the study.

(l) Data on project proposals that were considered by the Executive Committee and other information available in the Secretariat will be made available to the Consultant. The Consultant was requested to be as precise as possible when requested information (e.g., by including document numbers when available). Information will be provided on country programmes, project proposals, Fund disbursements, work programmes, and information provided under Article 7 of the Protocol (in cooperation with the Ozone Secretariat).

(m) The Consultant was asked to ensure that, during all country visits, priority would be given to visits to users and industry groups. OPUs, financial intermediaries and senior environment officials should also be interviewed.

(n) The Consultant will:

Meet next with the Sub-Committee: 24 July 1994
Submit preliminary draft report to Fund Secretariat: 6 September 1994
Submit draft report to Fund Secretariat: 1 November 1994
Submit final report to Fund Secretariat: 23 December 1994

(o) The Consultant will provide an outline of the report to the Sub-Committee during its July meeting.

(p) The Report is envisioned to include a 10-15 page Executive Summary and an additional 50-60 pages of text in the main body of Report. Additional materials will not be incorporated as appendices and instead will be submitted under separate cover. Country visit reports will not be part of the Report.

(q) The Addendum would include a response to the substantive comments received on the Report submitted in December. If new data are provided by the Fund Secretariat, the Consultant will evaluate these data and incorporate them in the Addendum as appropriate. The Executive Summary will be updated to reflect the Addendum.

(r) In seeking policy guidance from the Sub-Committee, the Consultant will submit in writing policy issues to the Fund Secretariat which will in turn submit the request to all members of the Sub-Committee. Sub-Committee members will communicate their views to the Chairman of the Sub-Committee who will communicate the decision to the Consultant. A short time frame, e.g., three working days, for a response from Sub-Committee members was acceptable and a non-response within the specified time frame would constitute no comment on the issue. It was understood that a decision would be rendered in five working days from the date of the query of the Consultant.

(s) The following countries should be visited by the Consultant: Brazil, Cameroon, Chile, China, Egypt, India, Malaysia, and Mexico. The Consultant developed the following list of countries for which data would be sought by means of phone and fax contacts:

Africa: Algeria, Kenya, Nigeria, Senegal, and Zimbabwe
Asia: Indonesia, Jordan, Pakistan, Philippines, and Thailand
Latin American/Caribbean: Ecuador, Panama, Trinidad/Tobago, Uruguay, and Venezuela

(t) The Consultant will provide the Sub-Committee through the Secretariat, with copies of the proposed data collection forms by mid-June for review.

(u) The Sub-Committee will provide the Consultant with letters of introduction to:

- Article 5 countries,
- UNEP Nairobi,
- Montreal Protocol Assessment Panels, and
- Implementing agencies and financial intermediaries.

(v) The study will move forward on the following assumptions for all of the scenarios:

- Projected demand for ODS until production controls begin,
- The Fund provides project support at current levels, and
- Nominal prices rise over time.

(w) Costs will be defined as both Fund-supported costs (as defined by the Executive Committee's and Parties' guidelines and procedures) and real resource costs.

4 The Chair closed the meeting at 12 noon on 24 May 1994.

ANNEX I

MEETING OF THE SUB-COMMITTEE FOR THE REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

(23-24 May 1994)

Agenda

Monday, 23 May 1994

9:00 - 10:30	**Sub-Committee meets** (without Consultant)
10:30 - 10:45	**Opening remarks**
10:45 - 11:15	**Study overview** (by Consultant)
11:15 - 11:45	**General observations**
	Presentation and discussion of Study Framework (a task-by-task presentation and discussion of the Consultant's proposal)
11:45 - 12:30	. Definition of Phase-out Schedule Scenarios (Task 2)
	. Data requirements (Task 3)
	. Data collection (Task 4)
12:30 - 14:00	**Lunch**
14:00 - 16:00	**Presentation and discussion of Study Framework** (continued)
	. Financial and atmospheric analysis (Task 5)
	. Institutional/Policy Analysis (Task 6)
	. Conclusions and recommendations (Task 7)
16:00 - 16:20	. Incorporation of Parties' comments and updating the 31 December report (Tasks 14-15)

