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DRAFT REPORT ON THE REVIEW UNDER PARAGRAPH 8 OF ARTICLE 5 OF THE MONTREAL PROTOCOL

REPORT UNDER PARAGRAPH 8 OF ARTICLE 5

OF THE MONTREAL PROTOCOL

DRAFT

Submitted to:

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

Submitted by:

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November 4, 1994

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 Keith Bowers, 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 ratifying the Montreal Protocol on Substances that Deplete the Ozone Layer, more than 130 of the world's nations have agreed to phase out the consumption and production of ozone depleting substances (ODS). A key feature of the Protocol is that it includes separate phase-out schedules for two different types of countries. Developed countries are to complete their phase-out of the most significant ozone depleting chemicals by 1996. Special status under Article 5 of the Protocol has been accorded to more than 90 developing countries, which currently have until 2010 to complete their phase-out of these chemicals. Article 5 countries are also eligible for financial support from the Multilateral Fund established by the Protocol.

Purpose of the Study

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 three meetings between the Study Team and the Sub-Committee, the fundamental purpose of the Study is to assess the feasibility of alternative phase-out schedules for Article 5 countries, taking into account impediments to and incentives for technology transfer as well as the implementation of the financial mechanism.

Phase-out Schedules Analyzed

3. A total of eleven phase-out schedules are analyzed in this Study. Ten of the scenarios differ with respect to four key parameters discussed below. An eleventh scenario investigates the fastest economically feasible phase-out subject to a cost-effectiveness constraint. The four parameters that collectively define the scenarios can be summarized as follows:

- Phase-out Date: For each scenario, a single date is defined on which, with the exceptions noted below, all production of ODS is assumed to cease.

- Service Tail: In certain scenarios, use of new ODS is allowed after the phase-out date to service existing refrigeration and air conditioning equipment. Such a tail eliminates the need for retrofits or early retirements.

- Service Tail with Accelerated Phase-out: In two scenarios, ODS use in new refrigeration and air conditioning equipment is phased out in 1999 rather than by the phase-out date. Use of ODS to service this equipment is then allowed after the phase-out date. This is in contrast to the tail scenario described above which allows use of ODS in new equipment until the phase-out date, rather than 1999.

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

4. An eleventh scenario was analyzed that assumed all substitute technologies would be implemented as soon as commercially available subject to the condition that retrofits of existing equipment would not be required. This scenario is fundamentally different all others in that a phase-out schedule with interim targets is not specified, instead the speed of phase-out is determined by the simulation model used for the Study. Thus, in order to maximize cost effectiveness, this scenario includes a tail to service existing ODS-containing equipment. Exhibit ES-1 summarizes the features of all eleven scenarios.

5. The remainder of this Executive Summary describes the highlights of the Study, which comprises four elements, including data collection, policy and institutional analysis, cost and ODS use estimates, and environmental assessment. For each element, the relevant methodology and key findings are presented. After a quick review of the scope of this Study, the Executive Summary concludes with an integrated analysis of the results.

DATA COLLECTION

Characterization of 21 Article 5 Countries

6. The first element of the Study involved an extensive data collection effort, focused on the situation in Article 5 countries. The Study Team visited eight Article 5 countries and interviewed over 170 individuals in-country to collect data required for the Study. The country visits involved interviews with government officials, staff of the ozone protection unit (OPU), industry representatives, chemical distributors, ODS producers, and trade associations.[1] Thirteen other Article 5 countries responded to a faxed questionnaire, which addressed several factors related to the feasibility of various phase-out schedules. The Study Team also reviewed 40 Country Programmes (CPs) and over 60 investment project proposals. Exhibit ES-2 illustrates the 21 countries studied as part of this report.

Input from International Organizations

7. Staff from several other organizations also provided substantial input, including:

- The Multilateral Fund Secretariat in Montreal;
- The Ozone Secretariat in Nairobi;
- 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);
- Members of the Executive Committee of the Multilateral Fund, including three donor countries and five Article 5 countries;
- The UNEP Technology and Economic Assessment Panel (TEAP);
- The UNEP Scientific Assessment Panel;
- Chemical and technology producers; and
- Several environmental and development oriented non-governmental organizations active on the issue of stratospheric ozone depletion.

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[1] These in-country interviews, as well as all other interviews done for the Study, were conducted on a not-for-attribution basis.

Exhibit ES-1: Definition of Phase-out Scenarios

Scenario	Phase-out Date	Service Tail?	Service Tail with Accelerated Phase-out?	Duration of Reimbursed Operating Cost (years)
1996 Phase-out	1996			2
2000 Phase-out	2000			2
2006 Phase-out	2006			2
2006 Phase-out with Service Tail	2006	Yes		2
2010 Phase-out	2010			2
2010 Phase-out with Service Tail	2010	Yes		2
Fast as Cost-Effectively Possible	See Text	Yes		2
2006/1999 Phase-out with Service Tail	2006		Yes	2
2010/1999 Phase-out with Service Tail	2010		Yes	2
2000 Phase-out w/4 Years Reimbursement	2000			4
2010 Phase-out w/4 Years Reimbursement	2010			4

Exhibit ES-2

Countries Studied

Countries Visited

Brazil
Cameroon
Chile
China
Egypt
India
Malaysia
Mexico

Countries Responding to Questionnaire

Ecuador
Indonesia
Jordan
Kenya
Nigeria
Pakistan
Panama
Philippines
Thailand
Trinidad & Tobago
Uruguay
Venezuela
Zimbabwe

8. Of note is that when, pursuant to its Terms of Reference (TOR), the Study Team contacted the TEAP, the Team found that information from the TEAP's current reviews is being updated. The Team followed the Co-Chair's advice to consult existing TEAP documents for data on feasibility, cost, and performance of alternatives.

Descriptive Overview of Collected Data

9. Data collected by the Study Team were used for all elements of the Study. Chapter 4 presents a descriptive overview of the Team's findings related to specific items in the TOR. Analysis and interpretation of these data have, for the most part, been reserved for Chapters 5 and 6 (i.e., the policy and institutional analysis and the modeling analysis, respectively). Highlighted below are the key findings from Chapter 4 organized around the items in the TOR.

10. Actual and Approved Transfer of Resources (TOR Item 1-a-ii-1): Data to assess the transfer of Multilateral Fund resources to Article 5 countries were obtained from the Fund Secretariat. The data indicate that 685 projects (worth US $198.5 million) have been approved by the Executive Committee as of its 13th Meeting. To date, few of the 197 approved investment projects have been completed, though many have been initiated. Among other types of projects, the highest completion rate is associated with training projects which, by their nature, tend to be of a shorter duration than other projects.

11. Availability of ODS and Rate of Implementation (TOR item 1-a-ii-2): Based on the countries studied, some shortages of ODS were observed, principally halons and CFCs other than CFC-11 and CFC-12. Data on price trends suggest a diverse situation. Prices seem to have remained steady in the ODS producing countries. In other countries, regional differences were observed with prices apparently on the increase in Africa and Latin America while remaining generally unchanged in Asia. For countries experiencing significant ODS supply disruptions or rapid escalations in price, some phase-out activity appears to have occurred as direct result.

12. Rate of Technology Transfer in Article 5 Countries (TOR item 1-a-ii-3): Implementation of low- and non-ODS technologies in Article 5 countries varies considerably across ODS-use sectors and across countries. In general, phase-out implementation has progressed farthest in the aerosols and flexible foams sectors, but is in the early stages in domestic refrigeration and, to a lesser extent, rigid foams. In the halons and solvents sectors, phase-out 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. A rapid transition to non-ODS technologies is underway in the manufacture of mobile air conditioners (MACs) though widespread retrofits of existing MACs has not occurred.

13. Transfer of Non-ODS Technologies between Article 5 Countries (TOR item 1-a-ii-4): While no actual transfer of non-ODS technologies between Article 5 countries has been observed in the countries visited, such transfer is in the planning phases and will likely occur in the next year or two. In addition, transfer of skills and knowledge related to non-ODS technologies (as distinct from the technologies themselves) has occurred in some sectors.

14. Current Plans as Articulated in Country Programmes (TOR item 1-b): Many Article 5 countries have indicated in their CP that their phase-out will be accelerated relative to the requirements of the Montreal Protocol. Several countries have, however, made acceleration contingent upon receipt of substantial support from the Multilateral Fund. In 29 of 40 CPs analyzed, countries have committed to phase out CFCs earlier than 2010. If the stated phase-out date for each country is weighted to reflect the country's use of each chemical, the average phase-out dates can be computed as follows: CFCs -- 2007, halons -- 2008, carbon tetrachloride -- 2009, and methyl chloroform (MCF) -- 2001. While the average phase-out schedule for MCF represents a 14 year acceleration compared to the Protocol requirement, the accelerations shown for other chemicals represent only small advances over the Protocol date. It is also important to note that these dates do not reflect more than 50 countries that do not yet have approved CPs.

15. Operation of the Fund and UNEP/OzL.Pro/ExCom/10/40 Annex I (TOR item 1-c): The TOR require the Team to take into account an earlier analysis for the Executive Committee entitled "Report on the Operation of the Financial Mechanism Since 1 January 1993" and to update pertinent information in the document. The Team has done so and provided updated descriptions of the project cycle for the four implementing agencies in Attachment 1.

16. Progress and Problems in Implementing Country Programs (TOR item 1-d): Issues concerning progress made and problems encountered by Article 5 countries in implementing their CPs are central to the Study and are directly addressed in the policy and institutional analysis presented in Chapter 5 and in the modeling analysis described in Chapter 6. Presented below, therefore, are only the general themes that were evident in the data collected from the 21 countries studied in detail. Factors cited by several countries as impediments to phase-out include:

- Lack of awareness about the phase-out by enterprises in the country
- Lack of information about alternative technologies
- Lack of an OPU or recent establishment of OPU
- Lack of funding or capital for conversion to alternative technologies
- Unavailability of alternative technologies
- Complicated procedures for receiving Multilateral Fund assistance, particularly regarding funds disbursement

Factors facilitating the phase-out that were cited by more than one country include:

- Availability of cheaper substitutes (especially in aerosols and flexible foams)
- Foreign ownership of local ODS users or presence of multinational corporations
- Multilateral Fund support
- Awareness programs (both general and targeted)
- High or rising ODS prices

17. Legislation Enacted in Article 5 Countries (TOR item 1-e): Although a majority of Article 5 governments either have taken formal action to facilitate the phase-out 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.

18. Market Dynamics Impacting the Phase-out (TOR item 1-f): Seven major characteristics of the market dynamics in Article 5 countries have a significant influence on the phase-out, including

- Prices: ODS prices do not appear to have behaved consistently across all Article 5 countries. In producing countries and in Asia, prices have been relatively steady, while in Latin America and Africa, prices have risen appreciably. Generally, ODS phase-out has moved faster where prices are increasing rapidly.

- Export Orientation: In sectors with a preponderance of export-oriented enterprises, the phase-out has been accelerated. This has resulted from policies in developed countries that affect the feasibility or desirability of importing products that contain or are manufactured with ODS. Exporters have typically moved quickly to phase-out use of ODS to protect export markets.

- Ownership of ODS-Using Enterprises: Most Multinational Corporations (MNCs) have been phasing out ODS use worldwide, including in Article 5 countries. In one country, for example, most MNCs have phased out ODS use in the solvents sector, but phase-out by local enterprises has been very limited.

- Size and Formality of Enterprises: The presence of a significant informal sector can impede phase-out in a country. Characterized by several small ODS users, the informal sector relies upon more labor-intensive practices and less rigorously trained staff than the formal sector. It has often proven difficult to reach such enterprises with information about the ODS phase-out and phase-out projects may tax the financial and technical resources of these enterprises.

- Size of Existing Capital Stock Requiring Ongoing ODS Use: If expensive ODS-using equipment is in place, firms tend to move more slowly to alternatives than do enterprises where the value of the ODS-dependent capital stock is lower.

- Local Production of ODS: The availability of locally produced ODS and the accompanying low prices have tended to reduce the signals for accelerated phase-out. In addition, ODS producers in the Article 5 countries are now exporting to other, non-producer, Article 5 countries as well.

- Flow of Information about Non-ODS Technologies: Most large and many medium sized enterprises can obtain specific information from the Implementing Agencies or from the vendors of chemicals and technologies in non-Article 5 countries with which they have existing links. The lack of information on alternative technologies available to small and informal enterprises has impeded phase-out.

19. Feedback from Article 5 countries on Phase-out Scenarios: In both the country visits and the fax questionnaires, staff from OPUs were asked whether they expected to have difficulty meeting certain phase-out schedules. Exhibit ES-3 summarizes the responses received from the 21 countries regarding the feasibility of the various phase-out schedules.

Exhibit ES-3
Summary of Feedback From Article 5 Countries on Phase-out Schedules

Phase-out Schedule	Feasible	Not Feasible	No Opinion
2010	21	0	0
2006 with servicing tail	16	2	3
2006	9	11	1
1996	0	20	1

POLICY AND INSTITUTIONAL ANALYSIS

Use of Structured Analytic Framework

20. The second element of the Study Team's approach entailed compilation of the collected data and their analysis during a week-long policy workshop. This workshop was attended by ten members of the Team who employed a structured framework to identify, organize, and consider a series of qualitative policy and institutional issues that affect the phase-out of ODS. The Team first identified nine key actors that play some role in the process of technology transfer and then divided this process into twelve discrete steps. Next, the list of key actors and the steps in technology transfer were combined to create the matrix shown in Exhibit ES-4.

21. The Study Team used the matrix to determine in which steps each actor played a significant role and noted the result with a check mark in the matrix. Workshop participants then analyzed the policy and institutional issues associated with the significant cells in the matrix. The rationale behind this approach is that the 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 phase-out scenarios.

Identification of Policy and Institutional Considerations

22. A wide variety of policy and institutional factors determine when and in which sectors each country will be able to end its use of ODS. These factors can be divided into two categories based on whether they potentially have a primary or secondary impact on the phase-out. Primary factors directly and unambiguously affect the feasibility of various phase-out scenarios in the countries where they are operative. Each of these primary factors has a potential impact of several years on the final phase-out date. Other policy and institutional factors are more secondary in nature because they may affect the rate of technology transfer by only a year or two.

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.

Primary Factors Affecting Phase-out

23. Market Dynamics: The first primary factor affecting the phase-out relates to the markets for ODS technologies and the associated alternatives. Because most enterprises using ODS are for-profit entities that make business decisions primarily on the basis of economic considerations, various market forces can have a major influence on the decisions of enterprises to stop using ODS. These include, for example, international and domestic trade pressures and the prices of ODS and alternative technologies. The nature and direction of these forces play an extremely important role in the feasibility of alternative phase-out schedules.

24. Global Commitment and Financial Support for Phase-out: The second primary factor affecting the phase-out is the existence of the Montreal Protocol and the Multilateral Fund. These institutions represent the commitment made by over 130 countries to eliminate ODS use. The Montreal Protocol itself, as a high profile global agreement endorsed by governments and including specific obligations for signatory countries, provides the international focal point and legitimacy that drives the entire phase-out effort. The Multilateral Fund is the institutional mechanism for covering the incremental costs of the phase-out in Article 5 countries. Taken together, the Protocol and the Fund have proven to be a powerful incentive to encourage countries and enterprises to initiate phase-out activities.

25. Article 5 Country Governments - Policy Actions and Establishment of the OPU: The third primary factor affecting the phase-out is actions taken by the Article 5 country governments. This includes the establishment of a functioning OPU and the implementation of policies that directly affect ODS production, consumption, and commerce. The OPU plays an important role as a focal point for phase-out activities in a country. Without a functioning OPU of even a minimal size, the Secretariat and the implementing agencies cannot provide services as effectively to the country. In addition, the institution of specific policy measures can significantly affect the speed of phase-out in Article 5 countries. These measures may include, for example, import quotas, voluntary or mandatory ODS use or production controls, and ODS or technology taxes or subsidies.

26. Time Required for Societal Transition: The fourth primary factor affecting the phase-out 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 and must foster difficult technological transformations in diverse economic sectors. To do so successfully, they must overcome an array of technical, institutional, economic, and political constraints at the national and international levels and must do so amidst many additional complications including, for example, priority given to other critical social policies, varying levels of regulatory support, limited institutional capacity, sparse technical and economic data, and lack of local experts familiar with non-ODS technology.

Secondary Factors Affecting Phase-out

27. Four secondary factors were identified which may affect the rate of technology transfer and thus the feasibility of alternative phase-out schedules. They may combine or interact in some countries or industrial sectors to bring ODS phase-out to a temporary halt. They may also contribute to the uncertainty or risk surrounding phase-out projects perceived by ODS consuming enterprises, causing those enterprises to delay their phase-out efforts.

28. Identification, Evaluation, and Selection of Non-ODS Technologies at the Project Level: The first of the secondary factors identified by the Team relates to the degree to which technology transfer is affected by the fundamental choice of enterprises to stop using ODS and by factors that influence how enterprises identify, evaluate, and select replacement technologies. These factors may include 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 phase-out, while failure can lead to delay in phase-out 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.

29. The Terms of Project Financing for Article 5 Country Enterprises: The second of the secondary factors relates to the requirement that only the incremental costs of ODS phase-out will be financed by the Multilateral Fund. Depending on levels of uncertainty and risk, even with incremental costs fully subsidized, an enterprise may still be indifferent between its current and the alternative technologies. Fund grants which do not fully cover all the incremental costs from the enterprise's perspective, therefore, provide even less incentive for an enterprise to phase out.[2] The Executive Committee has put in place procedures to allow for sectoral phase-out strategies that include projects with net incremental savings and for concessional loans to address financing difficulties. While there has been some forward movement to develop sector-wide projects, the Implementing Agencies currently provide only grants and not loans. This is particularly important because enterprises in many Article 5 countries find it difficult to obtain project financing for ODS phase-out projects from sources other than the Multilateral Fund.

30. The Governance Structure and Operation of the Multilateral Fund: The third of the secondary factors addresses those aspects of the Multilateral Fund's structure and operations with the potential to affect the rate of technology transfer. The Executive Committee, Secretariat, and implementing agencies have different roles to play in the project development, approval, and implementation process. Although the roles of the Executive Committee and the implementing agencies have been defined, there appears to be a perception in the field that differing and confusing priorities and objectives sometimes emerge between the Executive Committee and the implementing agencies related to, for example, cost effectiveness, technical criteria, and safety criteria, slowing technology transfer efforts by requiring repetition of tasks or redesign of projects prior to submittal to the Executive Committee. The involvement of multiple agencies for administering the Multilateral Fund also sometimes causes confusion for enterprises in Article 5 countries.

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[2] 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, nor does it address normative issues regarding obligations of countries and enterprises to phaseout.

31. The Structure and Operation of OPUs in Article 5 Countries: While the existence of an OPU is a vital prerequisite for forward progress on ODS phase-out, both the capacity and capabilities of those OPUs that do exist have an impact on the phase-out. Some OPUs are autonomous organizations while others are part of larger government agencies, such as the national ministries responsible for environment or finance. Some OPUs have multiple staff dedicated solely to ozone protection issues, others have staff whose primary responsibilities have little to do with ozone, and still other countries do not have anyone working on the issue on a daily basis. Similarly, some OPUs are intimately involved in all stages of project development and implementation while others play a passive role.

Consequences for the Phase-out of Diversity among Countries

32. As the Study Team assessed alternative phase-out scenarios, it quickly became clear that the prospects for ODS phase-out are affected by different combinations of factors in different countries. 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.

33. In the context of the existing Protocol with a single phase-out date for Article 5 countries, the consequence of these differences is that the feasibility of a global phase-out scenario is determined by the countries that eliminate ODS last, rather than by those that will phase out sooner. Delayed phase-out may occur through deliberate planning or an unfortunate confluence of circumstances in specific countries. Either way, 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, when determining a global phase-out schedule.

Conclusions of Policy and Institutional Analysis

34. Based solely on its assessment of these policy and institutional factors, the Study Team determined that successful implementation of the phase-out in all Article 5 countries by 1996 would be impossible and that phase-out by 2000 would be extremely difficult. The feasibility of phase-out dates beyond 2000 cannot be ruled out strictly by policy and institutional factors. However, the possibility of meeting these targets depends in part on the implementing agencies' abilities to provide support and interventions based on the unique interplay of factors that affect ODS consumption and phase-out within each country or group of similar countries. The feasibility of global phase-out for any one of these scenarios also remains dependent, of course, on the commitment of Article 5 country governments to meet the requirements of the scenario.

COST AND ODS USE ESTIMATES

Definition of Model Outputs

35. The third element of the Study Team's approach was the development and use of a modeling tool to estimate the cost and predict ODS use over time for each of the eleven scenarios. Three types of costs were estimated:

- Fund Costs measure the expected financial demand on the Multilateral Fund from projects eligible for reimbursement. The cost components included in the Fund costs are those specified in the document entitled "Indicative List of Incremental Costs" adopted at the Second Meeting of the Parties to the Protocol. Key features of this measure of costs include consideration of a limited number of years of operating costs, the reduction of grants from the Fund to reflect the fraction of foreign, non-Article 5 ownership of ODS-using enterprises, the practical impossibility of using resources from projects with net savings to subsidize those with net costs, and the use of escalating ODS prices over time.[3]

- Real Resource Costs measure the increase in resources that will be expended by Article 5 countries in phasing out ODS relative to what would have been spent in the absence of the Montreal Protocol. Real resource costs include capital and one-time costs, (e.g., cost of new non-ODS-using equipment) and operating costs (e.g., chemical, labor, energy, and other recurrent costs). Key features of this measure of costs include consideration of operating costs over the full life of the investment project, the off-setting of projects with net costs against those with net savings, and use of ODS prices that are constant over time.[4]

- Actual Costs, a measure defined by the Sub-Committee for the Report, are identical to real resource costs with one exception. While ODS prices are assumed to be constant when measuring real resource costs, escalating prices are used in the calculation of actual costs. This measure reflects what the phase-out will actually cost Article 5 countries given the implementation of the Montreal Protocol and the likely increase in ODS prices that will follow.

All costs are calculated at discount rates of ten, five, and zero per cent. Ten per cent is assumed to be 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. Exhibit ES-5 below summarizes the key features of the three measures of cost.

36. The model computes annual projected ODP-weighted ODS use, which is simulated each year until the phase-out is complete across all Article 5 countries. Estimates of annual ODP-weighted use are divided by the quantity of chemical used in new equipment and to service existing equipment. For tail scenarios, the model also reports the quantity of ODP-weighted use required each year after the phase-out date to service existing equipment.

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[3] Rising ODS prices are incorporated in the estimate of Fund costs to reflect the practice of the Executive Committee to calculate Fund grants based on prices actually paid by enterprises.

[4] Constant ODS prices reflect the fact that the cost of producing ODS is unlikely to change significantly over the course of the phaseout. While ODS prices *are* likely to rise as the result of Protocol-induced scarcity, the costs of real resources used as inputs such as labor, energy, and supplies *are not*, meaning that increases in ODS prices will generate a financial windfall for ODS producers (or to their governments if windfalls are taxed away).

Exhibit ES-5
Comparison of Measures of Costs

Measure of Costs	Duration of Project Operating Costs Considered	Costs Reduced to Reflect Foreign Ownership?	Behavior of ODS Prices over Time	Projects with Costs Offset by those with Savings?
Fund Costs	Truncated to two or four years depending on scenario	Yes	Rising	No
Real Resource Costs	Full life of project	No	Constant	Yes
Actual Costs	Full life of project	No	Rising	Yes

Model Operation

37. The model begins with an estimate of the quantity of ODS that would have been used in Article 5 countries for 1993 in the absence of any reductions attributable to the Montreal Protocol.[5] Depending on the particular Article 5 country, the use estimate reflects information from Country Programmes, data reported by countries to UNEP, or a simple correlation between ODS use and Gross Domestic Product. Total unconstrained ODS use in Article 5 countries is estimated at 208,000 ODP tonnes per year. The total is allocated among more than 30 specific ODS applications, including, for example, CFC-11 chillers used for air conditioning and carbon tetrachloride used as a solvent.

38. The initiation of "model" ODS phase-out projects is then simulated. There are over 90 model projects, each representing a specific substitution scenario for a particular ODS application. One model project, for example, is defined as the substitution of HFC-134a technology for CFC-12 in the manufacture of mobile air conditioners while another specifies use of methylene chloride as a foam blowing agent in lieu of CFC-11. The model projects were developed based on several data sources, including investment projects approved by the Executive Committee, information collected from the 21 countries studied by the Team, various TEAP reports, and the professional judgement of the Study Team. Model projects are simulated to be initiated in one of two ways. Model projects are implemented either:

- On an accelerated basis, meaning that projects are initiated in the near-term without regard to specific reductions mandated by the Protocol but instead because of, for example, multinational ownership or a strong export orientation or

[5] The Study Team excluded one Article 5 country, the Republic of Korea, from the analysis based on this country's statement at the Sixth Meeting of the Parties that it would not request support for its ODS phaseout from the Multilateral Fund. This approach has been discussed with and approved by the Chair of the Sub-Committee for the Report.

- On a target-driven basis, meaning that projects are initiated only when an ODS reduction target becomes binding in a particular year thereby necessitating the investment in a phase-out project.

As projects are implemented, the model tallies the resulting costs and ODS use reductions.

39. The model also tracks the cost of ODS production phase-out projects. Estimates of production phase-out costs under a variety of technical and policy assumptions were developed by the Study Team and presented in the September 6, 1994 version of this report to the Sub-Committee. The Sub-Committee directed that, for the purposes of this Study only, an assumption should be made that the Multilateral Fund would provide US $621 million to finance production phase-out projects.

40. 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 phase-out costs.

Model Limitations

41. When evaluating results generated by the model, it is important to keep some key limitations in mind. For a complete review of the model limitations and their implications, refer to Chapter 3.

- The modeling framework tracks ODS use and implements projects on a global basis. It is not possible to make firm ' .ferences about the capability of any individual country to achieve a particular phase-out date.

- Model project costs were based for the most part on projects approved by the Executive Committee. This may bias cost estimates upward, since by definition, projects which offer enterprises net savings, which would lower the average cost, would not be presented to the Fund.

- The estimation of ODS prices is an extremely difficult analytic undertaking and the estimate of Fund costs and actual costs is quite sensitive to ODS prices.[6] A very simplified approach to price forecasting was used in the Study.

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[6] This limitation does not apply to real resource costs because this measure is based on constant ODS prices which are not subject to the uncertainty associated with price forecasting.

Results of Cost Analysis

42. Exhibit ES-6 summarizes the estimates of the cost to the Multilateral Fund of the scenarios analyzed. Results are presented at discount rates of 10 per cent and zero per cent and for ten of the eleven scenarios. There are no results for the 1996 phase-out scenario as the simulation model reported that, given the input assumptions about the timing and penetration of ODS substitute technologies, it is not feasible for Article 5 countries to complete an ODS phase-out by 1996.