16:20 - 16:30	**Study schedule**
16:30 - 17:00	**Agreements on issues**

- Country visits
- Adoption of framework
- Phase-out schedule scenarios
- Others

Tuesday, 24 May 1994

9:00 - 12:00	**Discussion of remaining issues and adoption of the Report**

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the Multilateral Fund for the
Implementation of the Montreal Protocol

Thirteenth Meeting
Montreal, 25-27 July 1994

Addendum

REPORT OF THE SUB-COMMITTEE FOR THE REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

(24 July 1994)

1. The second meeting of the Sub-Committee for the Report on the Review under Paragraph 8 of Article 5 of the Montreal Protocol was convened in the offices of the Fund Secretariat in Montreal on 24 July 1994. Following a brief review of organizational matters, the Consultant (representatives of ICF Incorporated and Tata Energy Research Institute) presented a progress report on the Review.

2. The Consultant stated that the data collection phase was nearing completion. All eight country visits have been conducted and 170 interviews of industry, government, trade groups, and others have been completed. In addition, interviews were conducted with UNDP and the World Bank. Other interviews were scheduled with UNEP (Paris and Nairobi), UNIDO, UNEP's science and technology assessment panels, and representatives of countries attending the Thirteenth Meeting of the Executive Committee. Responses to fax questionnaires have been received from eight countries. The Sub-Committee expressed satisfaction with the Consultant's plans to obtain responses from the seven outstanding fax questionnaires.

3. The Consultant indicated that it planned refinements to the phase-out schedule assessment model in the following areas: non-price factors, forecasting ODS prices, differences among Article 5 countries, the assessment of the production sector, and operationalising Fund guidelines. Concerning non-price factors, the Consultant will assess phase-out resulting from other market and institutional forces. After which, it will be assumed that projects with the most cost-effective technologies will be implemented. Concerning ODS forecasts, the study team will use unit abatement costs to develop price forecasts within the model and contact ODS manufacturers to check the price forecasts from the model. Instead of grouping Article 5 countries, the Consultant plans to use ODS consumption in each end use including the following market segments: export-driven consumption, domestic market consumption, and consumption in informal sectors.

4. The Sub-Committee decided that the Consultant should reflect the following assumptions in the report and that these assumptions are for the purposes of this study alone and should not be interpreted as Executive Committee policy.

5. Concerning the operationalisation of Fund guidelines, the Sub-Committee decided:

Period of operational costs

(a) The period for operational costs should be determined as a weighted average, by industrial sub-sector, of the operational cost periods included in projects submitted to the Thirteenth Meeting of the Executive Committee. Additionally, the Consultant will use a four year period for operational costs as an upper boundary for two of the scenarios to be determined by the Consultant.

Residual capital value

(b) The residual capital value of equipment should be assumed as zero except in the production sector where an estimate should be developed. The precision and rigor of the estimate is dependant upon available data and resources.

Halon and TCA recycling

(c) Halon recycling is eligible and should be included. TCA projects with a cost effectiveness below US $100 per ODP kilogram phased-out should be included.

6. Concerning the production sector, the Sub-Committee decided that the Consultant should use a reasoned approach and readily available technical information to estimate the costs of conversion on a global scale and not on a country or plant basis.

7. Concerning the incorporation of the costs and impact on the ozone layer of HCFCs and methyl bromide, the Sub-Committee decided that:

(a) The Consultant should contact the Technical and Economic Assessment Panel (TEAP) to determine what TEAP plans to propose as a phase-out schedule for these substances and determine to what extent this information could be incorporated into the assessment model either as a separate "off-line" calculation or as part of the model. The Consultant will inform the Sub-Committee of the results of discussions with TEAP by 5 August 1994.