Exhibit ES-6
Fund Costs ($US 1993 Millions)

Scenario	Discount Rate	
	10 Per cent	0 Per cent
1996	*Infeasible Scenario*	*Infeasible Scenario*
2000	3,787	5,392
2006	1,757	3,291
2006 with tail	935	2,179
2010	1,577	3,188
2010 with tail	855	2,181
Fast	1,357	2,092
2006/1999 with tail	1,307	2,549
2010/1999 with tail	1,261	2,641
2000 with four years	3,795	5,417
2010 with four years	1,803	3,490

43. Exhibit ES-7 presents the estimates of the real resource costs generated by the model. Results are not presented for the final two scenarios which represent sensitivity analyses done for Fund reimbursement rules. Consequently, real resource costs for these two scenarios are identical to those for the relevant phase-out scenarios (i.e., the 2000 and 2010 phase-outs).

Exhibit ES-7
Real Resource Costs ($US 1993 Millions)

Scenario	Discount Rate	
	10 Per cent	0 Per cent
1996	*Infeasible Scenario*	*Infeasible Scenario*
2000	4,299	6,706
2006	2,232	4,206
2006 with tail	1,197	3,795
2010	2,061	4,012
2010 with tail	902	3,593
Fast	2,045	3,374
2006/1999 with tail	1,819	4,081
2010/1999 with tail	1,750	4,103

44. Exhibit ES-8 provides the results of the analysis of actual costs for the eight scenarios for which they were estimated. The use of parenthesis denotes a negative number which, in the context of a cost analysis, suggests that there are savings associated with the indicated scenario.

45. ODP-weighted use estimates as well as more detailed results and analysis are presented in Chapter 6. In addition, the conclusion of the Executive Summary provides an integrated analysis of these cost results in the context of all of the other findings of the Study.

ENVIRONMENTAL ASSESSMENT

Measuring Impacts on Stratospheric Ozone

46. The fourth element of the Study Team's approach entailed assessment of the environmental impact of the eleven phase-out scenarios. 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 main source of chlorine and bromine reaching the stratosphere, the impact of each scenario on stratospheric chlorine levels (adjusted to reflect the impact of bromine) is a good indication of its potential harm to the ozone layer. Adjusted chlorine (Clx) loadings were estimated by taking the ODP-weighted use estimates generated in the modeling framework described above and using them as inputs to the Atmospheric Stabilization Framework (ASF).[7] The ASF in turn yielded annual adjusted Clx concentrations, in parts per billion (ppb).

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[7] 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.

Exhibit ES-8
Actual Costs ($US 1993 Millions)

Scenario	Discount Rate	
	10 Per cent	0 Per cent
1996	*Infeasible Scenario*	*Infeasible Scenario*
2000	1,441	499
2006	468	(2,145)
2006 with tail	(1,037)	(4,801)
2010	800	(1,636)
2010 with tail	(779)	(4,241)
Fast	(876)	(2,577)
2006/1999 with tail	(342)	(3,393)
2010/1999 with tail	173	(2,094)

47. To allow comparisons between phase-out scenarios, the annual adjusted Clx concentrations were aggregated to generate a single measure of cumulative adjusted Clx for each scenario. This was done by first determining the degree to which each annual concentration exceeded a baseline level of 2 ppb.[8] These exceedances were then added together to yield a measure of cumulative adjusted Clx concentrations expressed in terms of "ppb-years." The years after the point when the adjusted Clx concentration is simulated to drop below 2 ppb are not included in the cumulative concentration. As shown in the upper portion of Exhibit ES-9, this quantity is equivalent, in geometric terms, to the area under the annual adjusted Clx concentration curve and above a horizontal line drawn at a concentration of 2 ppb. To further facilitate comparisons among scenarios, the Study Team also computed the difference in the cumulative adjusted Clx concentration between each scenario and the scenario representing current policy under the Montreal Protocol (i.e., the 2010 phase-out scenario).

Results of Environmental Assessment

48. The lower portion of Exhibit ES-9 presents the impact of each phase-out scenario on the cumulative adjusted chlorine loadings to the stratosphere. All but two scenarios offer reductions in adjusted Clx loadings over the current policy baseline. The addition of a service tail to the 2006 and 2010 scenarios causes adjusted Clx loadings to exceed that associated with the 2010 scenario. The most significant reductions in cumulative adjusted Clx (in the range of 9 to 10 per cent) are offered by the 2000 scenario and the "fast as cost-effectively possible" scenario. Other scenarios show a more limited impact on cumulative adjusted Clx.

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[8] An adjusted Clx concentration of 2 ppb is used because this is a rough approximation of the values observed in the 1970s prior to the detection of the "ozone hole."

SCOPE OF STUDY

Boundaries of the Analysis

49. 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.

- The Study is not an evaluation of operation or policies of the Multilateral Fund or any affiliated organizations.
- The Study does not make any recommendations about phase-out schedules, though it notes cases where a particular scenario is infeasible.
- No information is presented on a country-specific basis. All data and conclusions are presented as applicable to the global community of Article 5 countries.
- 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 phase-out costs which are estimated in a summary manner.

50. Finally, it must be noted that the Study does not directly incorporate the reviews that are currently being conducted by the Technology 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.

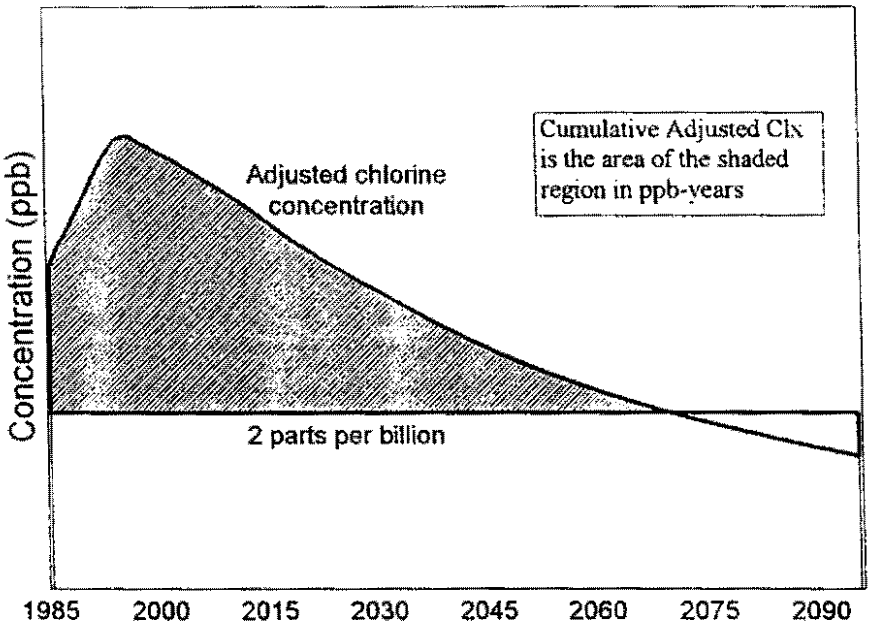
Treatment of HCFCs

51. 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 phase-out of HCFCs and methyl bromide, although it does provide an overview of the status of substitutes.

52. The Study Team contacted the Technology and Economic Assessment Panel (TEAP) to determine what the TEAP plans to propose as an HCFC phase-out 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.

Exhibit ES-9
Environmental Assessment

Calculation of Cumulative Adjusted Chlorine Loading
An Illustrative Example



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)
1996	--	--	--
2000	87.45	-9.39	-9.7%
2006	94.78	-2.06	-2.1%
2006 w/tail	98.43	1.60	1.6%
2010	96.83	0.00	0.0%
2010 w/tail	100.92	4.09	4.2%
Fast	88.27	-8.56	-8.8%
2006/1999 w/tail	95.21	-1.62	-1.7%
2010/1999 w/tail	95.77	-1.07	-1.1%
2000 w/4 years	87.45	-9.39	-9.7%
2010 w/4 years	96.83	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 2010 baseline scenario (scenario 5).

53. The TEAP believes that HCFCs are important to the phase-out 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

54. 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 phase-out of methyl bromide was similar to that used for HCFCs. 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. Chapter 1 of the report summarizes TEAP's findings with respect to methyl bromide.

INTEGRATED SUMMARY OF RESULTS OF THE STUDY

55. The fundamental purpose of this Study was to assess the feasibility of alternative phase-out schedules for Article 5 countries. The Study Team examined seven such scenarios, as presented in Chapter 2, from a variety of economic, environmental, and policy perspectives. In addition, the Study Team considered four variations of those scenarios, for a total of eleven scenarios. This chapter reports the major conclusions of the Study. (Note that costs are presented below on a discounted basis using a 10 per cent discount rate.)

56. In drawing conclusions about the various scenarios analyzed, it is important to keep in mind that four primary factors seem to be affecting the feasibility of phase-out in specific countries and thus the global phase-out: market dynamics, the global commitment and financial support for the phase-out, the actions of Article 5 Country governments, and the time required for societal transition. In addition, four secondary factors that may affect a particular country's phase-out 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. Along with each country's inherently different economic, technological, political, and cultural make-up, these factors affect each country's ability to phase-out ODS in a plethora of ways. In the context of the current Protocol with its single phase-out schedule for all Article 5 countries, however, one must consider that the feasibility of any scenario is determined not by the prospects for phase-out in countries that will act first, but rather by the situation in those countries that will phase-out last.

57. Phase-out by 1996. The Study Team concluded that a global phase-out by 1996 is not feasible. None of the CPs target such a date and every country that provided feedback for this Study stated that it could not meet a 1996 phase-out target. For this 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 phase-out. The quantitative modeling results support this assessment by showing that reduction targets for a 1996 phase-out could not be met.

58. Phase-out by 2000. Global phase-out 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 users in certain informal segments of ODS-using industry is six to seven years, effectively ruling out the 2000 target date since some enterprises would be stranded either without adequate supplies of ODS or appropriate non-ODS technologies. Furthermore, the capacities of Implementing Agencies, Article 5 governments and enterprises, and technology suppliers would be severely tested by this phase-out 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 phase-out. If a 2000 phase-out proves to be politically and institutionally possible, the quantitative modeling results show total Fund costs of US $3.8 billion, real resource costs of US $4.3 billion, and actual costs of US $1.4 billion. This scenario also resulted in the largest percentage decrease (about 10 per cent) of cumulative adjusted chlorine loading compared to the baseline scenario of 2010.

59. Phase-out by 2006. The Study Team concluded that a 2006 phase-out 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 phase-out 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 phase-out plans by 2006 that are based on the specific factors that drive local ODS consumption. As discussed previously, these factors vary considerably between countries due to their inherent diversity. Achieving a phase-out by 2006 would require distinct and deliberate actions to address the specific factors that may impede each country's ability to eliminate ODS. The feasibility of the 2006 and earlier phase-out 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 $1.8 billion, real resource costs of US $2.2 billion, and actual costs of US $468 million for this scenario. The scenario resulted in a relatively small percentage decrease of about 2 per cent in cumulative adjusted chlorine loading compared to the baseline scenario of 2010.

60. Phase-out 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 equipment retrofits, effectively lowering costs but delaying the actual ODS phase-out by approximately 14 years, to 2020. A number of countries that provided feedback on the issue stated that they could meet this phase-out date. For this scenario, Fund costs are estimated at US $935 million, real resource costs at US $1.2 billion, and actual resource costs at a savings of US $1.0 billion. Because the servicing tail delays the ultimate date of phase-out by several years, the scenario results in approximately 4 percentage points (i.e., -2.1% to +1.6%) more cumulative adjusted chlorine loading than in the scenario of a 2006 phase-out without a servicing tail.

61. Phase-out 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 phase-out in each individual country would still need to be addressed. For this scenario, the model estimates total Fund costs of US $1.6 billion, real resource costs of US $2.1 billion, and actual costs of US $800 million.

62. Phase-out by 2010 with a Servicing Tail. A servicing tail under the 2010 phase-out scenario would eliminate all need for equipment retrofits, thereby lowering the costs of the phase-out and delaying ultimate phase-out to 2022. Because of the delay, unlike almost all of the other scenarios, this one results in an increase of 4.2 per cent in cumulative adjusted chlorine loading compared to the baseline scenario of 2010. This represents the largest increase out of all the scenarios analyzed. Costs of this phase-out are estimated at US $855 million for Fund costs. US $902 million for real resource costs, and US $779 million in savings for actual costs.

63. Phase-out as Fast as Cost-Effectively Possible. The Study Team also estimated the fastest possible phase-out, subject to a cost effectiveness constraint that equipment retrofits would not be required. Under this scenario, new ODS using equipment need not be installed anywhere as of 2001. Based on the modeling results, virgin production of ODS can then be halted in 2012, with demand for ODS in existing equipment met through the year 2018 by recycling. Like the 2000 phase-out scenario, this scenario results in a significant decrease (approximately 9 per cent) in cumulative adjusted chlorine loading compared to the baseline scenario of 2010. The scenario produces total Fund costs of US $1.4 billion, real resource costs of about US $2.0 billion, and savings of US $876 million for actual costs. While the results of this scenario compare very favorably with the others analyzed in the Study, they must be examined more closely in order to consider how the scenario could actually be operationalized through the Montreal Protocol. Given the projection from the model that installation of new ODS equipment can be halted in 2001, the scenario can be likened to a phase-out by 2001 with a servicing tail. Alternatively, the Montreal Protocol could set different phase-out dates for each sector. Under either of these approaches, as explained in the discussion accompanying the 2000 phase-out scenario, because of policy and institutional difficulties, it is unclear whether all segments of ODS-using industry in developing countries could meet such a phase-out target.

64. Variations on these scenarios: servicing tails with accelerated phase-outs. The Study Team conducted sensitivity analyses regarding servicing tails with accelerated phase-outs. A service tail with an accelerated phase-out requires that ODS produced for the servicing tail could only be used for equipment manufactured prior to 1999. The results of these analyses are that scenarios with a servicing tail for such equipment and an accelerated phase-out increases the speed of phase-out only in certain parts of the refrigeration sector and also increases the costs of the phase-out slightly. For the scenario with a phase-out target date of 2006, the accelerated phase-out costs projected in the model are US $1.3 billion for Fund costs, US $1.8 billion for real resource costs, and savings of US $342 million for actual costs. An accelerated phase-out with servicing tail and a phase-out target date of 2010 yields estimated Fund costs of US $1.3 billion, real resource costs of US $1.8 billion, and actual costs of US $173 million.

65. Variations on these scenarios: duration of operating costs covered by the Fund. The impact of a variation in the duration of operating costs to be covered by the Multilateral Fund depends on the scenario being evaluated. In each case, however, it results in higher costs. For a 2000 phase-out, the Fund cost associated with reimbursing four years of operating cost instead of two years is about US $8 million more, while for the 2010 target, the difference is about US $226 million more.

66. In all scenarios analyzed, the majority of costs are projected to occur in the refrigeration and air conditioning sectors. Much of this cost is estimated to be caused by the need for retrofits to existing equipment. Such retrofit costs are avoided in scenarios that incorporate a service tail. As established in the policy and institutional analysis, however, the practical difficulties of setting up a servicing tail in most Article 5 countries are likely to result in some additional cost that the Study Team was not able to quantify in its analysis.

67. In summary, given the extraordinary technical difficulties that all Article 5 countries would face in trying to meet a 1996 target and the policy and institutional difficulties that some Article 5 countries believe would make infeasible the task of meeting a 2000 target, the earliest feasible phase-out date among those scenarios 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. Measured against a baseline of the cumulative adjusted chlorine loading for the 2010 scenario, the change in chlorine loading ranges between approximately a 10 per cent reduction, if the phase-out is achieved by 2000, and an increase of about 4 per cent with the scenario achieving a phase-out by 2010 using a servicing tail.

Chapter 1

INTRODUCTION

1.1 OVERVIEW

68. By ratifying the Montreal Protocol on Substances that Deplete the Ozone Layer, more than 130 of the world's nations have agreed to phase out the consumption and production of ozone depleting substances. A key feature of the Protocol is that it includes separate phase-out schedules for two different types of countries. Developed countries are to complete their phase-out 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 phase-out.

69. 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 phase-out 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 in document UNEP/Ozl.Pro/ExCom/12/37 Annex 5.

70. As described in the TOR and refined during three meetings between the Study Team and the Sub-Committee, the fundamental purpose of the Study is to assess the feasibility of alternative phase-out schedules for Article 5 countries. It first characterizes the factors that affect the phase-out 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 phase-out targets. By doing so, the report illuminates some of the policy issues that will be important during deliberations about adjustments to the phase-out schedule for Article 5 countries.

71. 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

72. 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 Technology 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.

73. 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 phase-out 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.

74. 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 phase-out 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 phase-out 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

75. 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.[9] The Sub-committee provided further direction upon its review of the preliminary draft of the report, during the meeting held September 29, 1994 in Nairobi.

76. The focus of the Study is on the phase-out schedules for CFCs, halons, methyl chloroform (MCF), and carbon tetrachloride (CTC).[10] Eleven distinct phase-out 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 actual cost (defined as identical to the real resource cost with one exception, namely, that rising ODS prices shall be assumed), the quantity of ODS used per year, and the environmental impact of ODS emissions on the stratosphere.

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[9] 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.

[10] Other ozone depleting substances are addressed in Section 1. 4 below.

77. 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 phase-out 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 phase-out 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.

78. Finally, it must be noted that the Study does not directly incorporate the reviews that are currently being conducted by the Technology 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

79. 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

80. 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, have been 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 much less than that of the CFCs.

81. HCFCs have been recognized as transitional substances important to the phase-out of CFCs. Because of their environmental impact, however, HCFCs are slated to be phased out under the Montreal Protocol by developed countries by the year 2030, although some government have decided to move faster (e.g., the European Union). The feasibility of an HCFC phase-out among Article 5 countries is not quantitatively addressed in this study for two reasons.[11]

- In almost all 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 difficult. In the absence of such information, it is not analytically possible to assess the cost and environmental impact of an HCFC phase-out.

- 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 phase-out projects, meaning that no firm data are available to estimate technical and economic project parameters in the context of Multilateral Fund policies and practices.

82. Accordingly, the Study Team contacted the Technology and Economic Assessment Panel (TEAP) to determine what the TEAP plans to propose as an HCFC phase-out 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.[12] Excerpts from the Co-Chair's memorandum follow:

83. "HCFCs are important to the phase-out 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.

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11 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.

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

- 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.

84. "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

85. 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 phase-out 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.[13]

86. "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.

87. "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.

88. "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.

89. "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.

90. "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.

91. "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.

92. "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.

93. "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

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

90 per cent of applied dose. Equipment is expected to commercially available soon and some recapture equipment, without recycling, is already in operation."[14]

1.5 STRUCTURE OF THE REPORT

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

- Chapter 2 gives an overview of the phase-out 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 phase-out schedules, as per the Terms of Reference.

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[14] 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.

Chapter 2

OVERVIEW OF SCENARIOS EVALUATED

95. This chapter describes the ODS phase-out scenarios for Article 5 countries analyzed in this study. These phase-out scenarios were developed based on input from the Subcommittee for the Report.[15] A total of eleven phase-out schedules are analyzed in this study. Ten of the scenarios differ with respect to four key parameters discussed below. An eleventh scenario investigates the fastest economically feasible phase-out subject to a cost-effectiveness constraint. The four parameters that collectively define the scenarios can be summarized as follows:

- Phase-out Date: For each scenario, a single date is defined on which, with the exceptions noted below, all consumption of ODS is assumed to cease.

- Service Tail: In certain scenarios, use of new ODS is allowed after the phase-out date to service existing refrigeration and air conditioning equipment. Such a tail eliminates the need for retrofits or early retirements.

- Service Tail with Accelerated Phase-out: In two scenarios, ODS use in new refrigeration and air conditioning equipment is phased out in 1999 rather than by the phase-out date. Use of ODS to service this equipment is then allowed after the phase-out date. This is in contrast to the tail scenario described above which allows use of ODS in new equipment until the phase-out date, rather than 1999.

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

96. An eleventh scenario was analyzed that assumed all substitute technologies would be implemented as soon as commercially available subject to the condition that retrofits of existing equipment would not be required. This scenario is fundamentally different from all others in that a phase-out schedule with interim targets is not specified; instead, the speed of the phase-out is determined by the simulation model. In order to maximize cost effectiveness, this scenario includes a tail to service existing ODS-containing equipment. Exhibit 2-1 summarizes the features of all eleven scenarios.

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[15] 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).

EXHIBIT 2-1: DEFINITION OF PHASE-OUT SCENARIOS

Scenario	Phase-out Date	Service Tail?	Service Tail with Accelerated Phase-out?	Duration of Reimbursed Operating Cost (years)
1996 Phase-out	1996			2
2000 Phase-out	2000			2
2006 Phase-out	2006			2
2006 Phase-out with Service Tail	2006	Yes		2
2010 Phase-out	2010			2
2010 Phase-out with Service Tail	2010	Yes		2
Fast as Cost-Effectively Possible	See Text	Yes		2
2006/1999 Phase-out with Service Tail	2006		Yes	2
2010/1999 Phase-out with Service Tail	2010		Yes	2
2000 Phase-out w/4 Years Reimbursement	2000			4
2010 Phase-out w/4 Years Reimbursement	2010			4

Chapter 3

METHODOLOGY

3.1 INTRODUCTION

97. 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 while Section 3.4 describes the modeling tools used to estimate the cost of implementing the ODS phase-out and the total ODS use required to service existing equipment in Article 5 countries under each of the phase-out scenarios. Section 3.5 presents the methodology used to estimate the environmental impacts associated with each of the phase-out scenarios.

3.2 DATA COLLECTION

98. 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

99. 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 phase-out 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 phase-out,
- In-country production of ODS, to determine if the country produces ODS and the impact of in-country production on the country's phase-out 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 to promote the ODS phase-out
  - Effectiveness of the OPU or its equivalent

  - -- Multilateral Fund activities
  - -- Activities underway outside the Fund and Implementing Agencies (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 phase-out schedules or the size of the Multilateral Fund), and

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

100. 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

101. 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.

102. 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 phase-out dates

- Feasibility of meeting various phase-out schedules

- Reductions in ODS use

- Factors impeding or facilitating ODS phase-out:

  - -- 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

103. 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

104. 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

105. 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 Thirteenth Meeting of the Executive Committee as observers to witness the deliberations firsthand, as well as to attend the Fourteenth Meeting to present a briefing on the preliminary draft of the report.

3.2.4 Ozone Secretariat

106. 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 phase-out schedules for Article 5 countries to contribute to the policy and institutional analysis.

3.2.5 Implementing Agencies

107. The four 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 phase-out schedules, as well as the progress of phase-out 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 and Office for Project Services
- UNIDO's Industrial Sectors and Environment Division
- UNEP's Industry and Environment Programme Activity Centre (IE/PAC)

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

3.2.6 The Executive Committee

108. 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 Technology and Economic Assessment Panel

109. 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

110. 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 phase-out schedule on the atmosphere. The Team consulted the Co-Chair of the SAP, who agreed with the Team's methodology for performing the atmospheric chlorine analysis. The Co-Chair also made suggestions regarding interpretation and presentation of results.

3.2.9 Chemical and Technology Producers

111. 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.

112. 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 seeking support from the Fund for phase-out of ODS production.

3.2.10 Environmental Organizations

113. 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 phase-out. 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.

3.2.11 Comments Received on Preliminary Draft of Report

114. The Study Team prepared a preliminary draft of this report which it submitted to the Fund Secretariat on September 4, 1994. Comments on the preliminary draft were received from the following: the Sub-committee for the Report; UNEP; Greenpeace; Friends of the Earth-USA; the Fund Secretariat; and the World Bank. The comments received have been addressed in this version of the Report. In addition, UNDP supplied the Study Team with some data on safety costs for cyclopentane and other hydrocarbon projects.

3.3 POLICY AND INSTITUTIONAL ANALYSIS

115. 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 phase-out 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.

116. 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 phase-out schedules being examined in this study. The findings are presented in Chapter 4 of the report.

117. The Study Team also generated an expansive list of policy and institutional issues affecting the phase-out in Article 5 countries. To organize the policy and institutional issues having the most significant impact on the phase-out, 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 involved in ODS phase-out activities in Article 5 countries and the relationships among them. Exhibit 3-1 presents the diagram of the relationships among the key actors in the phase-out of ODS in Article 5 countries.

118. 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.

119. 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

Exhibit 3-1
Relationships Among Key Actors in ODS Phaseout in Article 5 Countries

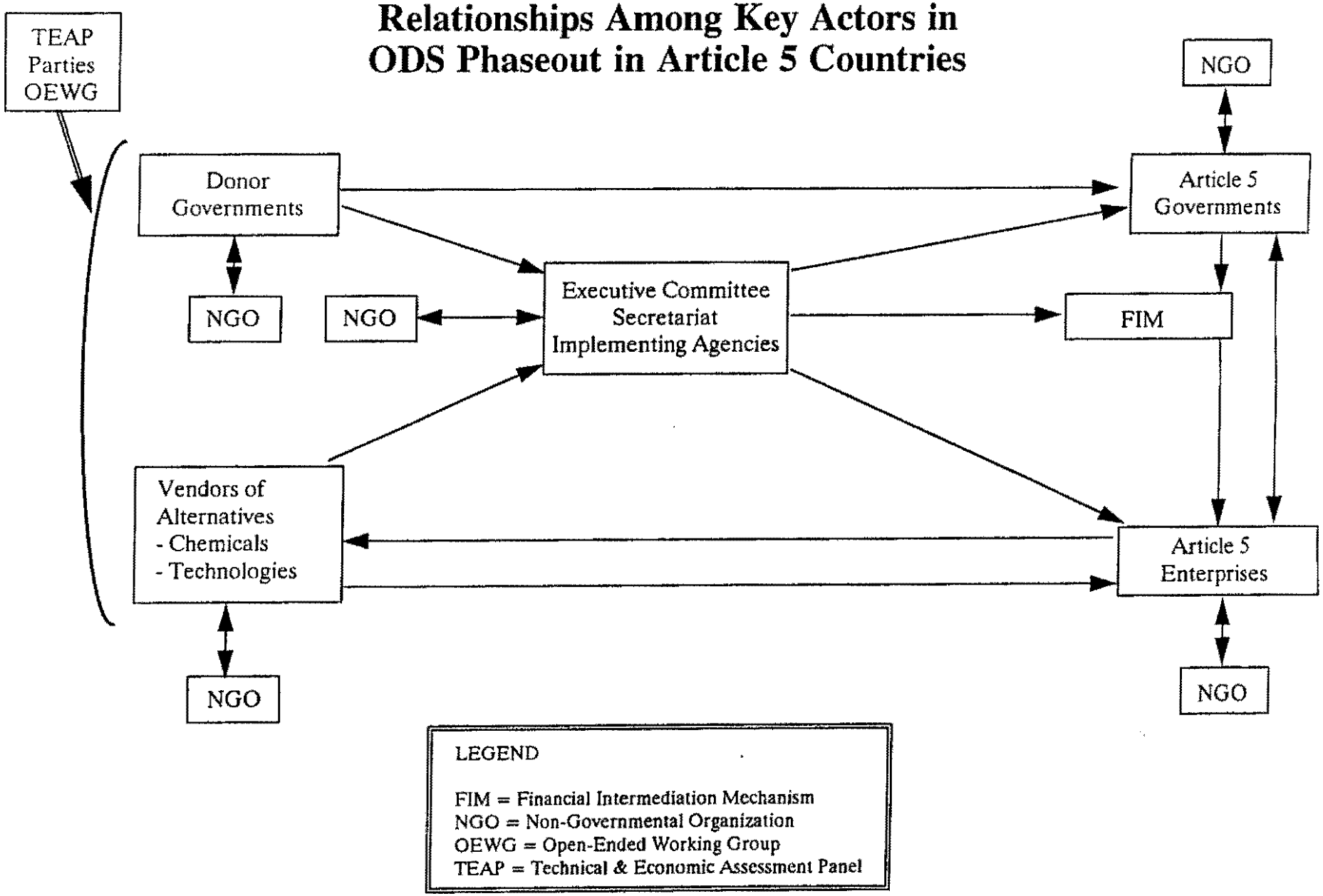

Exhibit 3-2

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. Technology is purchased or acquired
  11. Non-ODS technology is delivered and installed on the "shop floor"
  12. Non-ODS technology is adapted to local conditions and 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.

incentives at these key steps could have a significant effect on technology transfer and hence on the feasibility of alternative phase-out scenarios.[16]

120. 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 ESTIMATION OF COST AND ODS USE

121. This section presents the modeling tools used to estimate the costs associated with implementing investment projects to phase out the production and use of ODS in Article 5 countries under each of the phase-out scenarios. It also presents the methodologies used to estimate the non-investment costs associated each of the phase-out scenarios including the costs of supporting the activities of Implementing Agencies, the Secretariat, and the Executive Committee, institutional strengthening for Article 5 governments, and the information clearinghouse functions. 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

122. In considering approaches that could be used to estimate the costs associated with phasing out the production and use of ODS in Article 5 countries, the Study Team recognized that multiple factors impact the rate of implementation of investment projects. 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-price 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 locally-owned enterprises in Article 5 countries are currently phasing out their use of ODS to protect export markets in Article 2 countries.[17] Lastly, projects may be accelerated because many Article 5 governments have adopted aggressive phase-out schedules that are forcing enterprises in these countries to implement investment projects sooner than mandated under the current Protocol.

123. It is apparent that any simulation tool used to estimate the costs of the phase-out must adopt a hybrid approach that considers all of these factors. Indeed, a simulation technique that only

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[16] 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.

[17] The United States and other Article 2 countries have taken actions that make the exportation of ODS-containing products to these countries less attractive, such as labeling requirements, taxes on CFCs imported into the country. Furthermore, the imminent non-availability of ODS for servicing ODS-using equipment in Article 2 countries also will eliminate demand for such products from Article 5 countries. 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.

considered the economic incentives driving the phase-out would be inadequate as would one that only focused on the non-price related factors accelerating the phase-out. 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 production, use, and emissions of ODS 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.

124. The model simulation used in this analysis begins with an estimate of the quantity of ODS that would have been used in Article 5 over time in the absence of any reductions attributable to the Montreal Protocol. It then calculated the reduction in this use required over time to achieve a given phase-out scenario (as defined in Chapter 2). The initiation of "model" ODS phase-out projects is then simulated. There are over 90 model projects, each representing a specific substitution scenario for a particular ODS applications. Model projects are simulated to be initiated in one of the following two ways:

- On an accelerated-basis, meaning that projects are initiated in the near-term without regard to specific reductions mandated by the Protocol but instead because of, for example, multinational ownership or a strong export orientation or

- On a target-driven basis, meaning that projects are initiated only when an ODS reduction target becomes binding in a particular year thereby necessitating the investment in a phase-out project.

As projects are implemented, the model tallies the resulting costs and ODS use reductions.

125. The remainder of this subsection describes the simulation techniques used to calculate the costs and ODS use estimates under each scenario in greater detail. This discussion 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. These 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 impacts of the phase-out and Section 3.4.5 details the model limitations.

3.4.2 Model Outputs

126. The key outputs of the model for each scenario are real resource costs, the cost to the Multilateral Fund, actual costs, and annual ODP-weighted ODS use. Each of these outputs is discussed below.

3.4.2.1 Fund Costs

127. Fund costs are a measure of the 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" adopted at the Second Meeting of the Parties. Key features of this measure of cost include consideration of operating costs for up to only four years for each investment project (this analysis assumes two years of operating costs are reimbursable in the base scenario and performs a sensitivity assuming four years of operating

costs are reimbursable),[18] rising ODS prices over time in the calculation of such operating costs, exclusion of negative costs (or savings) for projects that are profitable without funding, and an adjustment to reflect the fact that projects are only reimbursed for a percentage of their costs equal to the percentage of domestic ownership.

3.4.2.2 Real Resource Costs

128. Real resource costs measure the increase in resources that will be expended by Article 5 countries in complying with the requirements of an ODS phase-out. 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).

129. Not all phase-out 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.[19] 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) expends resources that could produce other goods and services while the net effect of transfer payments on society is nil.[20]

130. In this analysis, real resource costs are calculated as the sum of all capital, one-time, and operating costs associated with phasing-out the production and use of ODS in Article 5 countries. Key features of this measure of cost include consideration of operating costs over the full economic life of the project (which was assumed to be ten years across all end uses in this analysis), the use of constant, pre-Protocol prices in calculating operating costs, and the off-setting of projects with net costs against those with net savings. Constant pre-Protocol prices are used in the calculation of real resource costs because, as explained above, ODS prices rise because the Protocol makes them scarce and not because more resources are required to produce them.

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[18] 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.

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

[20] 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.

131. 3.4.2.3 Actual Costs

Actual costs, a measure defined by the Sub-Committee for the Report, are identical to real resource costs with one exception.[21] While ODS prices are assumed to be constant when measuring real resource costs, escalating prices are used in the calculation of actual costs. This measure reflect what the phase-out will actually cost Article 5 countries given the implementation of the Montreal Protocol and the likely increase in ODS prices that will follow. Exhibit 3-4 compares the assumptions underlying the calculation of Fund, real resource, and actual costs.

132. Fund, real resource, and actual 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 phase-out 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.

Exhibit 3-4
Comparison of Measures of Costs

Measure of Costs	Duration of Project Operating Costs Considered	Costs Reduced to Reflect Foreign Ownership?	Behavior of ODS Prices over Time	Projects with Costs Offset by those with Savings?
Fund Costs	Truncated to two or four years depending on scenario	Yes	Rising	No
Real Resource Costs	Full life of project	No	Constant	Yes
Actual Costs	Full life of project	No	Rising	Yes

3.4.2.4 Annual ODP-Weighted ODS Use

133. The model simulation estimates the total quantity of ODP-weighted use each year until the phase-out is complete across all Article 5 countries. Estimates of annual 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 required each year after the phase-out date to service existing equipment (and thereby avoid retrofits or early retirements).

3.4.3 Model Inputs

3.4.3.1 Baseline ODP-Weighted Use in Article 5 Countries

134. The key inputs to the model related to baseline ODP-weighted use are total 1993 ODP-weighted use and the expected growth of this use in the absence of controls. The following four step process was used to estimate baseline use in the 91 Article 5 countries:

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[21] Actual costs were defined by the Subcommittee to the report in "Report of the Subcommittee to the Report Under Section 8 of the Montreal Protocol," UNEP/OzL.Pro/ExCom/14/14/Rev.1/29 September 94

135. Step 1: Obtained ODS use estimates and growth rates from the 42 Country Programmes prepared to-date[22]: 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. The first column of Exhibit 3-5 presents total ODP-weighted use estimates for each of the 42 countries with Country Programmes.

136. Step 2: Obtained ODS use estimates for an additional 23 countries from UNEP: 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 23 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 were 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 the most recent year for which data were reported to UNEP and a weighted average ODS growth rate for Article 5 countries developed based on the growth rates contained in the 42 Country Programmes noted above. The second column of Exhibit 3-5 presents the total ODP-weighted use estimates for the 23 countries reporting use estimates to UNEP.

137. Step 3: Obtained ODS use for the remaining 26 countries by correlating GDP and ODS use. 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. This regression analysis correlated total ODP-weighted 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 use in a given Article 5 country and the GDP and population for that country. This correlation was 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. The third column of Exhibit 3-5 presents the ODP-weighted use estimates for the 26 countries whose use estimates were developed using the regression analysis.

138. Step 4: Estimate ODP-weighted use by sector across all Article 5 Countries. 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). This division was accomplished as follows:

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22 As discussed in Chapters 4 and 5, a total of 40 Country Programmes were reviewed in undertaking the policy and institutional analyses described in this report. The use estimates presented in this section are based on 42 Country Programmes because two additional Country Programmes were submitted and approved at the Fourteenth Meeting of the Executive Committee in September 1994. The Study Team was able to incorporate the use estimates into the analysis contained in this section, but it was not feasible to incorporate any of the information contained in these two additional Country Programmes into the policy and institutional analyses.

Exhibit 3-5

1993 Unconstrained ODP Use (Metric Tons)

CP Data

1	Algeria	2,366
2	Argentina	4,616
3	Bangladesh	229
4	Botswana	36
5	Brazil	8,918
6	Burkina Faso	36
7	Cameroon	124
8	Chile	1,277
9	China	67,719
10	Colombia	2,172
11	Costa Rica	256
12	Cote d'Ivoire	296
13	Cuba	351
14	Ecuador	852
15	Egypt	2,757
16	Fiji	52
17	Ghana	122
18	Guatemala	309
19	India	17,824
20	Indonesia	7,552
21	Iran, Isl. Rep. of	2,924
22	Jordan	829
23	Kenya	123
24	Malawi	66
25	Malaysia	4,914
26	Maldives	6
27	Mauritania	17
28	Mauritius	82
29	Mexico	14,209
30	Panama	227
31	Philippines	3,036
32	Senegal	119
33	Seychelles	10
34	Sri Lanka	276
35	Sudan	725
36	Syrian Arab Rep.	1,558
37	Thailand	10,227
38	Turkey	3,785
39	Uganda	16
40	Uruguay	316
41	Zambia	26
42	Zimbabwe	320
TOTAL		161,676

UNEP Data

43	Bahamas	3
44	Bahrain	169
45	Benin	51
46	Bosnia & Herz.	4,098
47	Brunei Darussalam	99
48	Croatia	4,490
49	Dominica	312
50	Gabon	99
51	Guyana	25
52	Jamaica	528
53	Malta	339
54	Myanmar	18
55	Nigeria	1,247
56	Pakistan	3,180
57	Papua New Guinea	84
58	Rep. of Macedonia	1,910
59	Romania	3,443
60	Saudi Arabia	5,752
61	Solomon Islands	4
62	Tunisia	1,235
63	Venezuela	3,731
64	Viet Nam	1,382
65	Yugoslavia	9,705
TOTAL		41,905

GNP Data

66	Antigua & Barb.	14
67	Barbados	65
68	Central Africa	25
69	Dominican Rep.	226
70	El Salvador	189
71	Gambia	3
72	Grenada	6
73	Guinea	68
74	Honduras	83
75	Kiribati	0
76	Lebanon	129
77	Lesotho	23
78	Libya	1,568
79	Namibia	69
80	Nepal	66
81	Nicaragua	42
82	Niger	54
83	Paraguay	228
84	Peru	967
85	Saint Lucia	6
86	Samoa	7
87	St.Kitts & Nevis	3
88	Swaziland	14
89	Tanzania	48
90	Togo	33
91	Trinidad & Tob.	188
TOTAL		4,126

(1) Estimates of ODP-weighted use by sector were developed for the 42 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) To develop sector level estimates for the remaining countries, the Study Team decided to group Article 5 countries based on their GDP. This grouping was done because it was the Study Team's judgement that countries with similar levels of GDP would have similar divisions of ODP-weighted use by sector. In other words, the Study Team felt that countries with a low GDP would be expected to have a similar distribution of use by sector, and that this distribution would differ from that of high GDP countries. To group Article 5 countries, a graph was prepared that plotted each Article 5 country for which a Country Programme had been prepared according to its GDP and total ODP-weighted 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. Each of these countries were given their own group (i.e., Groups IV through VII) because they represent such a large portion of global use and because good information was available. Exhibit 3-6 presents the country groups developed based on this methodology.

(3) Sector level estimates were then developed for the countries for which a Country Programme had not been prepared by using the average distribution of use for countries with Country Programmes within the same group (i.e., the average distribution of use for low, medium, or high GDP for which Country Programmes were available).

The end result was baseline ODP-weighted use across all Article 5 countries by sector and chemical from 1993 to 2030. Exhibit 3-7 presents total ODP-weighted use by sector in each of the seven country groups for the year 1993. As can be seen from this exhibit, total ODP-weighted use in 1993 for all Article 5 countries was estimated to be 208,000 tonnes and this use was assumed to grow at a rate of 9.4 per cent per year until the base year for reduction was reached, at which point growth was frozen.

3.4.3.2 Mapping of Baseline ODP-weighted use in Article 5 Countries into Use Segments

139. The next step in developing the model inputs was to map ODP-weighted 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.

Exhibit 3-6

Country Groups

	GDP Range: 0.0-3.5 $US Billion	GDP Range: 3.5-20 $US Billion	GDP Range: >20 $US Billion	INDIV-IDUAL
1	Antigua & Barb.	Bahrain	Algeria	Brazil
2	Bahamas	Cameroon	Argentina	China
3	Barbados	Costa Rica	Bangladesh	India
4	Benin	Cote d'Ivoire	Chile	Mexico
5	Bosnia & Herz.	Cuba	Colombia	
6	Botswana	Dominican Rep.	Croatia	
7	Brunei Darussalam	Ecuador	Egypt	
8	Burkina Faso	El Salvador	Indonesia	
9	Central Africa	Gabon	Iran, Isl. Rep. of	
10	Dominica	Ghana	Libya	
11	Fiji	Guatemala	Malaysia	
12	Gambia	Jordan	Mauritania	
13	Grenada	Kenya	Myanmar	
14	Guinea	Lebanon	Nigeria	
15	Guyana	Nepal	Pakistan	
16	Honduras	Panama	Peru	
17	Jamaica	Papua New Guinea	Philippines	
18	Kiribati	Paraguay	Saudi Arabia	
19	Lesotho	Rep. of Macedonia	Thailand	
20	Malawi	Senegal	Turkey	
21	Maldives	Sri Lanka	Venezuela	
22	Malta	Sudan	Yugoslavia	
23	Mauritius	Syrian Arab Rep.		
24	Namibia	Trinidad & Tob.		
25	Nicaragua	Tunisia		
26	Niger	Uruguay		
27	Romania	Viet Nam		
28	Saint Lucia	Zimbabwe		
29	Samoa			
30	Seychelles			
31	Solomon Islands			
32	St.Kitts & Nevis			
33	Swaziland			
34	Tanzania			
35	Togo			
36	Uganda			
37	Zambia			

Exhibit 3-7

1993 ODP Use by Group and Sector
(Metric Tons)

Group	Aerosol	Foam	Halon	Refrig	Solvent CFC-113	Solvent CT	Solvent MCF	Other	Total
Low GDP	860	283	1,530	6,900	151	73	20	0	9,810
Medium GDP	2,000	2,070	935	7,200	312	70	93	35	12,700
High GDP	7,120	16,300	6,670	35,400	7,550	479	2,280	744	76,500
Brazil	255	1,030	68	6,670	246	51	600	0	8,920
China	10,200	5,630	15,400	30,100	3,770	353	134	2,100	67,700
India	1,580	1,410	4,830	3,170	325	6,280	73	156	17,800
Mexico	1,420	1,600	1,620	7,610	458	0	1,000	496	14,200
Total	23,500	28,300	31,100	97,000	12,800	7,310	4,200	3,530	208,000

Note: Values may not add exactly due to rounding.

140. The four key parameters that are used to divide total ODP-weighted 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.

- Is the Use in Formal or Informal: Within each sector, total ODP-weighted 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, as discussed in Chapters 4 and 5, informal enterprises are assumed to implement controls more slowly than formal enterprises and at a higher cost.

- Can the Use Result in a Reimbursable Project to 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.[23]

- Is the Implementation of Controls in a Given End Use Undertaken on an Accelerated or Target-Driven Basis: Total ODP-weighted use in each sector was also divided according to whether the control technologies available to replace it would be implemented to achieve a target (i.e., price driven) or in an accelerated fashion due to non-target driven reasons. Reasons that projects could be accelerated include 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, domestic enterprises phasing out early so that they can continue to export products to Article 2 countries, and aggressive national ODS phase-out strategies implemented by Article 5 countries.

141. Given that 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 the same proxy used to develop sector level ODP-weighted use estimates in Section 3.4.3.1 (i.e., GDP), would be a good proxy for mapping like groups of countries according to the four key parameters. The seven country groups described above were used to map ODP-weighted 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. This resulted in the 33 distinct use segments.

142. Exhibit 3-8 presents the 33 market segments. Part 1 of this exhibit defines each of the segments according to the five key parameters (sector, end use, formal or informal ODS use, whether the cost of phasing out the use in the segment potentially can be reimbursed by the Fund, and whether the control technologies used to replace ODS use are implemented in an accelerated or target driven fashion). Part 2 of the exhibit indicates the percentage of the total use in each sector that falls into a given segment for each of the seven country groupings. Finally, Part 3 of the exhibit indicates the total ODP-weighted use in each of the 33 segments.

3.4.3.5 Definition of Model Projects

143. 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;

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[23] 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.

Exhibit 3-8

Market Segments

	Part 1: Segment Definition					Part 2: Segment Mapping							Part 3: Mapped Use
	Sector	End Use	Formality	Potentially Reimbursible	Decision Rule	Low GDP	Med GDP	High GDP	Brazil	China	India	Mexico	ODP Tons
1	Refrig	Macs	Formal	Yes	Target	0%	10%	20%	0%	5%	0%	4%	9,604
2	Refrig	Macs	Formal	Yes	Accel	0%	10%	10%	16%	0%	8%	0%	5,577
3	Refrig	Macs	Formal	No	Accel	40%	20%	10%	0%	0%	4%	12%	8,776
4	Refrig	Comm Ref	Formal	Yes	Target	10%	15%	20%	56%	25%	40%	28%	23,505
5	Refrig	Comm Ref	Formal	No	Accel	30%	25%	20%	0%	5%	0%	28%	14,581
6	Refrig	Comm A/C	Formal	Yes	Target	0%	8%	5%	9%	10%	16%	0%	6,462
7	Refrig	Comm A/C	Formal	No	Accel	10%	2%	5%	9%	0%	0%	18%	4,573
8	Refrig	Dom Ref	Formal	Yes	Target	10%	8%	7%	10%	50%	32%	10%	21,239
9	Refrig	Dom Ref	Formal	No	Accel	0%	2%	3%	0%	5%	0%	0%	2,711
10	Aerosol	Propellant	Formal	Yes	Target	100%	60%	50%	33%	75%	0%	0%	13,365
11	Aerosol	Propellant	Formal	Yes	Accel	0%	30%	30%	0%	5%	50%	100%	5,457
12	Aerosol	Propellant	Informal	Yes	Target	0%	10%	20%	67%	20%	50%	0%	4,630
13	Foam	Flexible	Formal	Yes	Target	16%	10%	5%	7%	35%	7%	7%	3,319
14	Foam	Flexible	Formal	Yes	Accel	7%	10%	12%	7%	5%	11%	7%	2,802
15	Foam	Flexible	Informal	Yes	Target	2%	5%	8%	6%	5%	0%	6%	1,851
16	Foam	Packaging	Formal	Yes	Target	20%	15%	12%	10%	35%	0%	10%	4,554
17	Foam	Packaging	Formal	Yes	Accel	5%	10%	13%	10%	5%	33%	9%	3,333
18	Foam	Other	Formal	Yes	Target	40%	30%	25%	30%	15%	39%	6%	6,606
19	Foam	Other	Formal	Yes	Accel	10%	20%	25%	30%	0%	10%	55%	5,845
20	Halon	Streaming	N/D	Yes	Target	24%	19%	16%	15%	65%	62%	30%	15,114
21	Halon	Streaming	N/D	Yes	Accel	8%	13%	16%	85%	5%	12%	25%	3,122
22	Halon	Flooding	N/D	Yes	Target	68%	68%	68%	0%	30%	26%	45%	12,817
23	Solvent	CFC-113	Formal	Yes	Target	20%	15%	10%	0%	75%	50%	5%	3,847
24	Solvent	CFC-113	Formal	Yes	Accel	60%	70%	80%	100%	5%	50%	90%	7,361
25	Solvent	CFC-113	Informal	Yes	Target	20%	15%	10%	0%	20%	0%	5%	1,610
26	Solvent	CTC	Formal	Yes	Target	10%	10%	10%	26%	75%	5%	5%	654
27	Solvent	CTC	Formal	Yes	Accel	10%	10%	10%	48%	5%	53%	5%	3,435
28	Solvent	CTC	Informal	Yes	Target	80%	80%	80%	26%	20%	42%	90%	3,221
29	Solvent	MCF	Formal	Yes	Target	50%	40%	30%	26%	75%	0%	10%	1,088
30	Solvent	MCF	Formal	Yes	Accel	10%	20%	30%	48%	5%	67%	60%	1,649
31	Solvent	MCF	Informal	Yes	Target	40%	40%	40%	26%	20%	33%	30%	1,465
32	Other	Sterilization	N/D	Yes	Target	80%	80%	80%	50%	0%	100%	100%	1,275
33	Other	Tobacco	N/D	Yes	Target	20%	20%	20%	50%	100%	0%	0%	2,256

N/D = No Distinction drawn
Note: percentages for each sector and group add to 100 percent.

- ODP-weighted 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 ODP-weighted 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.
- Real resource Unit Abatement Cost (UAC)

144. Exhibit 3-9 defines the 98 model project in terms of the use segment to which they apply, the substitute technology modeled by the project, the date of availability of the project, the number of years required for it to reach maximum market penetration, the maximum market penetration of the model project, and the real resource UAC of the project. 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 reduction. In calculating operating costs from the real resource perspective, constant pre-Protocol prices for ODS are used.

145. The model projects were developed and parameterized (including the technology forecasts contained in Exhibit 3-9) based on a review of an array of investment projects approved by 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, input from the Technology and Economic AssessmentPanel, and the professional judgement of the Study Team.

146. 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 ODP-weighted use avoided. If there were multiple investment projects for a given model project, then the average of the values across the investment projects was used in parameterizing the model project.

147. In some cases, the Study Team used its best professional judgement in developing estimates of the cost and use avoided by the project. In all cases, these estimates were informed by the Team's extensive experience in analyzing phase-out costs and evaluating project proposals.

148. 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 control technologies.

149. 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.[24]

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

Exhibit 3-9
Definition of Model Project Parameters

Project	Relevant Segment	Substitute Chemical(s)	Date of Availability	Maximum Market Penetration	Years to Maximum Penetration	Unit Abatement Cost
1	1: Refr/Macs/Formal/Target	HFC-134a	1993	100%	7	$8.75
2	2: Refr/Macs/Formal/Accel	HFC-134a	1993	100%	4	$8.75
3	3: Refr/Macs/Formal/Accel	HFC-134a	1993	100%	4	$8.75
4	4: Refr/Comm.Ref/Formal/Target	HCFC-22/HCFC-141b	1993	40%	4	$4.15
5	4: Refr/Comm.Ref/Formal/Target	HFC-134a/HCFC-141b	1993	40%	6	$5.05
6	4: Refr/Comm.Ref/Formal/Target	HFC Blends/HCFC-141b	1995	20%	6	$5.41
7	5: Refr/Comm.Ref/Formal/Accel	HCFC-22/HCFC-141b	1993	40%	4	$4.15
8	5: Refr/Comm.Ref/Formal/Accel	HFC-134a/HCFC-141b	1993	30%	4	$5.05
9	5: Refr/Comm.Ref/Formal/Accel	HFC Blends/HCFC-141b	1994	30%	3	$5.41
10	6: Refr/Comm.AC/Formal/Target	HCFC-123	1993	65%	6	$10.15
11	6: Refr/Comm.AC/Formal/Target	HFC-134a	1993	15%	6	$11.31
12	6: Refr/Comm.AC/Formal/Target	HCFC-22	1993	15%	5	$13.71
13	6: Refr/Comm.AC/Formal/Target	HFC Blends	1995	5%	6	$13.74
14	7: Refr/Comm.AC/Formal/Accel	HCFC-123	1993	65%	2	$10.15
15	7: Refr/Comm.AC/Formal/Accel	HFC-134a	1993	15%	2	$11.31
16	7: Refr/Comm.AC/Formal/Accel	HCFC-22	1993	15%	2	$13.71
17	7: Refr/Comm.AC/Formal/Accel	HFC Blends	1994	5%	2	$13.74
18	8: Refr/Dom.Ref/Formal/Target	HFC-134a/HCFC-141b	1993	42%	6	$12.79
19	8: Refr/Dom.Ref/Formal/Target	HFC-134a/Cyclopentane	1994	28%	7	$11.01
20	8: Refr/Dom.Ref/Formal/Target	HFC-152a/HCFC-141b	1994	9%	7	$11.75
21	8: Refr/Dom.Ref/Formal/Target	HFC-152a/Cyclopentane	1994	6%	7	$9.86
22	8: Refr/Dom.Ref/Formal/Target	Hydrocarbons/HCFC-141b	1994	5%	7	$9.96
23	8: Refr/Dom.Ref/Formal/Target	Hydrocarbons/Cyclopentane	1994	10%	7	$9.33
24	9: Refr/Dom.Ref/Formal/Accel	HFC-134a/HCFC-141b	1993	33%	4	$12.79
25	9: Refr/Dom.Ref/Formal/Accel	HFC-134a/Cyclopentane	1993	33%	4	$11.01
26	9: Refr/Dom.Ref/Formal/Accel	HFC-152a/HCFC-141b	1993	2%	3	$11.75
27	9: Refr/Dom.Ref/Formal/Accel	HFC-152a/Cyclopentane	1993	2%	3	$9.86
28	9: Refr/Dom.Ref/Formal/Accel	Hydrocarbons/HCFC-141b	1993	15%	3	$9.96
29	9: Refr/Dom.Ref/Formal/Accel	Hydrocarbons/Cyclopentane	1993	15%	3	$9.33
30	10: Aero/Formal/Target	Hydrocarbons	1993	70%	4	($0.89)
31	10: Aero/Formal/Target	Carbon Dioxide	1993	30%	4	($1.20)
32	11: Aero/Formal/Accel	Hydrocarbons	1993	70%	3	($0.89)
33	11: Aero/Formal/Accel	Carbon Dioxide	1993	30%	3	($1.20)
34	12: Aero/Informal/Target	Hydrocarbons	1994	40%	6	$0.59
35	12: Aero/Informal/Target	Carbon Dioxide	1994	60%	6	$0.14
36	13: Foam/Flex/Formal/Target	MeCl	1994	100%	5	($0.01)
37	14: Foam/Flex/Formal/Accel	MeCl	1994	100%	3	($0.01)
38	15: Foam/Flex/Informal/Target	MeCl	1994	100%	7	$2.07
39	16: Foam/Pack/Formal/Target	Hydrocarbons	1994	45%	4	($0.08)
40	16: Foam/Pack/Formal/Target	Carbon Dioxide	1994	50%	3	($0.08)
41	16: Foam/Pack/Formal/Target	HCFC-22	1994	5%	2	$1.67
42	17: Foam/Pack/Formal/Accel	Hydrocarbons	1994	45%	3	($0.08)
43	17: Foam/Pack/Formal/Accel	Carbon Dioxide	1994	50%	3	($0.08)
44	17: Foam/Pack/Formal/Accel	HCFC-22	1994	5%	2	$1.67
45	18: Foam/Other/Formal/Target	HCFC-22/HCFC-141b	1994	30%	3	$1.29
46	18: Foam/Other/Formal/Target	HCFC-141b	1994	70%	3	$2.02
47	19: Foam/Other/Formal/Accel	HCFC-22/HCFC-141b	1994	30%	3	$1.29
48	19: Foam/Other/Formal/Accel	HCFC-141b	1994	70%	3	$2.02
49	20: Halo/Stream/Target	Dry Powder	1993	50%	4	($15.42)
50	20: Halo/Stream/Target	Carbon Dioxide	1993	50%	3	$7.01
51	21: Halo/Stream/Accel	Dry Powder	1993	50%	2	($15.42)
52	21: Halo/Stream/Accel	Carbon Dioxide	1993	50%	2	$7.01
53	22: Halo/Flood/Target	See halon recovery/recycling controls below				
54	22: Halo/Flood/Target					
55	22: Halo/Flood/Target					