(b) At a minimum, the Consultant should include an overview with a reasonable degree of detail on the present status of non-ODS substitutes for HCFCs and for methyl bromide as well as the status on the degree to which such substitutes are being used or planned to be used. This overview should be in the order of 2-4 pages included in the report and reflected in the executive summary on a half to a full page.

8. The Consultant and the members of the Sub-Committee agreed to the possibility of a Sub-Committee Meeting the day before the next Executive Committee Meeting.

9. The Chairman closed the Meeting at 12:00 noon.

ATTACHMENT 2

THE PROJECT CYCLES OF THE IMPLEMENTING AGENCIES

340. This attachment presents the updated descriptions of the project cycles of the four Implementing Agencies (IAs): World Bank, UNEP, UNDP, and UNIDO. In addition, updated summary descriptions of the IAs are provided where applicable.

WORLD BANK

341. **Background.** The World Bank became an implementing agency of the Multilateral Fund in 1991, when it entered into an agreement with the Executive Committee of the Multilateral Fund to channel resources to support investment operations for the phaseout of ozone-depleting substances (ODS). Initially, Montreal Protocol operations were coordinated on a regional basis, usually through the regional Technical Departments and with minimal support from the central Environment Department, leading to differences in quality and little standardization. In November 1992, a Bank-wide reorganization provided an opportunity to restructure the Bank's Montreal Protocol operations to create the needed critical mass and synergy for rapid quality improvements. Coordination functions were relocated in the Environment Department's Global Environment Coordination Division. This has led to important productivity gains. Standardization and streamlining of project preparation procedures and increased inter-regional exchange have contributed to improved focus on global program management, identification and evaluation of key policy issues. The Project and Sub-project cycles presented in the following paragraphs are a result of the streamlining effort undertaken by the Bank to accommodate a new business.

342. **Project Cycle.** The Project Cycle is usually initiated when a World Bank Country Department for the country concerned assigns a task manager to each project from its inception. To initiate discussions, the task manager will usually lead a mission to consult with the government on the project and the necessary measures which must be taken to ensure its preparation, approval and eventual implementation. In the context of most Bank projects, this often includes the selection of a financial intermediary who will handle in-country sub-project appraisal and disbursal of funds for project execution. Working with the country early in the process to select the financial intermediary and determine the terms of procurement, disbursement and sub-project eligibility criteria are critical to ensuring timely implementation of MP Bank projects. In an increasing number of countries, responsibility for project identification and preparation is being assumed locally. This has been made possible through the establishment of Montreal Protocol Project Preparation Advances which provide resources to a local executing agency to undertake project preparation work.

343. Following the initial mission or when sufficient understanding is reached on the project implementation approach, the Bank drafts what it calls an Executive Project Summary/Project Information Document (EPS/PID). This document is the vehicle that the Bank uses to obtain internal approval of a project. Annexes to the EPS/PID include sub-project summaries. Sub-project documentation, not the EPS/PID per se, are submitted to the Executive Committee for review. The sub-project documents are prepared in accordance with the agreed format.

344. To ensure that the best possible advice is provided in the technical review of ozone projects, the Bank has established the Ozone Operations Resources Group (OORG). This body, which is made up of internationally recognized experts, serves as a resource to the Bank, and through it, the

Multilateral Fund. Following OORG review of the sub-projects listed in the annexes to the EPS/PID and other available technical documentation, the Bank holds an internal review meeting with the Country Department. This meeting is also attended by peer reviewers and staff from the Bank's Global Environment Coordination Division, which is the focal point for MP operations coordination. With the introduction of "umbrella" grant agreements, the reviews meeting can be held somewhat independently of the status of sub-project preparedness given that the focus will be on the review of the implementation mechanism.

345. Usually, initial internal approval to submit the sub-projects for Executive Committee consideration is received at this meeting although the mechanism within an umbrella agreement does not require an internal review meeting to approve sub-projects, as this is done at the division level. Following this approval and the endorsement of the country, the Bank submits the sub-project documentation to the Fund Secretariat. As discussed above, the Bank indicates the kind of action it is requesting the Executive Committee to take (e.g., approval as a Work Programme amendment, final project approval, or permission to proceed).