Exhibit 3-9
Definition of Model Project Parameters (Cont'd)

Project	Relevant Segment	Substitute Chemical(s)	Date of Availability	Maximum Market Penetration	Years to Maximum Penetration	Unit Abatement Cost
56	23: Solv/CFC-113/Formal/Target	Aqueous	1993	20%	3	($0.56)
57	23: Solv/CFC-113/Formal/Target	Semi-Aqueous	1993	15%	5	($1.90)
58	23: Solv/CFC-113/Formal/Target	Chlorinated	1993	35%	2	($4.11)
59	23: Solv/CFC-113/Formal/Target	No Clean	1993	15%	5	($4.38)
60	23: Solv/CFC-113/Formal/Target	Organic	1993	15%	3	($0.65)
61	24: Solv/CFC-113/Formal/Accel	Aqueous	1993	20%	3	($0.56)
62	24: Solv/CFC-113/Formal/Accel	Semi-Aqueous	1993	15%	4	($1.90)
63	24: Solv/CFC-113/Formal/Accel	Chlorinated	1993	35%	2	($4.11)
64	24: Solv/CFC-113/Formal/Accel	No Clean	1993	15%	4	($4.38)
65	24: Solv/CFC-113/Formal/Accel	Organic	1993	15%	3	($0.65)
66	25: Solv/CFC-113/Informal/Target	Aqueous	1994	10%	6	$3.91
67	25: Solv/CFC-113/Informal/Target	Chlorinated	1994	50%	4	($4.07)
68	25: Solv/CFC-113/Informal/Target	Organic	1994	40%	5	$1.42
69	26: Solv/CTC/Formal/Target	Aqueous	1993	5%	5	$3.70
70	26: Solv/CTC/Formal/Target	Chlorinated	1993	75%	3	($1.56)
71	26: Solv/CTC/Formal/Target	Organic	1993	20%	5	$1.67
72	27: Solv/CTC/Formal/Accel	Aqueous	1993	5%	4	$3.70
73	27: Solv/CTC/Formal/Accel	Chlorinated	1993	75%	3	($1.56)
74	27: Solv/CTC/Formal/Accel	Organic	1993	20%	4	$1.67
75	28: Solv/CTC/Informal/Target	Aqueous	1993	5%	10	$11.21
76	28: Solv/CTC/Informal/Target	Chlorinated	1994	75%	5	($1.02)
77	28: Solv/CTC/Informal/Target	Organic	1993	20%	10	$4.70
78	29: Solv/MCF/Formal/Target	Aqueous	1993	20%	5	$1.79
79	29: Solv/MCF/Formal/Target	Aqueous	1993	20%	5	$2.85
80	29: Solv/MCF/Formal/Target	Chlorinated	1993	30%	3	($0.64)
81	29: Solv/MCF/Formal/Target	Organic	1993	30%	3	$2.21
82	30: Solv/MCF/Formal/Accel	Aqueous	1993	40%	4	$1.79
83	30: Solv/MCF/Formal/Accel	Chlorinated	1993	30%	3	($0.64)
84	30: Solv/MCF/Formal/Accel	Organic	1993	30%	3	$2.21
85	31: Solv/MCF/Informal/Target	Aqueous	1993	15%	10	$3.93
86	31: Solv/MCF/Informal/Target	Chlorinated	1994	60%	5	($0.63)
87	31: Solv/MCF/Informal/Target	Organic	1994	25%	6	$3.31
88	32: Othr/Ster/Target	EOCO2	1993	100%	4	$0.83
89	33: Othr/Tobacco/Target	Carbon Dioxide	1993	100%	5	$10.40

Project	Relevant Segment	Description	Date of Availability	Maximum Market Penetration	Years to Maximum Penetration	Unit Abatement Cost
90	1-3: Refr/Macs	Recovery/Recycling	1996	50%	3	$2.80
91	4-5: Refr/Comm.Ref	Recovery/Recycling	1996	50%	3	$2.42
92	6-7: Refr/Comm.AC	Recovery/Recycling	1996	75%	3	$1.98
93	20-21: Halo/Stream	Recovery/Recycling	1996	60%	3	$0.53
94	22: Halo/Flood	Recovery/Recycling	1996	80%	3	$0.53

Project	Relevant Segment	Description	Date of Availability	Kgs Avoided Per Year	Cost of Retrofit	Unit Abatement Cost*
95	1-3: Refr/Macs	Retrofit/Retire	1994	0.4	200	NA
96	4-5: Refr/Comm.Ref	Retrofit/Retire	1994	40	500	NA
97	6-7: Refr/Comm.AC	Retrofit/Retire	1994	80	33000	NA
98	8-9: Refr/Dom.Ref	Retrofit/Retire	1994	0.3	100	NA

* Unit abatement costs for retrofit projects depend on the age of the equipment retrofitted.

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

3.4.3.6 Estimation of ODS Prices Over Time

151. It was necessary to develop estimates of the rise in ODS prices likely to occur under each scenario in order to estimate the Fund and actual phase-out costs. The Study Team initially intended to obtain estimates of future ODS prices from chemical manufacturers worldwide. This proved to be infeasible, however, because manufacturers felt they could not give credible estimates.

152. 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 limit the applicability of the standard microeconomic model for pricing in the context of a phase-out. 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. Theoretically, no user would 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 phase-out target each year. However, the Fund breaks this connection by reimbursing the costs of projects. This effectively reduces user costs to zero and, therefore, reduces the force that drives prices in the standard model.

153. 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 basis for estimating price increases over time. In each scenario prices for each chemical were assumed to begin to rise in the year in which ODS use restrictions are first imposed in Article 5 countries under a given phase-out scenario. Prices were then assumed to increase linearly from the base price of the chemical up to two-thirds of the value of the UAC of the most expensive control implemented in the year in which new ODS use must be phased out. Exhibit 3-10 presents the base prices (pre-Protocol prices) assumed for each of the major ODS and substitute chemicals. Exhibit 3-11 presents the price rises over time under each of the phase-out scenarios developed based on the methodology described above.

3.4.3.7 Production Costs

154. This section describes the approach used to develop an estimate of the cost of the phase-out of ODS production in Article 5 countries. The cost of phasing out such production is used in the modeling framework as an input to the calculation of the Fund costs. This estimate is not used in the calculation of real resource or actual costs because to distinguish the costs of the production phase-out from the cost of phasing out ODS use would lead to "double counting." This is because 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 and actual cost estimates produced by modeling framework described above. It is, of course, a policy matter for the Executive Committee to determine how to compensate

Exhibit 3-10

Chemical Prices

Chemical	Price ($/Kg)
CFC-11	2.15
CFC-12	2.50
CFC-113	4.79
CFC-114	2.38
CFC-115	1.00
CT	2.55
MCF	1.28
H-1211	18.30
H-1301	13.73
HCFC-22	3.64
HCFC-123	10.12
HCFC-124	11.39
HCFC-141b	4.63
HCFC-142b	4.75
HFC Blends	9.96
HFC-125	12.26
HFC-134a	7.35
HFC-152a	5.06
Aqueous	2.50
Carbon Dioxide	0.40
Chlorinated	0.63
Comp.Gas	0.63
Cyclopentane	1.99
Dry Powder	0.67
EOCO2	1.40
Hydrocarbons	0.83
MeCl	0.79
Organic	2.75
Semi-Aqueous	3.00

Exhibit 3-11

ODS Price Forecasts
($US/Kg)

2000 Phaseout Schedules

Chem	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CFC-11	2.2	2.9	3.6	4.3	5.0	5.7	6.4	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
CFC-12	2.5	3.3	4.0	4.8	5.6	6.3	7.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
CFC-113	4.8	5.0	5.2	5.4	5.7	5.9	6.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
CT	2.6	3.2	3.8	4.4	5.0	5.7	6.3	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
MCF	2.8	2.9	3.0	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.2	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
H-1211	18.3	18.7	19.1	19.5	19.9	20.2	20.6	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
H-1301	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7

2006 Phaseout Schedules

Chem	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CFC-11	2.2	2.2	2.2	2.2	2.2	2.2	2.9	3.6	4.3	5.0	5.7	6.4	7.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
CFC-12	2.5	2.5	2.5	2.5	2.5	2.5	3.3	4.0	4.8	5.6	6.3	7.1	7.8	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
CFC-113	4.8	4.8	4.8	4.8	4.8	4.8	5.0	5.2	5.4	5.7	5.9	6.1	6.3	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
CT	2.6	2.6	2.6	2.6	2.6	2.6	3.2	3.8	4.4	5.0	5.7	6.3	6.9	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MCF	2.8	2.8	2.8	2.8	2.8	2.8	3.0	3.2	3.4	3.6	3.8	4.1	4.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
H-1211	18.3	18.3	18.3	18.3	18.3	18.3	18.7	19.1	19.5	19.9	20.2	20.6	21.0	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
H-1301	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7

2010 Phaseout Schedules

Chem	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CFC-11	2.2	2.2	2.2	2.2	2.2	2.2	2.6	3.1	3.6	4.0	4.5	5.0	5.5	5.9	6.4	6.9	7.4	7.8	7.8	7.8	7.8	7.8	7.8
CFC-12	2.5	2.5	2.5	2.5	2.5	2.5	3.0	3.5	4.0	4.5	5.0	5.6	6.1	6.6	7.1	7.6	8.1	8.6	8.6	8.6	8.6	8.6	8.6
CFC-113	4.8	4.8	4.8	4.8	4.8	4.8	4.9	5.1	5.2	5.4	5.5	5.7	5.8	5.9	6.1	6.2	6.4	6.5	6.5	6.5	6.5	6.5	6.5
CT	2.6	2.6	2.6	2.6	2.6	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.5	5.9	6.3	6.7	7.1	7.5	7.5	7.5	7.5	7.5	7.5
MCF	2.8	2.8	2.8	2.8	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
H-1211	18.3	18.3	18.3	18.3	18.3	18.3	18.6	18.8	19.1	19.3	19.6	19.9	20.1	20.4	20.6	20.9	21.2	21.4	21.4	21.4	21.4	21.4	21.4
H-1301	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7

chemical producers whose customers may also be receiving Fund support to cover the cost of purchasing ODS substitutes.

155. The methodology and results presented in this sub-section were to developed to provide a basis for estimating the potential level of support that may be provided to chemical producers in Article 5 countries by the Fund. As described below, the analysis used a series of simplified approaches to estimate a range of potential phase-out costs for chemical producers in Article 5 countries. This range of cost estimates was presented to the Subcommittee to the Report in September of 1994, and based on the mid-point of the range of cost estimates, the Subcommittee instructed the Study Team to assume, for the purposes of this report only, that the Fund would provide $621 million to finance production phase-out projects.[25]

156. The remainder of this sub-section presents a brief overview of the approach used to estimate the phase-out costs, followed by the primary elements of the approach and the results of the analysis.

Overview

157. Enterprises in several Article 5 countries produce significant quantities of ODS. As the global phase-out 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.

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

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25 Based on the Study Team's analysis, the Subcommittee to the Report initially instructed the Study Team to assume that the Fund would provide $700 million to finance production phaseout projects in Article 5 countries. At the Sixth Meeting of the Parties held in October 1994, however, the Republic of Korea indicated it would make no claims on the Multilateral Fund. Given that the $700 million figure assumed that the Republic of Korea would seek assistance from the Fund for production phaseout projects, the Study Team was subsequently instructed by the Chairman of the Subcommittee to the Report to remove the Republic of Korea from the analysis and reduce the estimate of the level of financing available from the Fund for phaseout production projects to $621 million.

159. 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.[26] In addition, the Study Team could not develop a simple approach to determine when these costs would be incurred; thus, the estimate of production phase-out costs is independent of the calculation of phase-out costs for ODS use and does not vary across the eleven phase-out scenarios described in Chapter 2.

Profile of ODS Production in Article 5 Countries

160. 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.

161. 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 to 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. In addition, production estimates for the Republic of Korea have been excluded from this analysis because at the Sixth Meeting of the Parties held in October 1994, representatives of its government indicated that it would not make any claims on the Multilateral Fund. As shown in Exhibit 3-12, actual production, at present, appears to be far below production capacity.

Estimation of Cost to the Multilateral Fund to Address ODS Production

162. In order to estimate the Fund cost associated with phase-out 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 producing each ODS and the leading alternative chemicals based on their prices.

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26 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.

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

Exhibit 3-12
Estimated ODS Production and Capacity in Article 5 Countries
(Adjusted to reflect foreign ownership and the exclusion of the Republic of Korea)

Chemical	Quantity Produced (MT/yr) In Latest Year Data Available	Production Capacity[27] (MT/yr)
CFC 11/12	48,000	136,000
CFC 113	<1,000	1,600
Halon 1211	3,500	7,000
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.

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[27] The production capacity for carbon tetrachloride has been prorated to include only that portion likely to be used for non-feedstock purposes.

163. 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,[28] 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 (i.e., the principle asset) 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.

164. 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.

165. 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 phase-out scenarios.[29]

166. 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. 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.

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

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[28] See "Annual Statement Studies: 1990," Robert Morris Associates, page 83.

[29] 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.

- 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.

168. When considering this approach to estimating the cost of the ODS production phase-out, several factors should be kept in mind. First, 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.

169. Second, 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.

170. Finally, this analysis is a global, rather than country or plant, level analysis. As such, it does not involve development of a production phase-out 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.

Production Phase-out Cost Estimates

171. Exhibit 3-13 presents the results of the production cost analysis. This range of cost estimates was presented to the Subcommittee to the Report in September of 1994, and based on the mid-point of the range of cost estimates, the Subcommittee instructed the Study Team to assume, for the purposes of this report only, that the Fund would provide $621 million in support to finance production phase-out projects in Article 5 countries.

Exhibit 3-13
Production Phase-out Costs

Fund Reimbursement Rule	Undiscounted Cost (US $ Million) to Phase out Production Based on:	
	Current Production	Existing Capacity
Savings Netted from Grant: Capital Cost Only	18.8	73.5
Savings Netted from Grant: Capital Cost + 4 Years Operating Cost	123.0	481.4
Savings Set Equal to Zero: Capital Cost Only	65.1	180.4
Savings Set Equal to Zero: Capital Cost + 4 Years Operating Cost	426.6	1,181.6
Lost Profits Paid in Lieu of Savings: Capital Cost Only	92.2	242.8
Lost Profits Paid in Lieu of Savings: Capital Cost + 4 Years Operating Cost	453.7	1,243.0

3.4.3.8 Non-Investment Costs

172. In addition to the costs associated with investments in projects to phase out 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 phase-out 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.

173. 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.[30] This cost was assumed not to vary over time or across the various phase-out scenarios analyzed.

174. 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 phase-out scenario being analyzed, a different approach was used. The approach entailed applying a 13 per cent support fee to all investment projects undertaken by UNDP and UNIDO, and a 8 per cent support fee to all investments projects undertaken by the World Bank. It was assumed that the World Bank would undertake all of the ODS production plant phase-out projects and about 50 per cent of the investment projects to phase

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

out ODS use. 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 by UNDP and UNIDO and 8 per cent of the cost of all investment projects undertaken by the World Bank.[31] This non-investment cost estimate is included in the estimates of real resource, actual and Fund costs.

3.4.4 Operation of the Model

175. The algorithm used to estimate the real resource, Fund, and actual costs is presented graphically in Exhibit 3-14 and can be summarized as follows:

(1) Estimate total baseline ODP-weighted use across all Article 5 countries in the absence of controls beginning in 1993.

(2) Calculate the total reduction in ODP-weighted use that must be achieved in a given year to comply with the phase-out targets specified in a given scenario. This is simply the difference between unconstrained use and the total use allowed under the scenario each year.

(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 ODS demand after implementation of the accelerated model projects. If this demand exceeds the target, then implement price driven projects in order of decreasing cost-effectiveness. The cost-effectiveness of each project is measured using the real resource unit abatement cost. Once the target has been reached for a given year, the model determines if it has reached the final year of the analysis. If it has not, it moves to the next year and repeats the simulation described above beginning with estimating the ODP-weighted use reductions required to meet the target for the next year.

(5) Once the simulation is complete, the model prorates the $621 million cost associated with phasing out ODS production in Article 5 countries over the appropriate time interval and calculates the non-investment costs.

(6) The model then calculates the total real resource, Fund, and actual costs based on the sequence of projects implemented over time, the prorated production costs, and the non-investment costs.

(7) 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.

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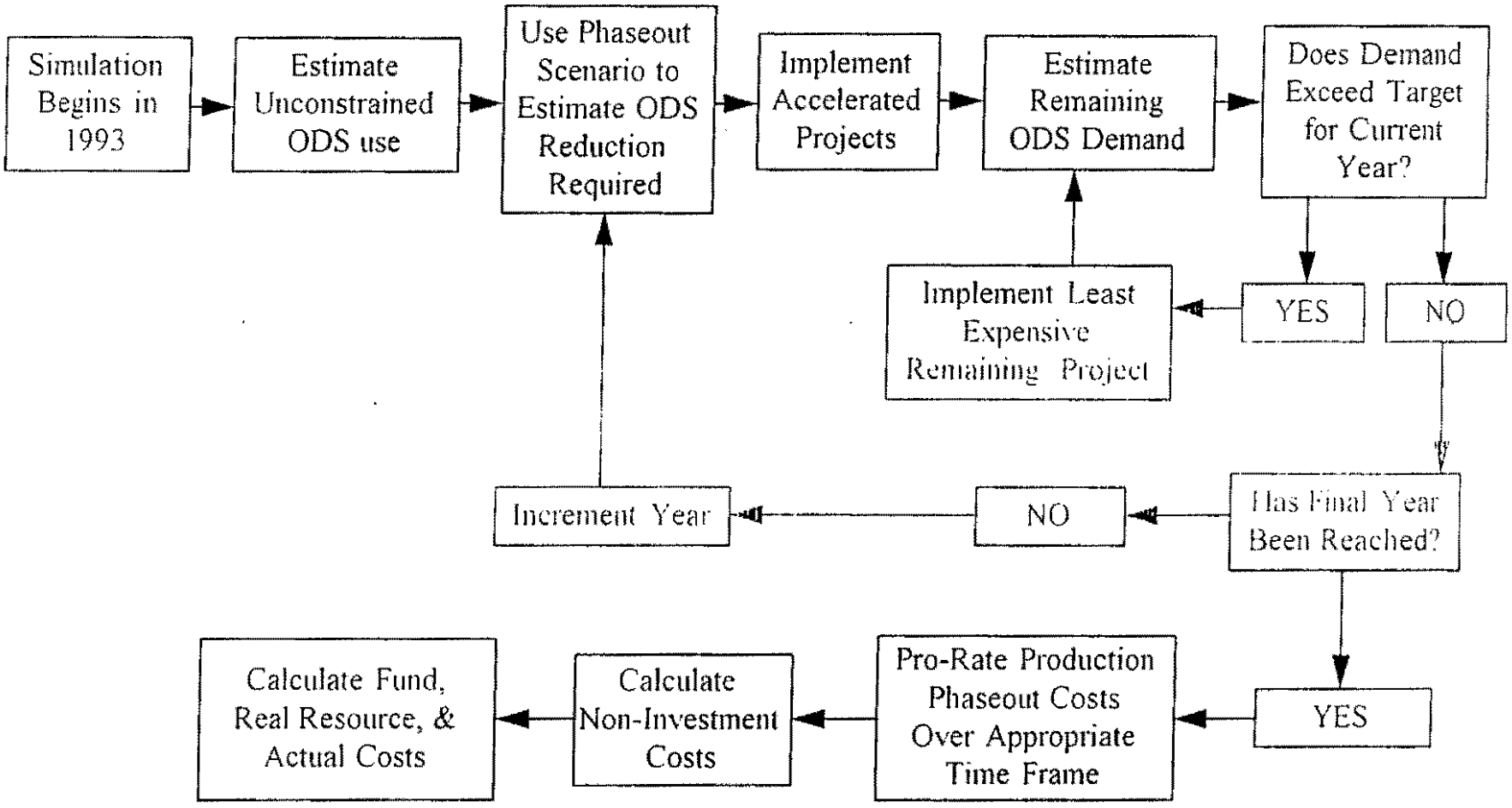
31 See "The Administrative Costs of the Financial Mechanism (Draft)," UNEP/OzL.Pro/ExCom/14/12. Note that the figure of 8 per cent for the World Bank is based on its expected future administrative cost of 5 per cent plus a separate 3 per cent fee provided by the World Bank to its local financial intermediaries for supervising project implementation.

Exhibit 3-14

Model Algorithm



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

3.4.4.1 Estimate Baseline ODP-weighted use

176. The methodology used to develop estimates of baseline ODP-weighted use across all Article 5 countries was described in section 3.4.3.1. It is important to note that the model does not track ODP-weighted use at the individual Article 5 country level. Instead, the model tracks total use for the 33 use segments across all Article 5 countries.

3.4.4.2 Total ODP-Weighted Use Reduction Required to Meet the Target Each Year

177. Given an estimate of baseline ODP-weighted use through time, and the phase-out target specified by a given scenario, the model calculates the total use 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 Accelerated Model Projects

178. 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 phase-out 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 the phase-out 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 to protect their export markets often without the impetus of a rise in prices.

179. 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 Implementation of Target Driven (Price-Based) Model Projects

180. After implementing the non-price controls, the model calculates the additional ODP-weighted 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 ODP-weighted use 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.

181. 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 phase-out 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.

3.4.4.7 Estimation of Fund Costs

182. 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 projects 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 will potentially be implemented in any given use segment is calculated as the total ODP-weighted use in that segment each year divided by the quantity of ODP-weighted use eliminated by a given model project. In addition to the costs associated with investment projects to reduce ODS use, the costs of phasing out ODS production in Article 5 countries and non-investment (administrative costs) are added to the costs associated with phasing out ODS use. As discussed in Section 3.4.3.7, the total production phase-out costs are calculated at $621 million over the time period of the analysis. Total non-investment costs are calculated as described in Section 3.4.3.8.

183. 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 3.4.2.1.

184. 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.

185. 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 document UNEP/OzL.Pro/ExCom/13/39 Add. 1).[32]

186. 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.

3.4.4.8 Estimation of Real Resource Costs

187. 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. 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

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[32] 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."

technological innovation that will reduce the cost of alternative technologies over time. In addition, the non-investment (administrative) costs are included in real resource costs. Section 3.4.2.2 presents additional details on the process used to estimate real resource costs.

3.4.4.9 Estimation of Actual Costs

Actual costs, a measure defined by the Sub-Committee for the Report, are identical to real resource costs with one exception. While ODS prices are assumed to be constant when measuring real resource costs, escalating prices are used in the calculation of actual costs. This measure reflect what the phase-out will actually cost Article 5 countries given the implementation of the Montreal Protocol and the likely increase in ODS prices that will follow.

3.4.4.10 Tail Scenarios

188. In analyzing tail scenarios, the modeling framework estimates the quantity of ODP-weighted use required each year to avoid potentially retrofit and early retirement controls in the refrigeration and air conditioning sector.[33] 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. Finally, it should be noted in developing estimates of the quantity of use required to service existing equipment, the model does not address the issue of whether sufficient quantities of ODS will be produced to meet this requirement.

3.4.5 Model Limitations

189. First, the modeling framework tracks ODP-weighted 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 limitation tends to underestimate phase-out costs.

190. 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 limitation tends to underestimate costs by delaying (therefore discounting more) some expensive projects while expediting (therefore discounting less) a corresponding number of inexpensive projects.

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[33] The quantity of ODS required each year to service existing refrigeration and air conditioning equipment is, in part, a function of the lifetime of the equipment. In this analysis, it was assumed that the average lifetime of equipment was 7 years for MACs, 15 years for commercial refrigeration, 20 years for commercial air conditioners equipment, and 15 years for domestic refrigeration.

191. Third, as discussed in Section 3.4.3.6, the estimation of ODS prices forecasts is an extremely difficult analytic undertaking and the estimate of Fund and actual costs are quite sensitive to ODS prices. A very simplified approach to price forecasting was used in this Study.

192. Fourth, the quantitative results presented in this analysis are highly dependent on the quality of the underlying data used in the modeling analysis. As described previously, the Study Team devoted significant effort and resources to obtaining the highest quality data available. Even with this effort, however, it must be recognized that the quality of the data collected was uneven, and, as a result, the quantitative estimates presented in this analysis are uncertain.

193. Fifth, there are a number of limitation associated with the model projects:

- 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 these data may 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 offer net incremental cost savings

- In culling technical and economic data for use in the model projects from the 62 projects, the Study Team relied solely on the documentation provided by the Implementing Agencies to the Secretariat 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.[34]

- The majority of investment projects used to parameterize the model have not actually been implemented on the shop floor. As a result, it is not possible to test whether the cost estimates contained in the documentation supporting these projects accurately reflected the costs upon implementation of the project.

- In using such model projects to simulate the ODS phase-out in Article 5 countries, the Study Team does not mean to imply that these specific technologies will be the actual ones used to achieve the phase-out. The Team recognizes that the phase-out will occur over the next ten to twenty years and that the specific technologies used to achieve it will likely change due to technological innovation. The Team did, however, incorporate a technological innovation factor in the cost of ODS phase-out projects which serves to reduce these costs over time as technologies mature.

194. Sixth, in order to conduct the modeling exercise, it was necessary to make a number of assumptions about the implementation of Multilateral Fund policies. These key assumptions include:

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[34] 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.

- Methyl chloroform projects in the solvents sector would not be funded if their unit abatement cost was above $100 per kilogram.

- The total funding available from the Fund for investment projects to phase out the production of ODS in Article 5 countries will be $621 million.

- HCFC and methyl bromide projects are not included in estimates of the phase-out costs.

- The cost of land acquisition is not included in the cost of the model projects. This is because no projects submitted to date have included such costs. It is possible that some future projects, particularly those proposing a shift to hydrocarbons and incorporating a factory relocation, may include requests for the costs of land acquisition.

- Two years of operating costs are reimbursed by the Multilateral Fund. This figure was calculated by taking the average duration over which operating costs were calculated for all projects presented at the Thirteenth meeting of the Executive Committee. The range of periods was zero to four years and the calculated average was two years.

As made clear by the Sub-Committee to the Report, these assumptions were made solely for the purposes of this analysis and should not "prejudice any future policy decisions of the Executive Committee."[35]

195. Seventh, the modeling framework assumes that ODS prices will rise in Article 5 countries once the phase-out targets begin to limit ODS use. It may be the case, however, that governments in Article 5 countries will limit the ODS price rises that can occur through the use of price controls or other economic interventions. Government policies designed to hold down such price rises would result in higher Fund and actual costs than calculated in this study.

196. Eighth, the modeling framework does not assume that recycled ODS are banked prior to the phase-out date for use after this date. If such a bank were assumed to be created, it could potentially significantly reduce the cost of the phase-out 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 phase-out date.

3.5. SIMULATION OF ENVIRONMENTAL ASSESSMENT

197. The purpose of the environmental assessment is to provide a comparative measure of the impact of each of the proposed phase-out 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

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35 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/14/14/Rev.1/29 September 1994.

simplified model, the Atmospheric Stabilization Framework (ASF), to estimate the impact of each phase-out schedule on stratospheric chlorine loading.

198. 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.

199. 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, adjusted chlorine loading is used to compare the atmospheric impact of each scenario.[36] The analysis involved the following steps:

- Estimate Article 5 emissions from the use estimates developed in Section 3.3.4.1 with emission estimates from the developed world assuming it complies with the Copenhagen Amendment to create a global emissions scenario for each proposed phase-out schedule; and

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

200. 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. The ASF yielded annual adjusted Clx concentrations, in parts per billion (ppb), over the period 1993 to 2030 for each phase-out scenario.

201. To allow direct comparisons between different phase-out scenarios, the annual adjusted Clx concentrations were aggregated to generate a single measure of cumulative adjusted Clx for each scenario. This was done by first determining the degree to which each annual concentration exceeded a baseline level of 2 ppb.[37] The exceedances for each of the years above 2 ppb were then added together to yield a measure of cumulative adjusted Clx concentrations expressed in terms of "ppb-years." As shown in Exhibit 3-15, this quantity is equivalent, in mathematical terms, to the area under the annual adjusted Clx concentration curve and above a horizontal line drawn at a concentration of 2 ppb. To further facilitate comparisons among scenarios, the Study Team also computed the percentage difference in the cumulative adjusted Clx concentration between each scenario and the scenario representing current policy under the Montreal Protocol (i.e., the 2010 phase-out scenario).

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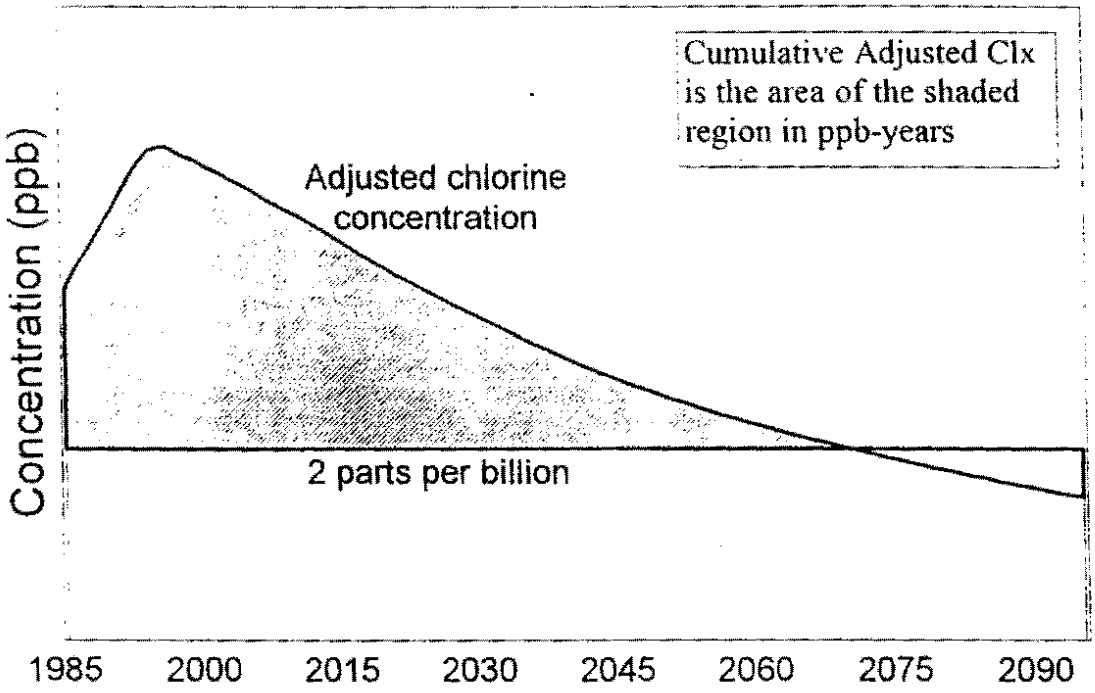
[36] Adjusted stratospheric chlorine loading is defined as the concentration of chlorine in the stratosphere plus 40 times the concentration of bromine in the stratosphere. This calculation assumes that bromine molecules are 40 times more effective at destroying ozone than chlorine. Using adjusted chlorine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

[37] An adjusted Clx concentration of 2 ppb is used because it is a rough approximation of values observed in the 1970s prior to the detection of the ozone hole.

Exhibit 3-15

Calculation of Cumulative Adjusted Clx
An Illustrative Example



Chapter 4

OVERVIEW OF DATA COLLECTED BY STUDY TEAM

4.1 INTRODUCTION

202. 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 phase-out schedules for Article 5 countries. Accordingly, this chapter provides a descriptive overview of the 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 phase-out schedules being evaluated under this study. Please refer to document UNEP/OzL.Pro/ExCom/12/37 Annex 5 for the TOR. In addition, the minutes of the May, July, and September meetings provide clarification on the TOR provided by the Sub-Committee to the Study Team.

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

203. Data to assess the transfer of Fund resources to Article 5 countries were obtained from the Fund Secretariat and are extracted from the data base of projects approved by the Executive Committee.[38] 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.[39] 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.

204. 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 have been completed. Finally, no institutional strengthening projects have been completed yet 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.

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[38] This data base 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.

[39] The cost data presented in Exhibit 4-1 do not show funds disbursed by the implementing agencies for projects that currently are underway but not yet completed; rather, the cost data reflect amounts approved and allocated by the Executive Committee as well as expenditures for completed projects only.

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 (in millions)

Type of Project	Cost of Projects Approved by ExCom	Final Cost of Completed Projects	Cost of Projects Not Yet Completed[40]	Percentage of Funds Disbursed For Fully Completed Projects
Investment	US $141.74	US $2.28	US $139.47	2%
Institutional Strengthening	8.77	0	8.77	0%
Project Preparation	17.36	3.89	11.48	22%
Training	7.02	2.07	2.94	29%
Other	23.63	2.62	17.47	11%
Total	US $198.52	US $10.86	US $180.14	5%

Source: Data from the Inventory of Approved Projects as at July 1994, provided by the Fund Secretariat.

40 The numbers across columns do not sum to totals due to differences between the amount of funds approved by the Executive Committee and funds actually disbursed by the implementing agencies for fully completed projects. Furthermore, the figures do not reflect funds disbursed by the implementing agencies to date for ongoing projects.

205. 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 as of July 1994. A total of 29 per cent of all approved projects have been completed; these projects account for five per cent of the total funds approved and allocated for projects by the Executive Committee. All funds that have been approved by the Executive Committee have been transferred to the implementing agencies for disbursement. The data available in the Inventory of Approved Projects do not provide the amount of funds disbursed on projects that are underway but not yet fully completed.

206. 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 meeting 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 13th Meeting of the Executive Committee. This information indicates that, as of July 1994, a significant number of projects that were approved prior to the Tenth Executive Committee Meeting remain to be completed, amounting to 160 projects. Of these, investment projects account for the largest portion, with 50 projects remaining to be completed. It should be noted, however, that some disbursements are occurring for ongoing projects.

207. 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 for administrative costs, which includes its overhead costs, separately from projects it submits for approval. The World Bank's allocations for administrative costs are accounted for under project preparation.

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

208. 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 phase-out activities. The Study Team did not look at CPs for this TOR item because, for the most part, they would not indicate the status of actual phase-out 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 phase-out rate.[41] These data sources provide the most current information on this issue.

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[41] 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[42]

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)[43]
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 as at July 1994, provided by the Fund Secretariat.

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42 This table does not distinguish between projects that are underway but have not yet reached completion and those that have not yet been initiated.

43 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 (in millions)[44]

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)[45]
Investment	US $139.47	US $42.38	US $15.65	US $15.86	US $20.93	US $44.65
Institutional Strengthening	8.77	.84	.82	.72	1.96	4.43
Project Preparation	11.48	1.23	4.37	.96	1.37	3.55
Training	2.94	.12	.77	.31	.45	1.29
Other	17.47	1.79	3.76	3.70	1.96	6.26
Total	US $180.14	US $46.36	US $25.37	US $21.55	US $26.67	US $60.18

Source: Data from the Inventory of Approved Projects as at July 1994, provided by the Fund Secretariat.

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[44] This table does not distinguish between projects that are underway but have not yet reached completion and those that have not yet been initiated.

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

209. 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 phase-out in production of CFC-115 taking place in industrialized countries, which supply CFC-115 to the country.

210. 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 continue to be available.

211. 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. A halon bank is also being implemented in one country of the eight visited.

212. 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.

213. Another five countries responding to the fax questionnaire indicated some increase in prices but did not characterize the increase as significant, which suggests 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[46] 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. In general, regional trends in ODS prices were identified, with increases in prices seen in Africa and Latin America (with the increase more significant in local currency than in dollars), whereas prices remained steady in Asia.

214. 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 phase-out activity has been observed.

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[46] 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.

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)

215. 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 phase-out 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.

216. The phase-out 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.[47] In three other countries, at least 50 per cent phase-out has occurred, and in two countries, initial phase-out activities have commenced. Though three of the countries visited instituted early legislation banning ODS use in this sector, the phase-out process in all eight countries has been largely driven by the economic advantages of using hydrocarbon as a propellant. In some countries, however, the non-availability of high-quality hydrocarbon has limited the phase-out in certain applications, such as perfume sprays and room fresheners. Some phase-out in applications such as insecticide sprays has occurred in these countries with the use of destenched liquified petroleum gas (LPG).

217. In the flexible foams sector, replacement of ODS blowing agents by methylene chloride, water, and HCFC blends is occurring rapidly in most countries visited. This phase-out process has been driven by the early acceptance of substitute technology, its low cost, and the availability of Fund financing. 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 phase-out process and are at various stages of project preparation and implementation.

218. 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 phase-out are only now being developed in many of these countries. Most of these projects are based on cyclopentane or HCFC-141b technologies. Rapid phase-out in at least four of the countries is expected on the basis of these projects.

219. In four of the eight countries visited, no halon phase-out 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 phase-out 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

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[47] A small amount of ODS consumption may remain in the aerosols sector for use in measured dose inhalers.

are in the process of preparing a recycling plant project. A halon banking plan is being implemented in a sixth country.

220. 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 in these countries expect to complete phase-out implementation by 1998, though servicing and/or retrofitting of residual stock is expected to continue as long as allowed. Most refrigerator manufacturers are in the process of or have completed a shift away from fully CFC-blown foam to alternatives which include low-CFC foam, HCFC-141b, or cyclopentane.

221. In the commercial refrigeration and air conditioning sectors, the Study Team found evidence that low-ODS technologies are already in use in the eight countries visited. HCFCs have traditionally been used in commercial air conditioning, as well as in other applications. 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, because HCFCs have been considered suitable alternatives to CFCs in these two sectors under the Montreal Protocol. As a result, more equipment is being installed that is based on HCFCs or HCFC/HFC blends. Decisions regarding the use of substances other than HCFCs as alternatives to CFCs in commercial refrigeration and air conditioning are likely to be taken in the near future due to increased concerns about the global warming potential of HCFCs, particularly HCFC-22.

222. The implementation of non-ODS technologies has been relatively fast in the MACs sector for the manufacture of new MACs. ODS phase-out 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 widespread conversion of existing MACs to alternative technologies is taking place in the eight countries visited due to the high price of MACs retrofits.

223. Phase-out 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 phase-out has occurred in local enterprises. In this country, the phase-out of ODS for export-oriented electronics cleaning is almost complete. By comparison, phase-out 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 phase-out implementation.

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

224. 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.

225. 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. Furthermore, UNEP has established regional networks of ozone protection officials in Article 5 countries to provide a forum for the exchange of information and ideas related to the countries' phase-out efforts.

226. It appears likely that, in the future, the transfer of non-ODS technologies between some Article 5 countries will occur. For example, an enterprise in one of the countries visited has developed non-ODS compressors for domestic refrigerators and expects to export the compressors to other neighboring 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)

227. 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 phase-out schedules currently planned by Article 5 countries. Data on phase-out schedules were then aggregated and analyzed to better understand the current plans of Article 5 countries.

228. Most CPs detail the country's phase-out 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 phase-out schedule for the first three chemical groups and a 2015 date for methyl chloroform. Many countries with CPs in place, however, have adopted accelerated phase-out schedules for all four groups. Exhibit 4-3 presents the distribution of phase-out dates by chemical group for those countries with an approved CP as of early September 1994.[48] The graphs indicate that, if countries adhere to the phase-out 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.

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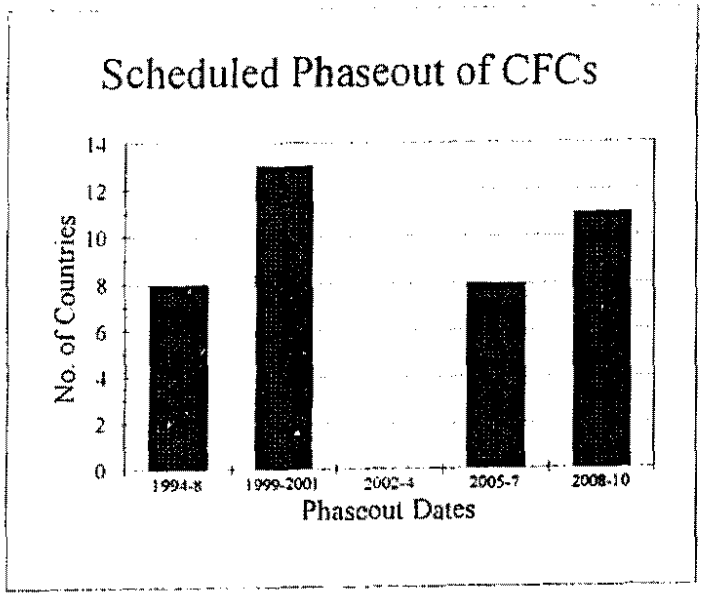
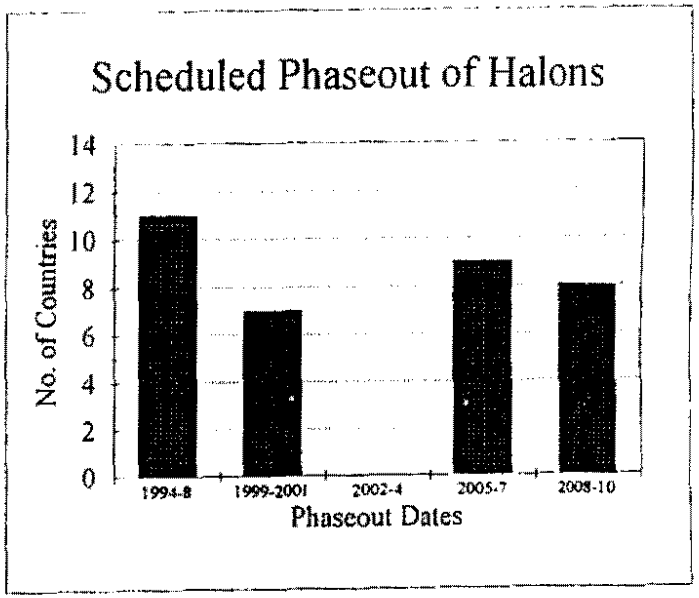
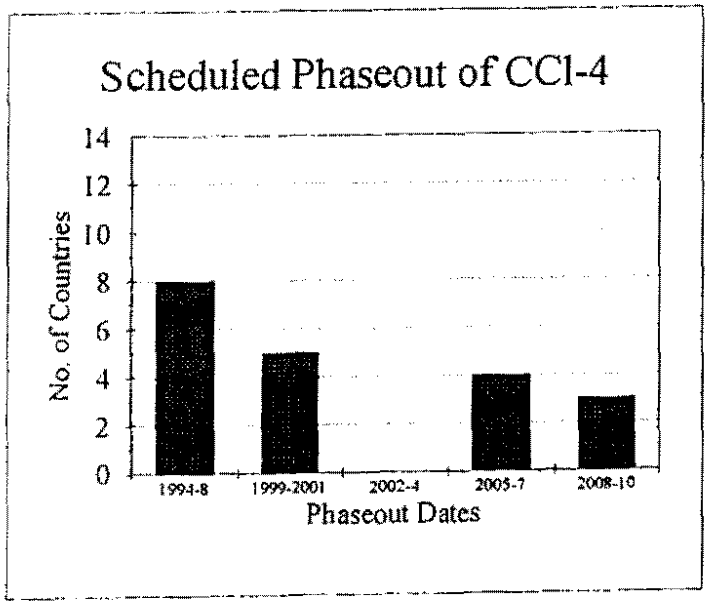
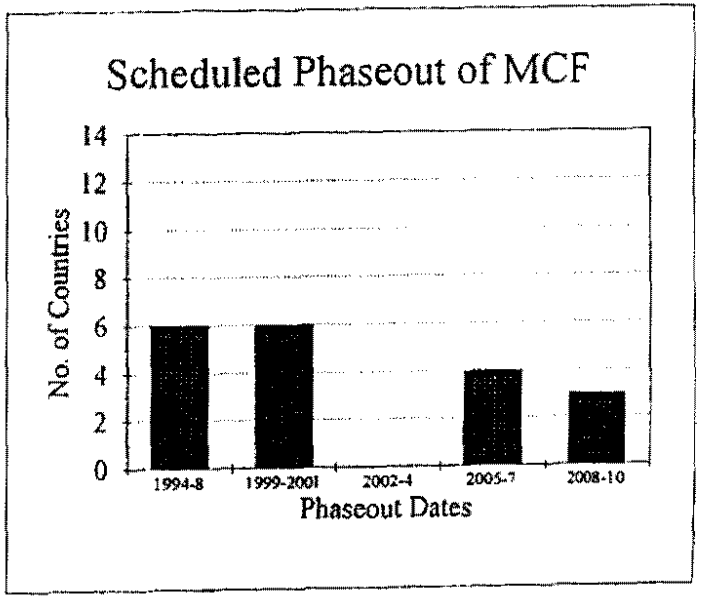
[48] The number of countries varies among the four graphs in Exhibit 4-3 because not all countries have set a phaseout date for each chemical group.

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

229. If the phase-out date for each country is weighted according to the ozone-depletion potential (ODP) of its consumption of a particular chemical group, a weighted average phase-out date for each chemical group can be calculated. These 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 phase-out 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 phase-out 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 phase-out, most ODP-weighted consumption will not be phased out until late in the next decade under current CP plans.

230. The analysis presented above reflects only the 40 Article 5 countries with approved CPs as of early September 1994. There are another 51 countries for which CPs have yet to be approved. Of the total consumption of 208,000 ODP tonnes per year, countries with CPs are thought to consume about 162,000 ODP tonnes or 78 per cent of the total.[49] If countries without CPs are assumed not to accelerate their phase-out and instead adhere to the Protocol schedule, the graph shown in Exhibit 4-4 can be adjusted to reflect all Article 5 countries. This adjustment is reflected in Exhibit 4-5, which depicts the schedules for all Article 5 countries assuming that countries without CPs adhere to the Protocol-specified phase-out schedule. Exhibit 4-5 illustrates again that the majority of the phase-out is planned to occur between 2008 and 2010.[50]

231. The Study Team thought that another perspective on the plans of Article 5 countries could be obtained by a review of the cost estimates for phase-out provided by Article 5 countries in their CPs. However, given the extreme variations in these data, it would have proven difficult to know how heavily to rely upon them when drawing inferences about global phase-out. First, there seems to be substantial variation across CPs in the method of calculating costs, 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. As a result, the Study Team determined that such an analysis would not yield useful results.

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

232. The TOR require the Study Team to take into account document UNEP OzL.Pro/ExCom/ 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 July 1, 1993. The document consists of the following sections: the structure of the Multilateral Fund; the process for accessing

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49 These figures do not include the Republic of Korea which, as explained in Chapter 3, has not been incroporated in the analysis.

50 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 4-4
ODP Tons Committed to Phaseout Dates for Article 5 Countries with CPs

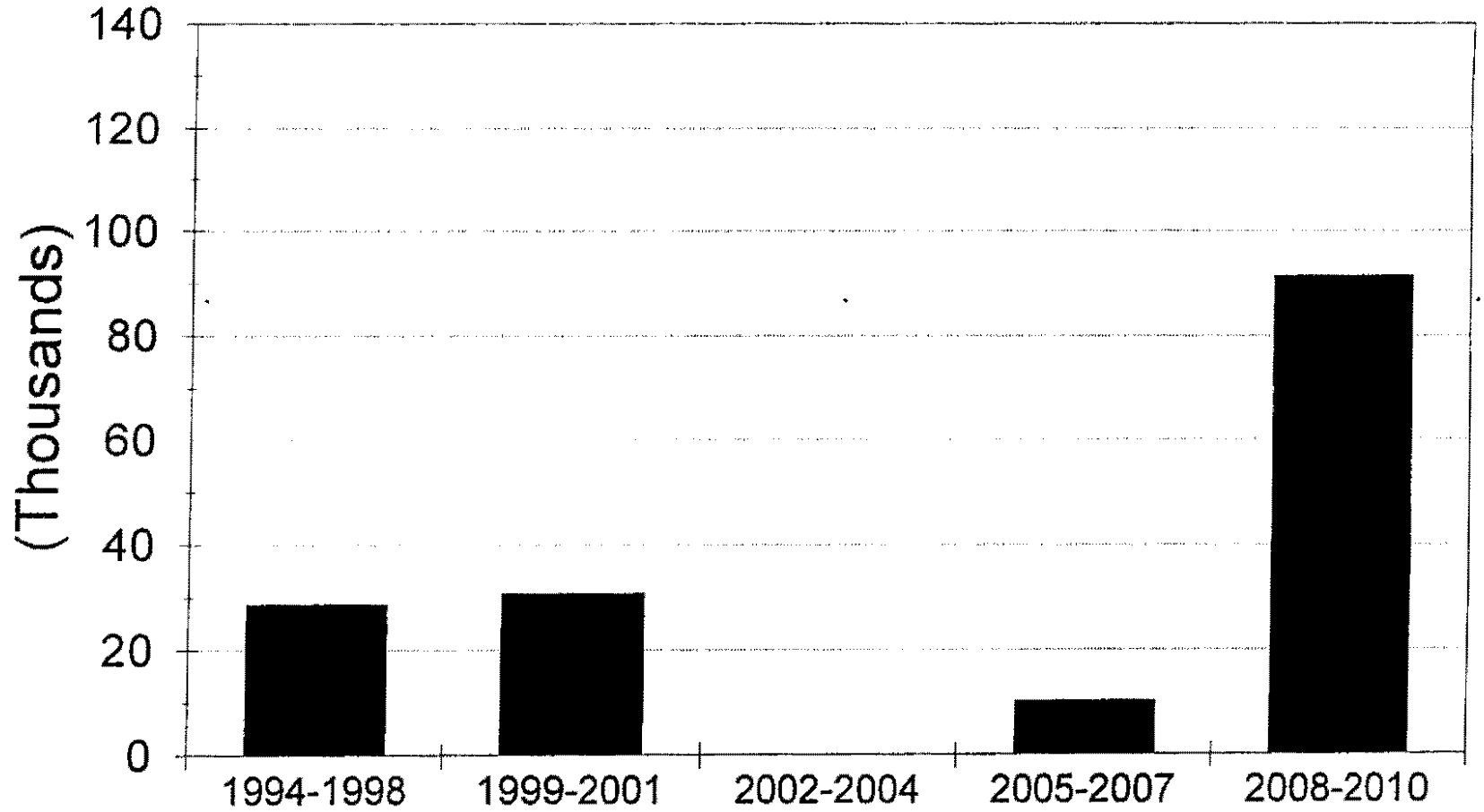
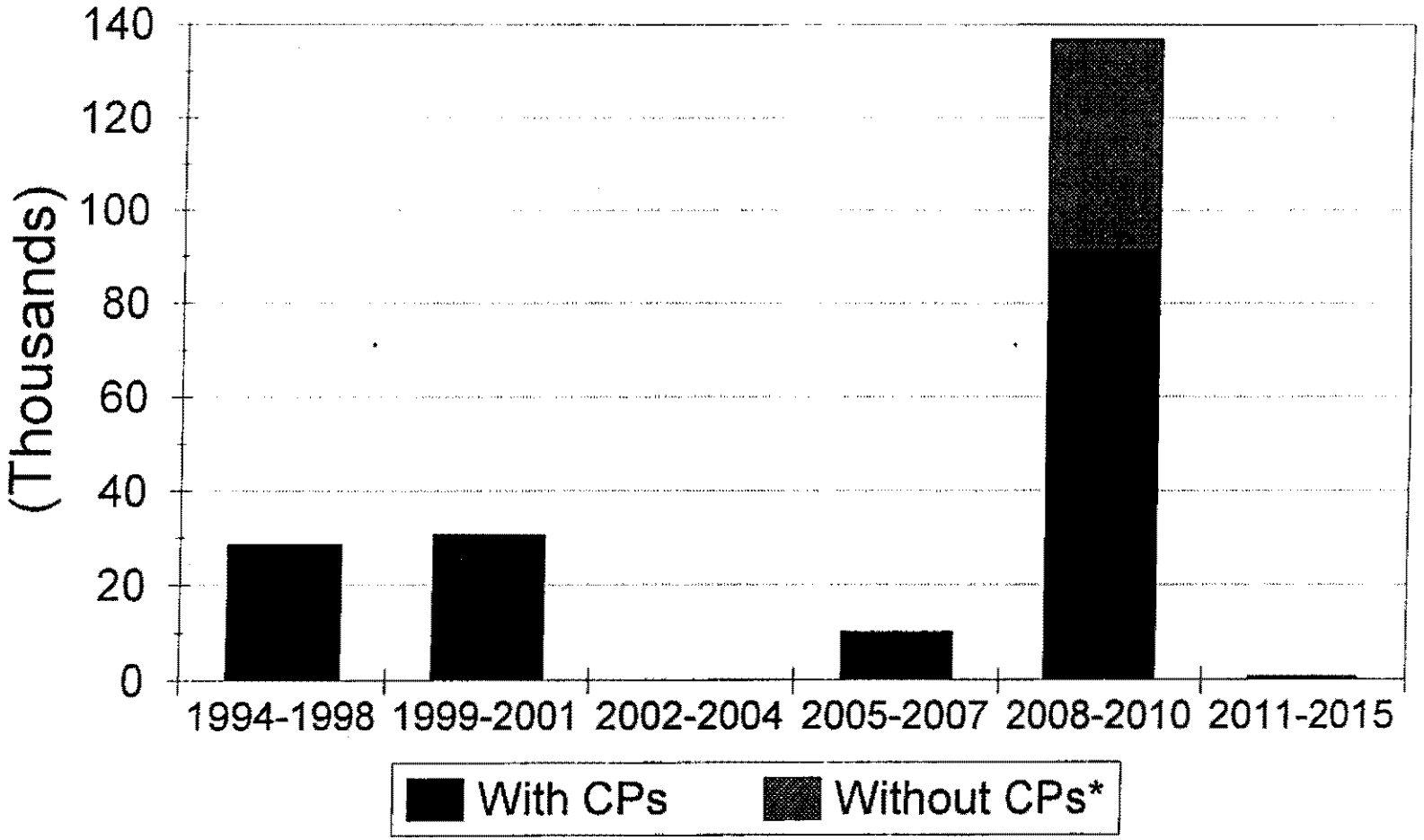


Exhibit 4-5
ODP Tons Committed to Phaseout Dates for All Article 5 Countries



*Countries without CPs are assumed to adhere to schedule specified by the Protocol.