346. For umbrella agreements that are in the process of being established, the Executive Committee approval of the sub-projects initiates the final project approval steps. Following Executive Committee approval, the Bank must change the EPS/PID into a Memorandum of Recommendation and prepare, or continue the process of developing, a legal grant agreement which are key documents on which Bank management can approve release of funds from the Ozone Projects Trust Fund for an Executive Committee-approved project. The need for Bank management approval is in keeping with the obligations of the Bank as defined in the agreement with the Executive Committee, including its fiduciary and project appraisal and supervision responsibilities.

347. The grant agreement process is in some cases the most time-consuming portion of the project approval process. There are several reasons for this. First, there are often a number of Agencies in the recipient country that are involved. Thus, final approval requires a high degree of coordination, both between the Bank and the Agencies and between the Agencies themselves.

348. The Bank has addressed these issues by initiating discussions of grant-related issues during the project's development, rather than waiting until the project has been approved. In that regard, the Executive Committee has encouraged relevant Implementing Agencies to implement sub-projects under one unique legal framework (umbrella agreement) with the relevant intermediary in the recipient country. To expedite Article 5 country approval of grant agreements, the Executive Committee also recommended that Article 5 countries consider the selection of a focal point and use interministerial bodies, as appropriate. As a result of these activities, it is expected that the development of subsequent grant agreements in Article 5 countries will be much easier, as many of the issues will have been worked out in the initial agreement. The use of umbrella grant agreements has significantly lessened the administrative burden.

349. Before the grant agreement can be finalized, the Bank must conduct a final appraisal of the projects. This is usually done after the first batch of sub-projects have been approved by the Executive Committee and is not required for the subsequent batches of sub-projects which are processed through an umbrella agreement. This involves a final review of local implementation arrangements and requirements. Over the last year, in order to expedite project implementation post Executive Committee approval, the Bank has moved in the direction of undertaking the functional equivalent of a pre-appraisal of the sub-projects prior to Executive Committee submission.

350. Once the project is authorized, the legal documents are signed by the Bank and the country, and the funds can be disbursed in accordance with its terms. In most cases, the money will be disbursed to a financial intermediary who will be responsible for local sub-project appraisals and implementation overview. This is because the Bank does not execute investment projects. Instead, their role is to monitor project implementation through regular supervision missions.

351. As indicated above, one unique attribute of the Bank's operation is that, whenever possible, it combines what would normally be considered as several discrete projects (referred to above as sub-projects) into a single "umbrella project". This reduces the administrative burden on its clients and staff, and, by including all the sub-projects in one grant, saves substantial time during project processing, as well as administrative costs. In any event, the Executive Committee reviews each sub-project which has an incremental cost of over US$ 500,000. Exhibit IBRD-1 shows the World Bank's project cycle.

UNEP

352. UNEP, as per its agreement with the Executive Committee of the Interim Multilateral Fund, has been tasked with the following work:

a) political promotion of the objectives of the Protocol
b) research and data-gathering, according to the provisions of the Protocol; and
c) clearing-house function comprising the following activities:

i) assist Parties operating under paragraph 1 of Article 5 of the Protocol, through country-specific studies and other technical cooperation, to identify their needs for cooperation;

ii) facilitate technical cooperation to meet these identified needs;

iii) collect and disseminate information and relevant materials, hold workshops and training sessions and other related activities for the benefit of Parties that are developing countries; and

iv) facilitate and monitor other multilateral regional and bilateral cooperation available to Parties that are developing countries.