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 implementing agencies; and a list of contributions and Fund disbursements as of June 24, 1993.

233. 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 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 4.2. Issues encountered, resolved and outstanding are addressed in both Chapters 4 and 5 of the report. Finally, Attachment 1 of this report includes updated descriptions of the project cycle for the four implementing agencies (UNEP, UNIDO, UNDP, and the World Bank) to reflect changes in their operating procedures that have been instituted since document UNEP/OzL.Pro/ExCom/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)

234. 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 phase-out 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.

235. To respond to this TOR item, the Study Team took a two-part 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 phase-out. 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. In addition, the Study Team employed data developed as part of the modeling exercise to assess current per capita consumption and its likely future growth.

236. Several general themes emerged from the qualitative review of data obtained from 21 Article 5 countries. The factors cited by a number of countries as impediments to phase-out include:

a. Lack of awareness about the phase-out by enterprises in the country
b. Lack of information about alternative technologies
c. Lack of an OPU or recent establishment of the 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

237. Factors facilitating the phase-out that were cited by more than one country include:[51]

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

238. From the group of countries that were visited or responded to the fax questionnaire, the Team then selected those which have had a CP in place for over a year to compare 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 projected unconstrained demand in absence of the phase-out and actual consumption for a given year arguably could provide one measure of any progress made in implementing CPs. For a given year, if actual consumption is less than the projected unconstrained demand presented in a country's CP, this difference could be said to represent the amount of ODS saved, i.e., not consumed, because of the country's phase-out efforts. Such a comparison would require consistent and reliable data.

239. 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 unconstrained demand for the same year.[52] 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. Arguably, the data may suggest that the phase-out may not be progressing as rapidly as had been expected. However, significant problems in the data do not support such an interpretation. First, the data are clearly limited. Second, Article 5 countries are now better able to account for ODS consumption. Finally, the data may reflect differences in the methods used to calculate consumption.

240. 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 3.4 of the report, the Study Team developed an estimate of total unconstrained ODP-weighted consumption in all Article 5 countries in 1993 from several data sources. Dividing this figure, 208,000 ODP tonnes, into the Article 5 population of 4.066 billion yields a per capita consumption figure of approximately 0.0001 ODP kg per capita for all Article 5 countries.

241. 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

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[51] 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.

[52] 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.

per cent. Therefore, in the absence of the phase-out program, the unconstrained ODS consumption in Article 5 countries might have grown to 886,211 ODP tonnes in 2010.[53]

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

242. 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;[54] and relevant sections of 35 country programmes. These data sources account for 41 of the Article 5 countries, including two countries without approved CPs. 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.

243. 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 phase-out, if such activity did not require formal legislative or regulatory authority.

244. 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 phase-out. 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 phase-out.

245. Several Article 5 countries acted early, beginning in 1989, to control aerosols, either through use bans, import controls, or manufacturing controls. Six of the 41 countries analyzed 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.

246. Although a majority of Article 5 governments either have taken formal action to facilitate the phase-out 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

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53 As noted above, these data do not reflect the Republic of Korea.

54 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?"

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.

247. 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.

248. 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 with 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.

249. The data suggest that, in general, laws and regulations follow rather than lead ODS phase-out in Article 5 countries. Presumably, if legal and regulatory actions were driving the phase-out, rather than merely facilitating it, many more legislative and regulatory responses would be in place. This finding suggests that, at this time, economic and political factors in general are affecting the ODS phase-out in Article 5 countries more than laws or regulations.

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

250. The Study Team reviewed the country visit reports and responses to fax questionnaires for data to identify the market dynamics impacting the phase-out in Article 5 countries. Seven major characteristics of the market dynamics in Article 5 countries have a significant influence on the phase-out. 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 phase-out has been accelerated. In three countries where export-oriented enterprises account for a significant fraction of the ODS usage in certain sectors, significant phase-out has already occurred because of the requirements in the importing countries. The need for rapid phase-out in these cases has led many enterprises to opt not to access the Fund for phase-out costs. One of the countries visited has only recently prepared its CP, but significant phase-out has already occurred because of the export orientation of its aerosols and foams sectors.

c. Ownership of ODS-Using Enterprises: Multinational corporations 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 phase-out by local enterprises has been very limited. On the other hand, phase-out 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 phase-out 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 phase-out; phase-out 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 phase-out. 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 phase-out 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 ODS 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 phase-out 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 phase-out.

f. Local Production of ODS: Five 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, but not for exports, 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 phase-out. 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 implementing agencies 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 phase-out. 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 phase-out 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 phase-out 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 phase-out 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 PHASE-OUT SCHEDULES

251. Feedback from Article 5 countries on the feasibility of various phase-out 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 phase-out schedules for Article 5 countries:

- phase-out by 2010
- phase-out by 2006, with a servicing tail[55]
- phase-out by 2006
- phase-out by 1996

252. Exhibit 4-6 summarizes the responses received from the 21 countries regarding the feasibility of the various phase-out schedules. All responding countries indicated that accelerating the phase-out date to 1996 for Article 5 countries would be infeasible. Some countries have a 1996 phase-out schedule for particular chemicals (e.g., CFC-113 or halons 1211 and 1301), but no country indicated it would be able to accelerate the phase-out in its country to 1996 across all ODS use sectors. One country has committed to accelerated phase-out schedules ranging from 1996 to 2010 for different sectors and end-uses. This country thought a 1996 phase-out 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.

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

Phase-out Schedule	Feasible	Not Feasible	Unknown[56]
2010	21	0	0
2006 with servicing tail	16	2	3
2006	9	11	1
1996	0	20	1

253. Approximately half of responding countries thought that phase-out by 2006 would be feasible and 89 per cent indicated that they considered phase-out by 2006 with a servicing tail feasible. Since 11 countries thought phase-out by 2006 would not be feasible, it seems reasonable to infer that at

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55 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 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.

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

least the same number of countries would also find phase-out by 2000 infeasible. Four countries did explicitly state that they could not meet such an accelerated phase-out schedule. Nevertheless, six other countries are already planning to phase out by 2000 or do not expect to experience significant difficulty in accelerating the phase-out date to the year 2000. It should be noted that there are over 90 Article 5 countries and that the countries included in Exhibit 4-6 represent about 72 per cent of total ODS consumption.

254. In many Article 5 countries, concerns over accelerated phase-out schedules centered around the issue of the impact of such an accelerated phase-out 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.

255. With respect to potential difficulties that may be encountered in implementing a servicing tail, one country noted that logistical difficulties may arise for the informal sector, which consists of small and dispersed users. 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. A third country believed that the final cut-off year for the tail would need to be carefully defined.

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

4.12 CONCLUSION

257. 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 (such as training projects) in terms of completion rate.

258. 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 phase-out activity appears to have occurred as a direct result.

259. Implementation of low- and non-ODS technologies in Article 5 countries varies considerably across ODS-use sectors and across countries. In general, phase-out 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, phase-out 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 widespread retrofits of existing MACs have been observed.

260. 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 phase-out efforts, it is likely that actual transfer of non-ODS technologies will occur.

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

262. 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. This result is most likely due to improvements in the measurement of consumption. Some countries did, however, show some reductions.

263. Factors cited by a number of countries as impediments to phase-out 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 phase-out 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.

264. Although a majority of Article 5 governments either have taken formal action to facilitate the phase-out 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.

265. The following characteristics of the market dynamics in Article 5 countries seem to have a significant influence on the phase-out: 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.

266. Feedback received from a number of Article 5 countries indicates that a phase-out date of 1996 would be infeasible. Although many countries thought a phase-out of 2000 would be infeasible, six of the countries studied are already planning to phase out by 2000 or do not expect to experience significant difficulty in accelerating the phase-out date to the year 2000. Some countries thought phase-out by 2006 would be feasible, and most thought phase-out by 2006 with a servicing tail would be feasible.

Chapter 5

POLICY AND INSTITUTIONAL FACTORS THAT AFFECT ALTERNATIVE ODS PHASE-OUT SCHEDULES

5.1 INTRODUCTION

5.1.1 Overview

267. The challenge of ODS phase-out 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.

268. Examining the particular determinants and thus the feasibility of ODS phase-out 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 phase-out of the diversity among Article 5 countries. The chapter then draws summary conclusions about the overall feasibility of the phase-out scenarios described in Chapter 2 based on these policy and institutional issues.

269. The results presented in this chapter reflect application of the analytic framework described in Section 3.2 to the data collected during this study, which 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 reviews these stages and the key actors considered in this analysis.

270. To the degree possible, the conclusions drawn from this analysis are incorporated in the quantitative simulation of costs 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 phase-out scenarios.

5.1.2 Introduction to Primary and Secondary Impacts on the ODS Phase-out

271. This chapter divides the policy and institutional factors that may affect alternative ODS phase-out schedules into two categories: factors having a primary impact on the ODS phase-out and factors having a secondary impact. Primary factors, such as market dynamics and the industrial structure within individual Article 5 countries, directly and unambiguously affect the feasibility of various phase-out scenarios in the countries where they are operative. Each of these primary factors has a potential impact of several years on the final phase-out date. Section 5.2 summarizes these primary factors.

Exhibit 5-2
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

272. Other policy and institutional factors, such as the internal operating procedures of the implementing agencies 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. As such, their potential impact is not as long-term as that of the primary factors, which have a potential impact of several years on the phase-out. While having an impact on individual projects, these secondary factors do not necessarily or directly affect the overall ODS phase-out schedule. Under certain circumstances, however, 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 phase-out process. Second, individual or groups of enterprises who believe that these factors increase the uncertainty or risk surrounding phase-out projects may delay their projects until a future time when the uncertainty or risk subsides, thereby also delaying the phase-out. Alternatively, some of these factors may speed the phase-out 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, also may have an impact on the feasibility of alternative phase-out schedules, although their impact is not as direct or long-term as that of the primary factors.

273. The analysis throughout this chapter highlights the fact that technology transfer and ODS phase-out 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 of the Fund. 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 phase-out.

5.2 PRIMARY FACTORS DIRECTLY AFFECTING THE PHASE-OUT SCHEDULES

274. The Study Team identified four primary factors that directly affect the feasibility of alternative phase-out 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 on each of these four primary factors.

5.2.1 Market Dynamics

275. The first primary factor affecting the phase-out relates to the markets for ODS technologies and the associated alternatives.[57] Various market forces drive enterprises to stop using ODS. These include, for example, international and domestic trade pressures and the prices of both ODS and alternative technologies. The nature and direction of these forces play an important role in the feasibility of alternative phase-out schedules. Factors which impede the market for non- and low-ODS technologies inhibit the ODS phase-out, and factors which facilitate that market help accelerate the phase-out. This section reflects the data on these market dynamics that are presented in Section 4.10.

5.2.1.1 Industry Structure in the Article 5 Countries

276. The foremost determinant of the rate of ODS phase-out in any country, beyond the Montreal Protocol itself, is the nature and structure of local industry in each ODS consuming sector. ODS phase-out 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

277. Enterprises and industries that sell products on the international market are generally much more active in phasing out ODS than industries that 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 phase-out requirements. 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.

278. On a related note, a number of Article 5 countries with strong linkages to neighboring developed country markets have put in place plans to phase out faster than required. These linkages are regional in nature, such as Botswana's link with South Africa and Mexico's link with the United States. Based on these plans, it appears that the dependence or close ties of some Article 5 countries' economies and markets with those of neighboring non-Article 5 countries tend to accelerate the phase-out in those Article 5 countries.

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[57] "Technologies" are assumed to include equipment as well as the chemical itself.

Ownership Structure of ODS Consuming Enterprises

279. 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 phase-out plans. Multinational enterprises often accelerate their phase-out 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 responsible products. The export orientation of many multinational enterprises contributes to the pressure to eliminate ODS use as well. Multinational access to information, technologies, and skilled support often facilitates these technology transfer efforts.

280. With respect to multinational companies and international partnerships, however, the phase-out 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 phase-out because they cannot obtain full incremental cost funding from either the Multilateral Fund or their foreign partners. Regardless of whether this result is consistent with broader Multilateral Fund objectives, it does affect the feasibility of some phase-out efforts.[58]

281. Government control of enterprises may also affect the ODS phase-out. 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 phase-out 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 phase-out decisions.

Size and Formality of Enterprises

282. Based on data collected for this study, the phase-out 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 phase-out to begin with, less likely to initiate phase-out 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.[59] Various parts of this chapter reference these important difficulties regarding small and informal enterprises.

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58 Section 5.3.2 discusses Multilateral Fund rules in more detail.

59 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.

Size of Existing Capital Stock Requiring Constant ODS Use

283. 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.[60] Furthermore, as the existing phase-out 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 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 phase-out schedule.[61]

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

284. The direct costs of ODS versus non-ODS technologies play a significant role in helping drive the phase-out in some countries. 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 phase-out. 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 phase-out. An important consequence of high ODS prices, of course, is that they shift a larger portion of the phase-out burden to the local consumers.

285. 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 phase-out 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 phase-out actions.

286. These price and supply issues warrant special attention during the consideration of the final years of the phase-out 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 ODS 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 might need to produce surplus ODS that could not be absorbed by the

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60 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.

61 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.

servicing tail, perhaps resulting in widespread low ODS prices which might become an incentive for other enterprises to continue or start using ODS again.

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

287. 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 phase-out if these critical actors do not receive certain information, including:

- 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 phase-out projects.

288. 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 institutions involved in Article 5 phase-out efforts are generally not providing a wide distribution of this information at the enterprise level.[62] Similarly, the majority of enterprises interviewed lacked complete information about the impending ODS phase-out 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 phase-out. 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.[63]

289. Information flow would become even more important with any accelerated phase-out schedule. Unless ODS prices seen by consumers rise drastically, significant market interventions would be required in most countries to facilitate the flow of phase-out, 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

290. The second primary factor affecting the phase-out is the existence of the Montreal Protocol and the Multilateral Fund. These institutions represent the commitment made by the over 100 countries that came together and pledged to eliminate ODS use globally. As such, they provide powerful incentives for countries to stop using ODS. The Montreal Protocol itself, as a high profile

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

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

global agreement endorsed by governments and including distinct obligations for signatory countries, provides the international focal point and legitimacy that drives the entire phase-out effort. Furthermore, the provisions contained in the Montreal Protocol affect markets for ODS technologies and their alternatives in a way that clearly helps guide phase-out planning by enterprises and governments.

291. 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 incremental costs of the phase-out in Article 5 countries. At a field level, if enterprises believe the global phase-out will occur, they see the Multilateral Fund as a mechanism for eliminating or lowering their portion of the cost of technology transition. In many circumstances, this has proven to be a powerful incentive to encourage enterprises to initiate phase-out projects. Additionally, the Multilateral Fund's information and financial resources have encouraged projects in certain sectors and countries where action would not otherwise be occurring for many years. Furthermore, several countries stated explicitly in their Country Programmes and through interviews that they will not be able to achieve a phase-out by the target dates without assistance from the Multilateral Fund, signaling the symbolic and practical importance of this institution.

292. 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. Similarly, 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

293. The third primary factor affecting the phase-out is actions taken by the Article 5 country governments. This includes the establishment of a functioning OPU and the implementation of policies that directly affect ODS production, consumption, and commerce. The OPU plays an important role as a focal point for phase-out activities in a country. Although the OPU may not directly influence project execution, it can nevertheless have an impact on a country's phase-out by facilitating in-country coordination efforts. Without a functioning OPU of even a minimal size, the Secretariat and the implementing agencies cannot provide services as effectively to the country. The basic existence of the OPU would be more significant under accelerated phase-out scenarios, where the Multilateral Fund becomes more important than it currently is 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 that OPUs are critically necessary -- regardless of their structure and organizational placement -- in order for the Multilateral Fund to operate effectively.

294. In addition to establishing responsive OPUs, direct policy actions by domestic governments can also significantly affect the feasibility of phase-out 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 other types 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 phase-out, and, in others, some of these actions have facilitated if not enhanced the movement to eliminate ODS use.

295. In these limited cases, these policy actions facilitate the phase-out in two distinct ways. First, they prompt the flow of authoritative information regarding ODS and alternatives among enterprises and industries, businesses react by trying to understand the implications of the global phase-out 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 have 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 ODS technologies in the short term, with obvious implications for the feasibility of a quick phase-out.

5.2.4 Time Required for Societal Transition

296. The fourth and final primary factor affecting the phase-out 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, they must foster difficult technological transformations in diverse economic sectors. To do so successfully, they must overcome an 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.

297. Several individuals interviewed by the Study Team drew comparisons of the timeframe for Article 5 phase-out to the time taken by developed countries to phase out ODS. It was noted that many such countries began the phase-out with CFC controls in aerosols in the late 1970s, and will complete the phase-out 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 phase-out 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 final phase-out date of 1996 or 2000 for all Article 5 countries would be extremely difficult or impossible to achieve.

5.3 SECONDARY FACTORS POTENTIALLY AFFECTING PHASE-OUT SCHEDULES

298. 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 phase-out schedules in several ways. They may combine or interact in some countries or industrial sectors to bring ODS phase-out to a temporary halt. They may also contribute to the uncertainty or risk surrounding phase-out projects perceived by ODS consuming enterprises, causing those enterprises to delay their phase-out 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

299. 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 phase-out, while failure can lead to delay in phase-out 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

300. 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, during the data collection phase of the Study, two enterprises were found that 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 a scale to match the needs and abilities of certain small or informal enterprises.

5.3.1.2 Uncertainty About Alternative Technologies

301. 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. Enterprises often prefer to continue using known technologies that carry low risks and 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

302. 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 phase-out. 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

303. 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;[64]
- *Implementing agencies under the Multilateral Fund* provide partial or complete assistance with technology identification, evaluation, and selection; and
- *Non-government organizations* can influence the range of technical options at the international level and at the national or local level within certain countries.

304. 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 suggest that the technology and chemical vendors and the implementing agencies sometimes prefer certain technology options for given ODS applications. Enterprises that recognize these biases may remain confused and hesitant 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.[65] 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 phase-out plans.

5.3.1.5 Market Exploitation by Owners of Proprietary Technologies

305. 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 prices subsidized by the Multilateral Fund.[66] 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.

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64 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.

65 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.

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

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 absolute price and control over their business, and they rejected the technology transfer deal.

5.3.2 The Terms of Project Financing for Article 5 Country Enterprises

306. The terms of financing that are offered to Article 5 enterprises for projects to convert to alternative technologies also affect the rate of technology transfer. These factors include the incremental cost rule applied by the Multilateral Fund, the principles for reimbursing enterprises, especially in situations where incremental costs are not fully covered from the point of view of the enterprise, and the availability to enterprises of alternative sources of funding. This section discusses how these factors affect the rate of technology transfer in Article 5 countries.

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

307. 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 phase-out, 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.[67] 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. It should be noted that the Executive Committee has put in place provisions for distributing incremental costs within a country's sectoral phase-out strategy to several projects, including projects with net incremental savings. Enterprises may not be aware of this, however.

308. On a related topic, the Executive Committee's policy not to provide grants to pay for technology conversions where increased profits offset project costs 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 recognize or believe the benefits of switching to the non-ODS process.[68] They therefore will not do so without outside financial assistance, or without receiving significant information about their non-ODS alternatives that

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67 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, nor does it address normative issues regarding obligations of countries and enterprises to phaseout.

68 Section 5.2 cites examples of this situation.

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.

309. The Executive Committee has addressed the issue of providing assistance to projects with net incremental savings in its Implementation Guidelines. The guidelines provide for the provision, for investment projects with short payback periods (i.e., 1-2 years), of highly concessional loans. If an implementing agency believes that a concessional loan is appropriate for a given project, it could recommend this action to the Executive Committee for approval. At the time this report was prepared, however, no implementing agency had as yet requested this action be taken. None of the implementing agencies have the authority to provide concessional loans from Trust funds held by them, so funds for the concessional loans would need to come from another source.[69]

310. 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.[70] Despite the establishment of guidelines by the Executive Committee, there appears to be continuing confusion regarding Multilateral Fund rules, which is attributable to a number of factors. Loose rule definition and discretion in applying rules does permit flexibility and provide a mechanism for achieving consensus at times. Confusion regarding the rules, however, also leads to perhaps additional work by the Secretariat, implementing agencies, OPUs, local financial intermediaries, and enterprises as they debate how to proceed in preparing and presenting projects for approval.

5.3.2.2 Financing for ODS Phase-out Projects from Non-Multilateral Fund Sources

311. Data collected for this study indicate that enterprises in many Article 5 countries have a difficult time obtaining financing for ODS phase-out projects from sources other than the 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 phase-out 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

312. 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 phase-out 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

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69 Refer to document UNEP/OzL.Pro/ExCom/3/18/Rev.1, Annex III, Section V, paragraph 3. See also the draft report prepared by the Fund Secretariat entitled "Projects That Might Realize Net Incremental Savings" (UNEP/OzL.Pro/ExCom/13/42).

70 The Executive Committee established guidelines for the preparation of project proposals at its Fifth Meeting and guidelines for project presentation at its Seventh Meeting. These guidelines subsequently have been revised to clarify and amplify existing decisions.

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. This section addresses the internal procedures of the implementing agencies as they relate to Montreal Protocol activities as well as the operation of the Executive Committee and the Fund Secretariat.

5.3.3.1 Perceived Mission and Priorities Among Multiple Agencies and the Executive Committee

313. Exhibit 3-1 in Chapter 3 presents the key actors involved in ODS phase-out efforts in Article 5 countries. The Executive Committee, Secretariat, and implementing agencies have different roles to play in the project development, approval, and implementation proces. The Executive Committee is responsible for establishing Fund policies and making funding approval decisions. The Secretariat, in addition to other duties, reviews project proposals prior to submittal to the Executive Committee for a final decision. The role of implementing agencies, defined through various legal agreements, consists of assisting Article 5 country governments in identifying, developing, and implementing projects.

314. Although the roles of the Executive Committee and the implementing agencies have been defined, there appears to be a perception in the field that 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 prior to submittal to the Executive Committee.

315. The involvement of multiple agencies for administering the Multilateral Fund also sometimes fosters confusion and delay in project development and implementation. The Executive Committee has accepted the internal procedures of all of the implementing agencies for carrying out Montreal Protocol activities, including their legal provisions for disbursements. Because the project cycles and operating modes differ among the implementing agencies, however, in some cases there appears to have been confusion regarding the appropriate procedures an enterprise or Article 5 government should follow in project development. Specifically, confusion or disagreement over Executive Committee policies 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 reviews along the process are certainly necessary, the problem arises when project reviews by the various entities involved in the process provide inconsistent feedback, leading to confusion and delays while the Secretariat, implementing agencies, OPUs, local financial intermediaries, and enterprises debate how to proceed in preparing and presenting projects for approval.[71]

316. 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.

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[71] Large organizations often experience difficulties when expanding the scope of their operations. Several of the organizations associated with the Multilateral Fund have been actively pursuing efforts to increase the effectiveness of their operations.

5.3.3.2 Operating Procedures of the Implementing Agencies

317. 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:[72]

- *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.

- *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.

318. 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. 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

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

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[72] It should be noted that there are significant differences in the operating procedures of the implementing agencies, including differing capacities for actually executing projects once they have been approved by the Executive Committee. For a summary description of the operation of each implementing agency's Montreal Protocol activities, please refer to Attachment 2 of the report.

320. 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 have anyone working on this issue on a daily basis. Similarly, some OPUs are intimately involved in all stages of project development and implementation while others play a passive role.

321. Differing social priorities, political priorities, levels of available resources, and institutional capacities of Article 5 countries account for these variations. In addition, the specific skills, talents, and personalities of individuals in the OPUs can have an impact. 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 phase-out responsibilities, the Fund cannot operate very effectively, if at all.

- *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 phase-out 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.* 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 <u>all</u> stages, even when this duplicates the responsibilities of other agencies or is beyond the OPU institutional capacity. While each sovereign party to the Montreal Protocol can clearly organize its phase-out efforts in the manner it believes 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. In <u>some</u> situations, this involvement may include technical review of projects, central coordination of projects, and many other tasks. 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.

322. 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 phase-out 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.

323. There is perhaps a linkage between the degree of OPU involvement in phase-out activities now, even if they are duplicative of other agencies' actions, and the institutional strengthening effect of such involvement in the longer term. Given that the ODS phase-out 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. The ODS phase-out will be a time-consuming effort but it will not need to be repeated once ODS are eliminated. As a result, making the investment in capacity building on an issue with a finite and non-repeating end may not be a critical endeavor. This situation can be compared to the need for capacity-building for longer term, on-going issues such as wastewater treatment or solid waste management, to name just two. Because the need for wasterwater treatment or solid waste management is a continuing concern, it seems reasonable to develop capacity for management of such issues in developing countries. On the other hand, if a significant amount of the skills and expertise developed through institutional strengthening efforts for ODS phase-out activities are transferable to other, long-term issues, the investment in time and resources may be worthwhile.

5.4 CONSEQUENCES OF DIVERSITY AMONG COUNTRIES FOR THE PHASE-OUT

324. As the Study Team assessed alternative phase-out scenarios, it quickly became clear that the prospects for ODS phase-out 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 phase-out in some countries is occurring almost as quickly as in the developed world, while at the other extreme, the phase-out to date in other countries has been extremely limited.

325. Variations in the significance of these factors are 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.

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

327. The Study Team's analysis of available country data suggests three general groupings of Article 5 countries in terms of ODS consumption and phase-out 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 range 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

328. 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 phase-out 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 phase-out 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.

329. Four primary factors that do affect the feasibility of phase-out scenarios in specific countries, and thus the global phase-out, were identified:

- Market dynamics;
- The global commitment and financial support for the phase-out;
- The actions of Article 5 Country governments; and
- The time required for societal transition.

330. Four secondary factors that may affect a particular country's phase-out 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.

331. Furthermore, prospects for ODS phase-out are affected by the interplay of these factors in each country, or in groupings of similar countries, which in turn depends on the economic, technological, political, and cultural circumstances countries face. As a result, the feasibility of a global phase-out scenario is determined by the countries that are the last to phase out. To reflect the idea of differences in the interplay of factors across countries, three groupings of similar countries have been developed and applied to the modeling exercise.

332. Based solely on its assessment of these policy and institutional factors, the Study Team determined that successful implementation of the phase-out in all Article 5 countries by 1996 would be impossible and that phase-out by 2000 would be extremely difficult. This conclusion is rooted in the fact that tens to hundreds of phase-out 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 phase-out 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 phase-out 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 phase-out.

333. The feasibility of phase-out 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 phase-out within each country or group of similar countries. The feasibility of global phase-out for these scenarios also remains dependent, of course, on the actions of specific Article 5 country governments.

334. For all scenarios with phase-out dates beyond the 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 phase-out scenarios. Chapter 7 summarizes and integrates the conclusions from each of these chapters into a final assessment of the phase-out scenarios.

Chapter 6

RESULTS OF SIMULATION OF COSTS, ODS USE, AND ENVIRONMENTAL IMPACTS

6.1 INTRODUCTION

335. This chapter presents estimates of costs, ODS use, and environmental impacts for each of the phase-out scenarios. Sections 6.2 through 6.4 present three measures of costs: Fund costs, real resource costs, and actual costs. Section 6.5 presents estimated environmental impacts including forecasted ODS use and future concentrations of stratospheric chlorine and bromine.

6.2 FUND COSTS

336. Exhibit 6-1 presents the costs to the Multilateral Fund of investment projects to reduce ODS use, conversion of ODS production capacity, and non-investment project activities. Investment projects to reduce ODS use are divided into capital, operating, and chemical costs for new equipment and recycling and retrofit costs for existing equipment.[73] The following points should be considered in reviewing these results:

337. First, results are not presented for a 1996 phase-out schedule. A 1996 phase-out was found to technically infeasible in Article 5 countries because technologies to replace ODS use in new equipment could not penetrate the market quickly enough to achieve a phase-out by this date. This is reflected in the modeling framework by the model's inability to simulate the achievement of the required reduction targets. A 2000 phase-out was found to be technically feasible, but resulted in costs of $3.8 billion to the Fund. These costs include $2.2 billion in retrofit costs.[74] All other phase-out scenarios were determined to be technically feasible and involved relatively minor or no retrofit costs.

338. Second, as explained in Chapter 3, the costs of phasing out ODS production were 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. Per the instructions of the Sub-Committee, an figure of $621 million has been included in all scenarios. This estimate was spread over the duration of the phase-out and discounted appropriately. As a result, production phase-out costs vary when presented at a 10 per cent discount rate, although they are constant in nominal dollars. It should be noted that the figure of $621 million was assumed to include all administrative costs associated with the production phase-out. As a result, non-investment costs associated with the production phase-out have not been calculated separately.

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[73] As explained in Chapter 3, operating costs in this report are understood to include only non-chemical operating costs. Chemical operating costs are tracked separately.

[74] It should be noted that retrofit technologies are changing quickly and their costs are likely to decline over time. If such reductions occur, the cost of the 2000 phase-out schedule would be reduced.

Exhibit 6-1

Cost to Multilateral Fund by Type

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Investment Projects for Non-ODS Using Technologies					Production Phaseout	Non-Investment	Total
	New Equipment			Existing Equipment				
	Non-Chemical							
	Capital	Operating	Chemical	Recycling	Retrofit			
1996	--	--	--	--	--	--	--	--
2000	616	368	(258)	69	2,176	451	365	3,787
2006	518	331	(77)	157	270	353	205	1,757
2006 w/tail	391	203	(220)	183	0	212	165	935
2010	475	302	(30)	164	159	304	203	1,577
2010 w/tail	318	138	(155)	193	0	201	160	855
Fast	692	384	(248)	66	0	273	191	1,357
2006/1999 w/tail	510	328	(133)	167	0	240	194	1,307
2010/1999 w/tail	485	324	(111)	168	0	195	200	1,261
2000 w/4 years	508	646	(388)	37	2,176	451	365	3,795
2010 w/4 years	451	547	(31)	148	159	304	225	1,803

Exhibit 6-2

Cost to Multilateral Fund by Sector*

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Aerosol	Foam	Halon	Refrig	Solvent	Other	Production	Total
1996	--	--	--	--	--	--	--	--
2000	0	55	69	3,040	108	63	451	3,787
2006	2	61	79	1,136	104	22	353	1,757
2006 w/tail	3	67	87	415	117	34	212	935
2010	2	62	83	1,026	87	14	304	1,577
2010 w/tail	3	70	92	365	99	24	201	855
Fast	2	71	78	645	196	92	273	1,357
2006/1999 w/tail	2	63	83	775	111	32	240	1,307
2010/1999 w/tail	2	65	84	799	93	23	195	1,261
2000 w/4 years	0	8	78	3,137	61	61	451	3,795
2010 w/4 years	0	58	85	1,282	60	13	304	1,803

* Non-investment costs have been spread proportionally across all non-production sectors.

339. Third, scenarios with later phase-out dates have lower costs than those with earlier phase-out dates. There are a number of reasons for this including cost reductions due to technological innovation, increased discounting of costs occurring in later years, and avoidance of retrofits.

340. Fourth, service tail scenarios show considerable cost savings. For instance, the 2006 phase-out schedule costs $US 1.7 billion, while the 2006 phase-out with tail costs only $US 935 million. These savings occur primarily because refrigeration and production phase-out projects are delayed and because there are no retrofits in the tail scenario. The delay of refrigeration and production phase-out projects reduces costs because projects are implemented later in the decade and thus are more heavily discounted relative to projects in scenarios without a tail. In addition, avoided ODS use is achieved later when ODS prices are higher, resulting in greater chemical savings due to its elimination.

341. Fifth, the 2006/1999 and 2010/1999 tail scenarios have higher costs than the 2006 and 2010 tail scenarios. This is because the requirement that ODS use in new equipment be phased out in 1999 accelerates refrigeration projects, causing them to occur earlier and at a higher cost.

342. Sixth, Fund costs for the Fast scenario are less than Fund costs for all non-tail scenarios. This is in part because the Fast schedule has no retrofits due to its service tail. In addition, because projects are implemented as soon as possible, the Fast scenario minimizes growth in baseline ODS use occurring before the establishment of the base year. In other words, the quantity of ODS use that must be phased out is lower in the Fast scenario than in any other. Since the number of projects required to achieve a phase-out is proportional to the quantity of ODS use, the fast scenario requires fewer projects than other scenarios, and this reduces overall Fund costs.

343. Seventh, 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 in the refrigeration sector. Chemical savings are also influenced by the rise in ODS prices forecasted to occur in each scenario. Because prices rise more quickly with earlier phase-out schedules, there are increased chemical savings from avoided ODS use.

344. Finally, in a few scenarios the Fund costs appear to be counter-intuitive. For example, the Fund capital costs for the 2000 and 2010 phase-out scenarios change when the period that operating costs are reimbursed increases from two to four years. This is explained by the fact that Fund costs exclude consideration of projects with net incremental savings. Some projects that have net incremental costs with two years of operating costs have net incremental savings when four years of operating costs are considered. These projects are not eligible for reimbursement, and their capital costs are no longer included in total Fund costs.

345. Exhibit 6-2 presents Fund costs for each of the major sectors: aerosols, foams, halons, refrigeration, solvents, other, and ODS production. In reviewing the costs by sector, it is apparent the majority of costs occur in the refrigeration and air conditioning sector across all phase-out scenarios. This is because the sector is capital-intensive with significant service requirements and often involves the use of expensive alternative chemicals.

346. Exhibit 6-2 indicates that the aerosol sector will require very little support from the Fund to achieve the phase-out. This result is driven by the significant operating cost savings in the aerosol

sector resulting from 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 model results. It is our belief that this inconsistency arises because the modeling framework employs price forecasts that result in significant chemical savings and 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.

6.3 REAL RESOURCE COSTS

347. Exhibit 6-3 presents real resource costs by type for each of the phase-out schedules. Exhibit 6-4 presents real resource costs by sector. A number of observations can be made concerning these results.

348. First, total real resource costs are greater than total Fund costs. There are three main reasons for this: (1) the Fund is assumed to reimburse two years of operating costs in this analysis, while real resource costs include operating costs over the entire life of the project; (2) the Fund cost calculation is based on rising ODS prices, while real resource costs are based on pre-Protocol ODS prices; and (3) the Fund reduces the total cost of a project by its percentage of foreign ownership, while real resource costs ignore foreign ownership.

349. Second, although the factors listed above tend to make real resource costs higher than fund costs, there are some factors that reduce real resource costs relative to Fund costs. For example, in the sector-by-sector results, some real resource costs are negative while Fund costs are zero or positive. This result arises because projects with net incremental savings reduce real resource costs (i.e., projects with net savings off-set projects with net costs), but not Fund costs since, as a practical matter, the Fund cannot use projects with net savings to off-set projects with net costs. Furthermore, since real resource costs count operational and chemical costs over a longer period than Fund costs, projects are more likely to show net real resource savings in sectors where chemical savings exceed operational costs. These effects are particularly apparent in the aerosols, halons, and solvents sectors where chemical savings can be significant.

350. Third, because production phase-out costs are already reflected in the prices of ODS alternatives, they are already included in real resource costs. The production phase-out cost of $621 million assumed in the Fund cost calculation is not added to the real resource costs in order to avoid double counting.

6.4 ACTUAL COSTS

351. Exhibit 6-5 presents actual costs by type for each of the phase-out schedules. Exhibit 6-6 presents actual costs by sector. Actual costs are intended to reflect the incremental costs of the phase-out over a baseline assuming implementation of the Montreal Protocol and the likely increase in ODS prices to follow. Actual costs are often negative because of the chemical savings that result from switching away from increasingly expensive ODS.

Exhibit 6-3

Real Resource Phaseout Costs by Type

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Investment Projects for Non-ODS Using Technologies					Production Phaseout	Non-Investment	Total
	New Equipment			Existing Equipment				
	Non-Chemical							
	Capital	Operating	Chemical	Recycling	Retrofit			
1996	--	--	--	--	--	--	--	--
2000	810	1,589	(767)	126	2,176	NA	365	4,299
2006	700	1,411	(505)	150	270	NA	205	2,232
2006 w/tail	552	895	(598)	184	0	NA	165	1,197
2010	645	1,331	(433)	156	159	NA	203	2,061
2010 w/tail	458	673	(581)	192	0	NA	160	902
Fast	889	1,656	(813)	122	0	NA	191	2,045
2006/1999 w/tail	699	1,397	(631)	160	0	NA	194	1,819
2010/1999 w/tail	656	1,368	(633)	160	0	NA	200	1,750
2000 w/4 years	NA	NA	NA	NA	NA	NA	NA	NA
2010 w/4 years	NA	NA	NA	NA	NA	NA	NA	NA

Note: Real resource costs are not presented for 4-year operating cost scenarios, which are distinguished only by their definition of Fund costs

Exhibit 6-4

Real Resource Phaseout Costs by Sector

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Aerosol	Foam	Halon	Refrig	Solvent	Other	Production	Total
1996	--	--	--	--	--	--	--	--
2000	(100)	122	(50)	4,275	(56)	109	NA	4,299
2006	(81)	81	(17)	2,213	(11)	48	NA	2,232
2006 w/tail	(82)	95	(9)	1,130	(2)	65	NA	1,197
2010	(72)	73	(13)	2,099	(57)	31	NA	2,061
2010 w/tail	(80)	93	(3)	898	(52)	47	NA	902
Fast	(105)	134	(55)	1,880	48	142	NA	2,045
2006/1999 w/tail	(83)	91	(48)	1,804	(9)	63	NA	1,819
2010/1999 w/tail	(80)	88	(47)	1,804	(59)	45	NA	1,750
2000 w/4 years	(100)	117	(49)	4,286	(62)	108	NA	NA
2010 w/4 years	(72)	72	(13)	2,128	(62)	31	NA	NA

Note: Real resource costs are not presented for 4-year operating cost scenarios, which are distinguished only by their definition of Fund costs

* Non-investment costs have been spread proportionally across non-production sectors.

Exhibit 6-5

Actual Phaseout Costs by Type

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Investment Projects for Non-ODS Using Technologies					Production Phaseout	Non-Investment	Total
	New Equipment			Existing Equipment				
	Non-Chemical							
	Capital	Operating	Chemical	Recycling	Retrofit			
1996	--	--	--	--	--	--	--	--
2000	810	1,589	(3,268)	(230)	2,176	NA	365	1,441
2006	700	1,411	(2,100)	(19)	270	NA	205	468
2006 w/tail	552	895	(2,573)	(76)	0	NA	165	(1,037)
2010	645	1,331	(1,581)	42	159	NA	203	800
2010 w/tail	458	673	(2,077)	7	0	NA	160	(779)
Fast	889	1,656	(3,377)	(234)	0	NA	191	(876)
2006/1999 w/tail	699	1,397	(2,581)	(51)	0	NA	194	(342)
2010/1999 w/tail	656	1,368	(2,068)	18	0	NA	200	173
2000 w/4 years	NA	NA	NA	NA	NA	NA	NA	NA
2010 w/4 years	NA	NA	NA	NA	NA	NA	NA	NA

Note: Actual costs are not presented for 4-year operating cost scenarios, which are distinguished only by their definition of Fund costs.

Exhibit 6-6

Actual Phaseout Costs by Sector

($US 1993 Millions, Discounted at 10%)

Phaseout Scenario	Aerosol	Foam	Halon	Refrig	Solvent	Other	Production	Total
1996	--	--	--	--	--	--	--	--
2000	(550)	(424)	(87)	3,127	(675)	50	NA	1,441
2006	(398)	(234)	(45)	1,727	(585)	4	NA	468
2006 w/tail	(401)	(238)	(37)	202	(577)	14	NA	(1,037)
2010	(304)	(152)	(32)	1,771	(481)	(3)	NA	800
2010 w/tail	(332)	(163)	(23)	212	(480)	8	NA	(779)
Fast	(544)	(410)	(90)	732	(653)	89	NA	(876)
2006/1999 w/tail	(401)	(242)	(74)	947	(583)	12	NA	(342)
2010/1999 w/tail	(332)	(168)	(65)	1,216	(484)	6	NA	173
2000 w/4 years	(550)	(429)	(86)	3,137	(680)	50	NA	NA
2010 w/4 years	(304)	(153)	(33)	1,800	(486)	(3)	NA	NA

Note: Actual costs are not presented for 4-year operating cost scenarios, which are distinguished only by their definition of Fund costs.

* Non-investment costs have been spread proportionally across non-production sectors.

6.5 IMPACT ON ODS USE AND THE ENVIRONMENT

352. Exhibit 6-7 presents yearly ODP-weighted 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 phase-out date and the quantity required to service existing equipment after the production phase-out date. A number of observations can be made concerning these results.

353. First, the 2000 and 2010 phase-outs show ODS use until 2004 and 2014 respectively. This is because of the London Amendment's 2005 phase-out date for methyl chloroform.

354. Second, tail scenarios show continued virgin ODS use for as long as required to service existing equipment. In the 2006 with tail scenario virgin ODS use continues until 2020, while in the 2010 with tail scenario virgin ODS use continues as late as 2022. The length of the service tail depends on the timing of phase-out projects for new refrigeration equipment, the service lifetimes of refrigeration equipment, and on the effectiveness of recycling at meeting service needs. It should be noted that ODS using equipment remains in service longer than might be inferred from this exhibit because recycling (rather than virgin ODS) meets some service needs.

355. The Fast scenario (fastest economically feasible phase-out) results in a phase-out of ODS use in new equipment by 2002 and a phase-out of virgin ODS use in existing equipment by 2013. Under this scenario, recycled ODS is used to service existing equipment until 2018. Of note is the fact that this schedule achieves deep interim targets in the early years of the phase-out. As a result, total ODS use is comparable to the 2000 phase-out schedule even though ODS use continues well beyond 2000.

356. Exhibit 6-8 presents totals for ODP-weighted use prior to the phase-out dates and ODP-weighted use in the service tail. Of note is the fact that none of the simulated service tails is particularly large. The largest service tail is in the 2006 phase-out with tail scenario, and is 156,000 tonnes.

357. Exhibit 6-9 presents the impact on cumulative adjusted chlorine associated with each of the of the phase-out scenarios. The exhibit also presents the change in cumulative adjusted chlorine for each of the scenarios relative to the levels calculated for the 2010 phase-out schedule. The most significant changes in cumulative adjusted chlorine occur in the 2000 and Fast phase-out schedules. In these scenarios cumulative adjusted chlorine is reduced by 9 to 10 per cent. In general, a service tail increases cumulative adjusted chlorine by about 4 per cent.

6.6 SUMMARY OF RESULTS

358. Exhibit 6-10 presents a discount rate sensitivity and compares the cost results to environmental impacts. Two scenarios that are of particular interest are the 2006 phase-out with tail, which results in significant cost savings without much change in cumulative adjusted chlorine, and the Fast phase-out, which is the least expensive scenario to offer significant reductions in cumulative adjusted chlorine.

359. Exhibit 6-11 presents detailed cost results by type and sector for each of the three cost measures. Non-investment costs are not included in this table.

Exhibit 6-7

Consumption of Virgin ODP by Scenario
(Millions of Kilograms)

Scenario	1996	2000	2006	2006 Tail	2010	2010 Tail	FAST Tail	2006/ 1999 w/ Tail	2010 1999 w/ Tail	2000 w/4 yr	2010 w/4 yr
1993	194.2	194.2	194.2	199.0	194.2	199.0	181.3	199.0	199.0	194.2	194.2
1994	189.4	178.7	189.4	202.3	189.4	202.3	146.2	202.3	202.3	178.7	189.4
1995	182.6	96.1	182.6	206.0	182.6	206.0	114.9	206.0	206.0	96.1	182.6
1996	176.5	70.9	176.5	212.8	176.5	212.8	77.9	212.8	212.8	70.9	176.5
1997	168.7	31.6	168.7	214.4	168.7	214.4	55.5	214.4	214.4	31.6	168.7
1998	160.2	14.9	160.2	215.8	160.2	215.8	35.9	215.8	215.8	14.9	160.2
1999	138.8	10.6	138.8	195.8	138.8	195.8	29.2	119.7	119.7	10.6	138.8
2000	134.2	1.3	134.2	196.2	134.2	196.2	23.8	116.3	116.3	1.3	134.2
2001	132.4	1.2	132.4	196.8	132.4	196.8	21.0	112.9	112.9	1.2	132.4
2002	109.1	1.1	109.1	175.7	109.1	175.7	18.5	93.9	93.9	1.1	109.1
2003	106.6	1.1	106.6	165.8	106.6	165.8	16.3	82.1	82.1	1.1	106.6
2004	104.1	1.1	40.6	42.1	104.1	165.4	14.0	30.3	79.5	1.1	104.1
2005	84.2	0.0	32.6	33.8	84.2	99.3	11.7	21.9	25.8	0.0	84.2
2006	81.8	0.0	0.0	27.3	81.8	98.3	9.3	15.8	22.8	0.0	81.8
2007	38.8	0.0	0.0	24.1	38.8	49.7	6.8	12.6	18.4	0.0	38.8
2008	36.5	0.0	0.0	21.0	36.5	46.6	4.6	9.4	15.3	0.0	36.5
2009	34.7	0.0	0.0	18.0	34.7	43.6	2.9	7.4	13.2	0.0	34.7
2010	1.3	0.0	0.0	15.3	1.3	22.7	1.7	5.6	6.9	0.0	1.3
2011	1.3	0.0	0.0	12.9	1.3	20.3	1.0	4.0	5.4	0.0	1.3
2012	1.3	0.0	0.0	10.4	1.3	17.8	0.2	2.4	3.8	0.0	1.3
2013	1.3	0.0	0.0	8.0	1.3	15.4	0.0	0.9	2.3	0.0	1.3
2014	1.3	0.0	0.0	6.6	1.3	13.1	0.0	1.0	2.3	0.0	1.3
2015	0.0	0.0	0.0	5.1	0.0	9.4	0.0	0.5	0.6	0.0	0.0
2016	0.0	0.0	0.0	3.6	0.0	7.0	0.0	0.1	0.1	0.0	0.0
2017	0.0	0.0	0.0	2.1	0.0	5.5	0.0	0.0	0.0	0.0	0.0
2018	0.0	0.0	0.0	0.6	0.0	4.0	0.0	0.0	0.0	0.0	0.0
2019	0.0	0.0	0.0	0.8	0.0	2.4	0.0	0.0	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.3	0.0	1.5	0.0	0.0	0.0	0.0	0.0
2021	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2,079	603	1,766	2,413	2,079	2,803	773	1,887	1,972	603	2,079

Exhibit 6-8

ODP Consumption and Service Tail
(Millions of Kilograms)

Scenario	1996	2000	2006	2006 Tail	2010	2010 Tail	FAST Tail	2006/ 1999 w/ Tail	2010 1999 w/ Tail	2000 w/4 yr	2010 w/4 yr
Pre-Tail	2,079	603	1,766	2,257	2,079	2,683	773	1,827	1,957	603	2,079
Service Tail	0	0	0	156	0	120	0	60	15	0	0
TOTAL	2,079	603	1,766	2,413	2,079	2,803	773	1,887	1,972	603	2,079

Exhibit 6-9

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)
1996	--	--	--
2000	87.45	-9.39	-9.7%
2006	94.78	-2.06	-2.1%
2006 w/tail	98.43	1.60	1.6%
2010	96.83	0.00	0.0%
2010 w/tail	100.92	4.09	4.2%
Fast	88.27	-8.56	-8.8%
2006/1999 w/tail	95.21	-1.62	-1.7%
2010/1999 w/tail	95.77	-1.07	-1.1%
2000 w/4 years	87.45	-9.39	-9.7%
2010 w/4 years	96.83	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 2010 baseline scenario (scenario 5).

Exhibit 6-10
Summary of Costs and Atmospheric Impacts

Scenario	Fund Costs ($US 1993 Millions) 10%	5%	0%	Cumulate Adjusted Clx [1] (ppb-years)	Change in Cumulate Adjusted Clx [2]
1996	--	--	--	--	--
2000	3,787	4,487	5,392	87.4	-9.7%
2006	1,757	2,328	3,291	94.8	-2.1%
2006 w/tail	935	1,357	2,179	98.4	1.6%
2010	1,577	2,132	3,188	96.8	0.0%
2010 w/tail	855	1,279	2,181	100.9	4.2%
Fast	1,357	1,638	2,092	88.3	-8.8%
2006/1999 w/tail	1,307	1,768	2,549	95.2	-1.7%
2010/1999 w/tail	1,261	1,738	2,641	95.8	-1.1%
2000 w/4 years	3,795	4,503	5,417	87.4	-9.7%
2010 w/4 years	1,803	2,401	3,490	96.8	0.0%

Scenario	Real Resource Costs ($US 1993 Millions) 10%	5%	0%	Cumulate Adjusted Clx [1] (ppb-years)	Change in Cumulate Adjusted Clx [2]
1996	--	--	--	--	--
2000	4,299	5,291	6,706	87.4	-9.7%
2006	2,232	2,989	4,206	94.8	-2.1%
2006 w/tail	1,197	2,036	3,795	98.4	1.6%
2010	2,061	2,762	4,012	96.8	0.0%
2010 w/tail	902	1,675	3,593	100.9	4.2%
Fast	2,045	2,566	3,374	88.3	-8.8%
2006/1999 w/tail	1,819	2,656	4,081	95.2	-1.7%
2010/1999 w/tail	1,750	2,578	4,103	95.8	-1.1%
2000 w/4 years [3]	NA	NA	NA	87.4	-9.7%
2010 w/4 years [3]	NA	NA	NA	96.8	0.0%

Scenario	Actual Costs ($US 1993 Millions) 10%	5%	0%	Cumulate Adjusted Clx [1] (ppb-years)	Change in Cumulate Adjusted Clx [2]
1996	--	--	--	--	--
2000	1,441	1,173	499	87.4	-9.7%
2006	468	(238)	(2,145)	94.8	-2.1%
2006 w/tail	(1,037)	(2,204)	(4,801)	98.4	1.6%
2010	800	244	(1,636)	96.8	0.0%
2010 w/tail	(779)	(1,791)	(4,241)	100.9	4.2%
Fast	(876)	(1,527)	(2,577)	88.3	-8.8%
2006/1999 w/tail	(342)	(1,236)	(3,393)	95.2	-1.7%
2010/1999 w/tail	173	(405)	(2,094)	95.8	-1.1%
2000 w/4 years [3]	NA	NA	NA	87.4	-9.7%
2010 w/4 years [3]	NA	NA	NA	96.8	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 2010 baseline scenario

3. Real resource costs and actual costs are not presented for 4-year operating cost scenarios, which are distinguished only by their definition of Fund costs.

Exhibit 6-11
Detailed Results: Costs to the Multilateral Fund
($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2000	Aerosol	10,233	2,363	(12,290)	0	0	306
	Foam	96,258	13,401	(60,401)	0	0	49,258
	Halon	13,962	62,860	(51,846)	36,690	0	61,667
	Refrigeration	292,156	263,863	(56,947)	32,570	2,176,412	2,708,053
	Solvent	146,974	15,446	(66,403)	0	0	96,017
	Other	55,972	10,295	(9,904)	0	0	56,362
	Production	450,769	NA	NA	NA	NA	450,769
	TOTAL	1,066,324	368,228	(257,792)	69,260	2,176,412	3,422,432
2006	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	52,993	8,957	(10,246)	0	0	51,705
	Halon	8,143	36,661	(35,502)	57,999	0	67,301
	Refrigeration	293,509	264,636	42,515	99,152	270,339	970,152
	Solvent	132,472	13,416	(56,963)	0	0	88,925
	Other	20,211	4,641	(5,711)	0	0	19,141
	Production	352,609	NA	NA	NA	NA	352,609
	TOTAL	870,624	330,779	(77,119)	157,151	270,339	1,551,774
2006 w/tail	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	52,993	8,957	(10,246)	0	0	51,705
	Halon	8,143	36,661	(35,502)	57,999	0	67,301
	Refrigeration	159,689	135,801	(100,967)	125,384	0	319,907
	Solvent	134,184	13,516	(57,294)	0	0	90,405
	Other	25,443	5,842	(5,094)	0	0	26,191
	Production	212,456	NA	NA	NA	NA	212,456
	TOTAL	603,595	203,246	(220,316)	183,382	0	769,907
2010	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	52,993	8,957	(10,246)	0	0	51,705
	Halon	2,722	12,253	(9,324)	64,195	0	69,846
	Refrigeration	293,509	264,636	45,042	99,833	159,195	862,215
	Solvent	102,084	11,124	(40,195)	0	0	73,014
	Other	12,753	2,928	(3,900)	0	0	11,781
	Production	303,658	NA	NA	NA	NA	303,658
	TOTAL	778,406	302,367	(29,835)	164,027	159,195	1,374,160
2010 w/tail	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	63,889	9,909	(20,657)	0	0	53,140
	Halon	2,722	12,253	(9,324)	64,195	0	69,846
	Refrigeration	119,674	97,563	(70,946)	129,299	0	275,591
	Solvent	103,145	11,474	(39,471)	0	0	75,147
	Other	18,013	4,136	(3,685)	0	0	18,464
	Production	200,639	NA	NA	NA	NA	200,639
	TOTAL	518,769	137,803	(155,296)	193,493	0	694,770
Fast	Aerosol	11,173	2,580	(12,057)	0	0	1,696
	Foam	100,484	14,169	(55,993)	0	0	58,660
	Halon	15,889	71,534	(56,473)	33,200	0	64,151
	Refrigeration	292,156	263,863	(56,947)	32,570	0	531,641
	Solvent	203,756	19,317	(61,447)	0	0	161,626
	Other	68,103	12,758	(5,412)	0	0	75,449
	Production	273,401	NA	NA	NA	NA	273,401
	TOTAL	964,962	384,221	(248,329)	65,770	0	1,166,624

Note: These figures do not include non-investment costs.