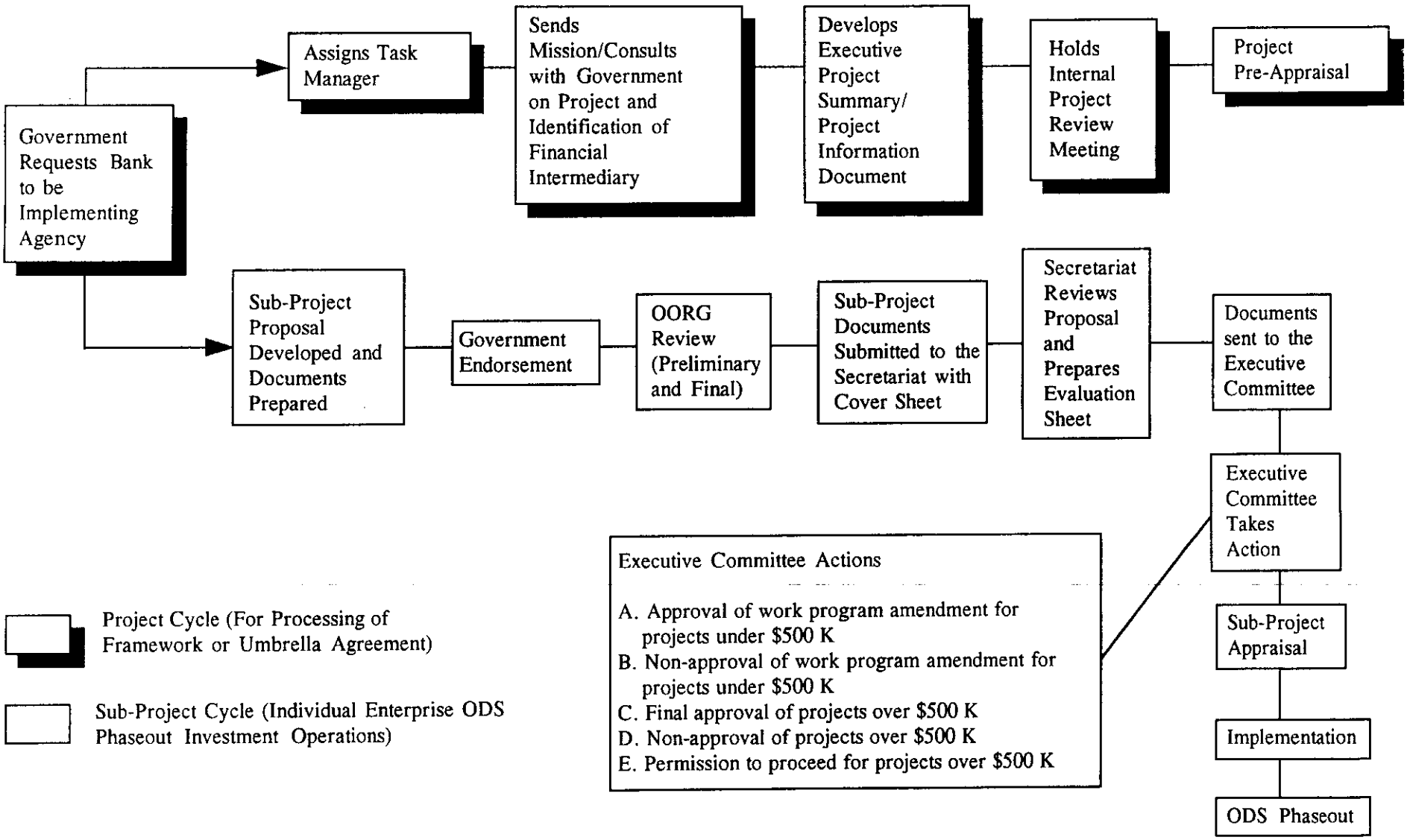
353. Based upon this agreement and a constant review of the needs of Article 5 countries, UNEP IE/PAC's OzonAction programme at present consists of the following elements:

a) **Information Exchange**, where information is being collected and disseminated through:

i) *OzonAction Information Clearinghouse*, an integrated service providing technical and policy information via diskette, on-line system, phone, fax, and mail;

ii) *OzonAction Newsletter and special supplements*. The newsletter is available quarterly in Arabic, Chinese, English, French, and Spanish;

Exhibit IBRD-1
World Bank Montreal Protocol
Project and Sub-Project Preparation



iii) *Sector-specific brochures and technology catalogues*, providing information on identifying and selecting alternative technologies to protect the ozone layer;

iv) *Information campaign materials*, to assist national ozone units with public awareness campaigns; and

v) *International Recycled Halon Bank Management Information Clearinghouse*, providing Parties with information about halon banking, recycled halon availability, non-halon alternatives, and halon banking.

b) **Networking and Institutional Strengthening**. Strengthening of institutions dealing with the phasing out of ODS in developing countries is an essential element in the protection of the ozone layer, and UNEP IE/PAC is assisting small Article 5 countries on a bilateral and regional basis.

Networks have been created for the exchange of experiences on strategies to phase out ODS among national ozone units in Southeast Asia, Latin America, and Africa.

c) **Training**. Training activities are organized at the regional level using the "train the trainer" approach, and support is provided to national activities. At workshops and training courses, participants are provided with the latest technical information and skills required for ODS phaseout.

d) **Country Programmes**. The UNEP IE/PAC OzonAction Programme assists low ODS-consuming countries to assess their current production and consumption and to develop their own phaseout action plans.

Exhibit UNEP-1 presents a summary description of UNEP.

UNDP

[AWAITING REVISION FROM UNDP]

UNIDO

[AWAITING REVISION FROM UNIDO]

Exhibit UNEP-1
Summary Description of United Nations Environment Programme

United Nations Environment Programme (UNEP)	
Role	• Fund treasurer: receives all financial contributions, transfers funds according to EC instructions and keeps accounts at not charge to the Fund and according to UN financial rules. • Political promotion of the objectives of the Protocol. • Research and data-gathering according to the provisions of the Protocol. • Clearinghouse functions as defined in Article 10 of the Protocol: assisting Article 5 countries identify their needs for cooperation; facilitating technical cooperation to meet these needs; collecting and disseminating of data; holding workshops and training sessions, and facilitating multilateral regional and bilateral co-operation available to Article 5 countries.
Organization	• The treasure function is located in Nairobi. • The clearinghouse and promotional activities are part of the Paris-based Industry and Environment Programme Activity Centre. • The OzonAction Programme's professional staff consists of a programme coordinator and 3 programme officers. • UNEP Regional offices participate in managing regional and bilateral activities in accordance with UNEP's decentralization policy. • UNEP IE/PAC has created a number of regional networks for ODS officers, and Regional Network Coordinators are located in Bangkok, Mexico, and Nairobi. • UNEP IE/PAC also uses a number of specialized consultants in the process of preparing the Country Programmes and in other activities.
Operating Philosophy	• UNEP IE/PAC involves the country to the maximum extent possible, thereby creating ownership and building local institutional capacity. • This leads to a "bottom-up" philosophy when identifying needs and during programme development and project identification. • The needs of Article 5 countries are regularly reviewed, and project guidelines are adjusted accordingly.
Coordination	• Coordination between implementing agencies has been institutionalized and sponsored by the Fund and takes place during annual preparation of the work programmes as well as on an ad-hoc basis. • UNEP IE/PAC cooperates with several other government agencies including Swedish International Development Agency, Finnish International Development Agency, and USEPA. UNEP IE/PAC also cooperates closely with UNEP TEAC/TOCs, NGOs, and industry associations. • Coordination of regional and bilateral activities is facilitated through the Regional Network Coordinators.
Process	• The interactive and consultative approach is exemplified by a broad-based Advisory Group from the EC, Secretariat, industry, NGOs, and developed and developing countries. • The network approach has proven very useful in assisting Article 5 countries on a regional basis.
Constraints	• Considering the large number of small, low-consuming Article 5 countries UNEP IE/PAC is assisting, efforts are being made to regionalize the activities in order to maximize the support within the financial constraints given by the very small projects. • As the support cost ratio varies with the size of the project, using a fixed support cost percentage (13 per cent) is clearly inadequate when dealing with small projects. Therefore a non-linear scale or a fixed-amount system should be considered.