Exhibit 6-11 (Cont'd)

Detailed Results: Costs to the Multilateral Fund

($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2006/1999 w/tail	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	52,993	8,957	(10,246)	0	0	51,705
	Halon	12,362	55,654	(47,380)	47,395	0	68,031
	Refrigeration	273,934	241,907	(1,481)	119,740	0	634,099
	Solvent	134,184	13,516	(57,294)	0	0	90,405
	Other	25,443	5,842	(5,094)	0	0	26,191
	Production	239,847	NA	NA	NA	NA	239,847
	TOTAL	749,450	328,344	(132,708)	167,135	0	1,112,220
2010/1999 w/tail	Aerosol	10,687	2,468	(11,212)	0	0	1,943
	Foam	63,889	9,909	(20,657)	0	0	53,140
	Halon	12,362	55,654	(46,976)	47,395	0	68,434
	Refrigeration	273,440	239,986	14,647	120,721	0	648,794
	Solvent	106,531	11,474	(42,713)	0	0	75,292
	Other	18,013	4,136	(3,685)	0	0	18,464
	Production	195,137	NA	NA	NA	NA	195,137
	TOTAL	680,059	323,627	(110,597)	168,116	0	1,061,205
2000 w/4 years	Aerosol	0	0	0	0	0	0
	Foam	47,953	7,650	(48,242)	0	0	7,361
	Halon	13,962	114,811	(96,425)	36,690	0	69,038
	Refrigeration	292,156	481,932	(155,983)	0	2,176,412	2,794,516
	Solvent	109,032	22,733	(77,415)	0	0	54,350
	Other	44,833	18,803	(9,670)	0	0	53,966
	Production	450,769	NA	NA	NA	NA	450,769
	TOTAL	958,706	645,929	(387,736)	36,690	2,176,412	3,430,001
2010 w/4 years	Aerosol	0	0	0	0	0	0
	Foam	52,993	16,360	(19,684)	0	0	49,669
	Halon	2,722	22,380	(17,030)	64,195	0	72,266
	Refrigeration	293,509	483,343	70,003	84,069	159,195	1,090,119
	Solvent	89,024	19,196	(57,004)	0	0	51,216
	Other	12,753	5,348	(7,124)	0	0	10,977
	Production	303,658	NA	NA	NA	NA	303,658
	TOTAL	754,658	546,628	(30,839)	148,264	159,195	1,577,906

Note: These figures do not include non-investment costs.

Exhibit 6-11 (Cont'd)
Detailed Results: Actual Costs
($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2000	Aerosol	46,405	85,522	(682,374)	0	0	(550,448)
	Foam	126,549	87,862	(644,197)	0	0	(429,786)
	Halon	31,638	236,803	(399,914)	36,690	0	(94,782)
	Refrigeration	363,417	1,074,964	(553,133)	(267,066)	2,176,412	2,794,595
	Solvent	177,646	60,605	(924,880)	0	0	(686,628)
	Other	64,111	42,879	(63,784)	0	0	43,206
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	809,766	1,588,636	(3,268,282)	(230,375)	2,176,412	1,076,157
2006	Aerosol	30,119	54,520	(482,702)	0	0	(398,063)
	Foam	88,995	60,632	(392,855)	0	0	(243,228)
	Halon	19,214	139,166	(273,100)	57,999	0	(56,723)
	Refrigeration	365,221	1,078,612	(76,424)	(76,948)	270,339	1,560,800
	Solvent	168,626	58,876	(827,338)	0	0	(599,836)
	Other	28,194	19,330	(47,300)	0	0	224
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	700,368	1,411,136	(2,099,719)	(18,950)	270,339	263,174
2006 w/tail	Aerosol	30,162	55,453	(487,478)	0	0	(401,864)
	Foam	93,691	64,182	(411,368)	0	0	(253,495)
	Halon	19,214	139,166	(273,100)	57,999	0	(56,723)
	Refrigeration	202,635	552,247	(514,079)	(133,774)	0	107,029
	Solvent	170,550	59,231	(833,202)	0	0	(603,421)
	Other	35,492	24,334	(53,798)	0	0	6,028
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	551,744	894,613	(2,573,027)	(75,775)	0	(1,202,445)
2010	Aerosol	24,904	43,893	(372,850)	0	0	(304,053)
	Foam	79,856	52,268	(293,519)	0	0	(161,394)
	Halon	15,622	93,796	(219,171)	64,195	0	(45,558)
	Refrigeration	365,221	1,078,612	26,180	(21,702)	159,195	1,607,506
	Solvent	140,269	49,964	(684,831)	0	0	(494,599)
	Other	18,940	12,197	(36,361)	0	0	(5,224)
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	644,812	1,330,730	(1,580,552)	42,492	159,195	596,677
2010 w/tail	Aerosol	28,258	52,326	(413,175)	0	0	(332,591)
	Foam	89,872	60,943	(331,513)	0	0	(180,698)
	Halon	15,622	93,796	(219,171)	64,195	0	(45,558)
	Refrigeration	154,989	397,799	(372,914)	(57,300)	0	122,573
	Solvent	143,120	50,933	(698,730)	0	0	(504,677)
	Other	26,147	17,228	(41,817)	0	0	1,558
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	458,008	673,026	(2,077,320)	6,894	0	(939,392)
Fast	Aerosol	50,316	92,858	(687,968)	0	0	(544,793)
	Foam	131,834	92,171	(646,100)	0	0	(422,094)
	Halon	36,287	269,130	(442,474)	33,200	0	(103,857)
	Refrigeration	363,417	1,074,964	(553,133)	(267,066)	0	618,183
	Solvent	229,446	73,236	(989,717)	0	0	(687,035)
	Other	78,164	53,141	(57,929)	0	0	73,376
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	889,464	1,655,501	(3,377,320)	(233,866)	0	(1,066,221)

Note: These figures do not include non-investment costs.

Exhibit 6-11 (Cont'd)
Detailed Results: Actual Costs
($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2006/1999 w/tail	Aerosol	30,162	55,453	(487,478)	0	0	(401,864)
	Foam	93,691	64,182	(411,368)	0	0	(253,495)
	Halon	28,986	209,947	(375,758)	47,395	0	(89,430)
	Refrigeration	339,754	983,697	(418,990)	(98,882)	0	805,580
	Solvent	170,550	59,231	(833,202)	0	0	(603,421)
	Other	35,492	24,334	(53,798)	0	0	6,028
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	698,635	1,396,844	(2,580,595)	(51,487)	0	(536,602)
2010/1999 w/tail	Aerosol	28,258	52,326	(413,175)	0	0	(332,591)
	Foam	89,872	60,943	(331,513)	0	0	(180,698)
	Halon	28,986	209,947	(366,834)	47,395	0	(80,506)
	Refrigeration	339,205	976,142	(219,582)	(29,694)	0	1,066,071
	Solvent	143,120	50,933	(695,156)	0	0	(501,102)
	Other	26,147	17,228	(41,817)	0	0	1,558
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	655,588	1,367,520	(2,068,076)	17,701	0	(27,267)
2000 w/4 years	Aerosol	46,405	85,522	(682,374)	0	0	(550,448)
	Foam	126,549	87,862	(644,197)	0	0	(429,786)
	Halon	31,638	236,803	(399,914)	36,690	0	(94,782)
	Refrigeration	363,417	1,074,964	(553,133)	(267,066)	2,176,412	2,794,595
	Solvent	177,646	60,605	(924,880)	0	0	(686,628)
	Other	64,111	42,879	(63,784)	0	0	43,206
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	809,766	1,588,636	(3,268,282)	(230,375)	2,176,412	1,076,157
2010 w/4 years	Aerosol	24,904	43,893	(372,850)	0	0	(304,053)
	Foam	79,856	52,268	(293,519)	0	0	(161,394)
	Halon	15,622	93,796	(219,171)	64,195	0	(45,558)
	Refrigeration	365,221	1,078,612	26,180	(21,702)	159,195	1,607,506
	Solvent	140,269	49,964	(684,831)	0	0	(494,599)
	Other	18,940	12,197	(36,361)	0	0	(5,224)
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	644,812	1,330,730	(1,580,552)	42,492	159,195	596,677

Note: These figures do not include non-investment costs.

Exhibit 6-11 (Cont'd)
Detailed Results: Real Resource Costs
($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2000	Aerosol	46,405	85,522	(232,169)	0	0	(100,243)
	Foam	126,549	87,862	(98,769)	0	0	115,642
	Halon	31,638	236,803	(363,016)	36,690	0	(57,884)
	Refrigeration	363,417	1,074,964	239,130	89,212	2,176,412	3,943,135
	Solvent	177,646	60,605	(306,458)	0	0	(68,206)
	Other	64,111	42,879	(5,265)	0	0	101,725
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	809,766	1,588,636	(766,547)	125,903	2,176,412	3,934,169
2006	Aerosol	30,119	54,520	(166,232)	0	0	(81,592)
	Foam	88,995	60,632	(77,505)	0	0	72,121
	Halon	19,214	139,166	(244,999)	57,999	0	(28,622)
	Refrigeration	365,221	1,078,612	240,543	92,024	270,339	2,046,739
	Solvent	168,626	58,876	(254,203)	0	0	(26,701)
	Other	28,194	19,330	(2,384)	0	0	45,139
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	700,368	1,411,136	(504,781)	150,023	270,339	2,027,086
2006 w/tail	Aerosol	30,162	55,453	(168,571)	0	0	(82,957)
	Foam	93,691	64,182	(78,132)	0	0	79,740
	Halon	19,214	139,166	(244,999)	57,999	0	(28,622)
	Refrigeration	202,635	552,247	154,886	125,533	0	1,035,302
	Solvent	170,550	59,231	(258,749)	0	0	(28,968)
	Other	35,492	24,334	(2,885)	0	0	56,942
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	551,744	894,613	(598,450)	183,532	0	1,031,438
2010	Aerosol	24,904	43,893	(141,112)	0	0	(72,315)
	Foam	79,856	52,268	(68,741)	0	0	63,384
	Halon	15,622	93,796	(199,542)	64,195	0	(25,929)
	Refrigeration	365,221	1,078,612	240,543	92,024	159,195	1,935,595
	Solvent	140,269	49,964	(261,545)	0	0	(71,312)
	Other	18,940	12,197	(2,438)	0	0	28,699
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	644,812	1,330,730	(432,835)	156,219	159,195	1,858,122
2010 w/tail	Aerosol	28,258	52,326	(161,515)	0	0	(80,931)
	Foam	89,872	60,943	(74,811)	0	0	76,003
	Halon	15,622	93,796	(199,542)	64,195	0	(25,929)
	Refrigeration	154,989	397,799	128,153	128,119	0	809,059
	Solvent	143,120	50,933	(270,562)	0	0	(76,509)
	Other	26,147	17,228	(2,851)	0	0	40,524
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	458,008	673,026	(581,128)	192,314	0	742,219
Fast	Aerosol	50,316	92,858	(248,201)	0	0	(105,027)
	Foam	131,834	92,171	(102,517)	0	0	121,489
	Halon	36,287	269,130	(407,126)	33,200	0	(68,509)
	Refrigeration	363,417	1,074,964	239,130	89,212	0	1,766,724
	Solvent	229,446	73,236	(288,888)	0	0	13,793
	Other	78,164	53,141	(5,606)	0	0	125,699
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	889,464	1,655,501	(813,208)	122,412	0	1,854,169

Note: These figures do not include non-investment costs.

Exhibit 6-11 (Cont'd)
Detailed Results: Real Resource Costs
($US 1993 Millions)

Schedule	Sector	Capital	Operating	Chemical	Recycling	Retrofit	TOTAL
2006/1999 w/tail	Aerosol	30,162	55,453	(168,571)	0	0	(82,957)
	Foam	93,691	64,182	(78,132)	0	0	79,740
	Halon	28,986	209,947	(349,582)	47,395	0	(63,254)
	Refrigeration	339,754	983,697	226,714	112,853	0	1,663,018
	Solvent	170,550	59,231	(258,749)	0	0	(28,968)
	Other	35,492	24,334	(2,885)	0	0	56,942
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	698,635	1,396,844	(631,205)	160,248	0	1,624,522
2010/1999 w/tail	Aerosol	28,258	52,326	(161,515)	0	0	(80,931)
	Foam	89,872	60,943	(74,811)	0	0	76,003
	Halon	28,986	209,947	(349,582)	47,395	0	(63,254)
	Refrigeration	339,205	976,142	225,880	112,853	0	1,654,080
	Solvent	143,120	50,933	(270,562)	0	0	(76,509)
	Other	26,147	17,228	(2,851)	0	0	40,524
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	655,588	1,367,520	(633,441)	160,248	0	1,549,914
2000 w/4 years	Aerosol	46,405	85,522	(232,169)	0	0	(100,243)
	Foam	126,549	87,862	(98,769)	0	0	115,642
	Halon	31,638	236,803	(363,016)	36,690	0	(57,884)
	Refrigeration	363,417	1,074,964	239,130	89,212	2,176,412	3,943,135
	Solvent	177,646	60,605	(306,458)	0	0	(68,206)
	Other	64,111	42,879	(5,265)	0	0	101,725
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	809,766	1,588,636	(766,547)	125,903	2,176,412	3,934,169
2010 w/4 years	Aerosol	24,904	43,893	(141,112)	0	0	(72,315)
	Foam	79,856	52,268	(68,741)	0	0	63,384
	Halon	15,622	93,796	(199,542)	64,195	0	(25,929)
	Refrigeration	365,221	1,078,612	240,543	92,024	159,195	1,935,595
	Solvent	140,269	49,964	(261,545)	0	0	(71,312)
	Other	18,940	12,197	(2,438)	0	0	28,699
	Production	NA	NA	NA	NA	NA	NA
	TOTAL	644,812	1,330,730	(432,835)	156,219	159,195	1,858,122

Note: These figures do not include non-investment costs.

Chapter 7

CONCLUSIONS

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

361. In drawing conclusions about the various scenarios analyzed, it is important to keep in mind that four primary factors seem to be affecting the feasibility of phase-out in specific countries and thus the global phase-out: market dynamics, the global commitment and financial support for the phase-out, the actions of Article 5 Country governments, and the time required for societal transition. In addition, four secondary factors that may affect a particular country's phase-out 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. Along with each country's inherently different economic, technological, political, and cultural make-up, these factors affect each country's ability to phase out ODS in a plethora of ways. In the context of the current Protocol with its single phase-out schedule for all Article 5 countries, however, one must consider that the feasibility of any scenario is determined not by the prospects for phase-out in countries that will act first, but rather by the situation in those countries that will phase-out last.

362. Phase-out by 1996. The Study Team concluded that a global phase-out by 1996 is not feasible. None of the CPs target such a date and every country that provided feedback for this study stated that it could not meet a 1996 phase-out target. For this 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 phase-out. The quantitative modeling results support this assessment by showing that reduction targets for a 1996 phase-out could not be met.

363. Phase-out by 2000. Global phase-out 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 users in certain informal segments of ODS-using industry is six to seven years, effectively ruling out the 2000 target date since some enterprises would be stranded either without adequate supplies of ODS or appropriate non-ODS technologies. Furthermore, the capacities of Implementing Agencies, Article 5 governments and enterprises, and technology suppliers would be severely tested by this phase-out 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 phase-out. If a 2000 phase-out proves to be politically and

institutionally possible, the quantitative modeling results show total Fund costs of US $3.8 billion, real resource costs of US $4.3 billion, and actual costs of US $1.4 billion. This scenario also resulted in the largest percentage decrease (about 10 per cent) of cumulative adjusted chlorine loading compared to the baseline scenario of 2010.

364. Phase-out by 2006. The Study Team concluded that a 2006 phase-out 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 phase-out 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 phase-out plans by 2006 that are based on the specific factors that drive local ODS consumption. As discussed previously, these factors vary considerably between countries due to their inherent diversity. Achieving a phase-out by 2006 would require distinct and deliberate actions to address the specific factors that may impede each country's ability to eliminate ODS. The feasibility of the 2006 and earlier phase-out 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 $1.8 billion, real resource costs of US $2.2 billion, and actual costs of US $468 million for this scenario. The scenario resulted in a relatively small percentage decrease of about 2 per cent in cumulative adjusted chlorine loading compared to the baseline scenario of 2010.

365. Phase-out 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 equipment retrofits, effectively lowering costs but delaying the actual ODS phase-out by approximately 14 years, to 2020. A number of countries that provided feedback on the issue stated that they could meet this phase-out date. For this scenario, Fund costs are estimated at US $935 million, real resource costs at US $1.2 billion, and actual resource costs at a savings of US $1.0 billion. Because the servicing tail delays the ultimate date of phase-out by several years, the scenario results in approximately 4 percentage points (i.e., -2.1% to +1.6%) more cumulative adjusted chlorine loading than in the scenario of a 2006 phase-out without a servicing tail.

366. Phase-out 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 phase-out in each individual country would still need to be addressed. For this scenario, the model estimates total Fund costs of US $1.6 billion, real resource costs of US $2.1 billion, and actual costs of US $800 million.

367. Phase-out by 2010 with a Servicing Tail. A servicing tail under the 2010 phase-out scenario would eliminate all need for equipment retrofits, thereby lowering the costs of the phase-out and delaying ultimate phase-out to 2022. Because of the delay, unlike almost all of the other scenarios, this one results in an increase of 4.2 per cent in cumulative adjusted chlorine loading compared to the baseline scenario of 2010. This represents the largest increase out of all the scenarios analyzed. Costs of this phase-out are estimated at US $855 million for Fund costs, US $902 million for real resource costs, and US $779 million in savings for actual costs.

368. Phase-out as Fast as Cost-Effectively Possible. The Study Team also estimated the fastest possible phase-out, subject to a cost effectiveness constraint that equipment retrofits would not be required. Under this scenario, new ODS using equipment need not be installed anywhere as of 2001. Based on the modeling results, virgin production of ODS can then be halted in 2012, with demand for ODS in existing equipment met through the year 2018 by recycling. Like the 2000 phase-out scenario, this scenario results in a significant decrease (approximately 9 per cent) in cumulative adjusted chlorine loading compared to the baseline scenario of 2010. The scenario produces total Fund costs of US $1.4 billion, real resource costs of about US $2.0 billion, and savings of US $876 million for actual costs. While the results of this scenario compare very favorably with the others analyzed in the Study, they must be examined more closely in order to consider how the scenario could actually be operationalized through the Montreal Protocol. Given the projection from the model that installation of new ODS equipment can be halted in 2001, the scenario can be likened to a phase-out by 2001 with a servicing tail. Alternatively, the Montreal Protocol could set different phase-out dates for each sector. Under either of these approaches, as explained in the discussion accompanying the 2000 phase-out scenario, because of policy and institutional difficulties, it is unclear whether all segments of ODS-using industry in developing countries could meet such a phase-out target.

369. Variations on these scenarios: servicing tails with accelerated phase-outs. The Study Team conducted sensitivity analyses regarding servicing tails with accelerated phase-outs. A service tail with an accelerated phase-out requires that ODS produced for the servicing tail could only be used for equipment manufactured prior to 1999. The results of these analyses are that scenarios with a servicing tail for such equipment and an accelerated phase-out increases the speed of phase-out only in certain parts of the refrigeration sector and also increases the costs of the phase-out slightly. For the scenario with a phase-out target date of 2006, the accelerated phase-out costs projected in the model are US $1.3 billion for Fund costs, US $1.8 billion for real resource costs, and savings of US $342 million for actual costs. An accelerated phase-out with servicing tail and a phase-out target date of 2010 yields estimated Fund costs of US $1.3 billion, real resource costs of US $1.8 billion, and actual costs of US $173 million.

370. Variations on these scenarios: duration of operating costs covered by the Fund. The impact of a variation in the duration of operating costs to be covered by the Multilateral Fund depends on the scenario being evaluated. In each case, however, it results in higher costs. For a 2000 phase-out, the Fund cost associated with reimbursing four years of operating cost instead of two years is about US $8 million more, while for the 2010 target, the difference is about US $226 million more.

371. In all scenarios analyzed, the majority of costs are projected to occur in the refrigeration and air conditioning sectors. Much of this cost is estimated to be caused by the need for retrofits to existing equipment. Such retrofit costs are avoided in scenarios that incorporate a service tail. As established in the policy and institutional analysis, however, the practical difficulties of setting up a servicing tail in most Article 5 countries are likely to result in some additional cost that the Study Team was not able to quantify in its analysis.

372. In summary, given the extraordinary technical difficulties that all Article 5 countries would face in trying to meet a 1996 target and the policy and institutional difficulties that some Article 5 countries believe would make infeasible the task of meeting a 2000 target, the earliest feasible phase-out date among those scenarios 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. Measured against a baseline of the cumulative adjusted chlorine loading for the 2010 scenario, the change in chlorine loading ranges between approximately a 10 per cent reduction, if the phase-out is achieved by 2000, and an increase of about 4 per cent with the scenario achieving a phase-out by 2010 using a servicing tail.

Attachment 1

THE PROJECT CYCLES OF THE IMPLEMENTING AGENCIES

373. 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

374. **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.

375. **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.

376. 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.

377. 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.

378. 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).

379. 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.

380. 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.

381. 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.

382. 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.

383. 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.

384. 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 and sub-project cycles. Exhibit IBRD-2 presents a summary description of the World Bank.

UNEP

385. 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.

386. 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;

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

387. Under the Multilateral Fund, UNDP assists countries in the formulation of country programmes, and supports technical assistance and pre-investment activities including feasibility studies, technology transfer evaluation, demonstration projects, and national/regional technical training programmes. At country request, UNDP is increasingly involved in investment project design and implementation in the foams, refrigeration and solvents sectors. UNDP is also designing sectoral phaseout strategies for low ODS-consuming countries in the foams and halons sectors.

388. UNDP has set up a Montreal Protocol Unit (MPU) which is part of the Energy, Climate and Pollution Group within SEED (Sustainable Energy and Environment Division). MPU is headed by a Task Manager - a senior staff position at the D-1 level. Its five full-time staff include two regional programme coordinators. UNDP has appointed five world-recognized sectoral experts on retainer contracts in the aerosols, foams, solvents, refrigeration and halons sectors respectively. In addition, over 30 consultants, both international and national, are currently utilized. As the need arises, UNDP also recruits consultants on a project-by-project basis from its MPU roster that at present has 200 listed consultants.

389. The MPU and its sector experts are responsible for programme and project development, technical project monitoring and overall programme management. As per UNDP rules, actual project implementation is handled either by UNDP's executing agency (Office for Project Services, or OPS) or by a national governmental agency, depending on the complexity of the project and operational necessities.

390. Requests for assistance for project preparation can come from an Article 5, para 1 country to UNDP directly (either to a Country Office or to MPU), as part of a country programme, or from UNDP consultants recruited at government request to help identify projects.

391. The detailed project proposals are then prepared by MPU staff and international and national experts/consultants with additional inputs being provided by UNDP Country Offices, governments and companies concerned. In some instances a first draft document is prepared by the Government or company directly. The project document, in addition to technical details, specifies the activities to be performed, their rationale and justification, expected results, the project budget, the work schedule and the responsibilities and inputs of each party to the project. When drafted, the project document is evaluated by an independent sector expert not connected with preparation of the project.

392. Project proposals are then reviewed and approved by the Government and MPU, following which the project document is submitted to the Fund Secretariat for review, feedback and revision if required. This usually entails further discussions with UNDP sector experts and often the Governments or companies concerned. When agreement is reached, the project is submitted to the Executive Committee for approval.

393. The Executive Committee approves projects taking into consideration the Fund Secretariat's recommendations. Where the Executive Committee requires only minor changes to the project proposal, it is amended and signed by the parties concerned. In the event the Executive Committee changes a project drastically or funds only part of the total requested costs, additional technical and financial review by UNDP may be needed to determine how the project should be implemented and amended. If the concerned Government and/or company concludes that the project is no longer feasible at the reduced funding level, UNDP would so inform the Executive Committee and funding received would be returned to the Fund.

394. The project document is then signed by UNDP, the Government and the concerned executing agency. Transfer of funds is a straight-forward process since for each new project UNDP only requires an addendum to the "Standard Basic Assistance Agreement" (SBAA) which UNDP has signed with 130 countries. This SBAA give UNDP country offices financial, legal and administrative authority to act and no additional legal, financial or grant agreement is necessary for implementation of UNDP projects under the Montreal Protocol. The attached figure demonstrates the UNDP project cycle.

395. During project implementation, MPU monitors the progress being achieved and provides substantive guidance to the companies as required. Following project completion and commissioning, UNDP has set in place a system for longer-term project evaluation and follow-up. Exhibit UNDP-1 shows UNDP's project cycle and Exhibit UNDP-2 presents a summary description of UNDP.

UNIDO

396. UNIDO's project cycle begins with the identification of an ODS problem in an Article 5 country. The identification of the problem leads to the development of project ideas and the characterization of the assistance that might be required for developing the project proposal. While country programmes provide a structured approach for the development of project ideas, they may also be developed by an Article 5 country, by UNIDO field staff or Headquarters staff on mission, or by another United Nations agency. In all cases, the UNIDO Country Strategy and Programmes Division systematically gathers the project ideas and makes them available to all department of UNIDO, field offices and the Article 5 country concerned, at regular intervals. If the project requires joint development and/or implementation with another Implementing Agency, cooperation is established during these initial stages.

397. The project formulation phase entails collecting and analyzing background information, designing and drafting the project proposal, in accordance with applicable guidance, in order to ensure its relevance, technical soundness and feasibility.

398. The project formulation requires close cooperation between various units at Headquarters, as well as among UNIDO, the recipient Article 5 country, and other Implementing Agencies. During this phase, the Quality Assurance Officers can provide advice, if required.

399. When the draft project document is completed, it is cleared by:

- The specialized branch which confirms that the project is feasible from technical and economic viewpoints; and

- The Country Strategies and Programmes Division which confirms that an official Government request has been received, the project complies with the country programme or with the request by an Article 5 country, and the project design is in accordance with the relevant formats and meets design standards.

400. Following the internal approval of UNIDO, the project is submitted formally to the Executive Committee of the Multilateral Fund for review and approval. Following the approval of the Executive Committee, the project is signed by UNIDO and the Government of the Article 5 country concerned.

401. Exhibit UNIDO-1 shows UNIDO's project cycle.

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

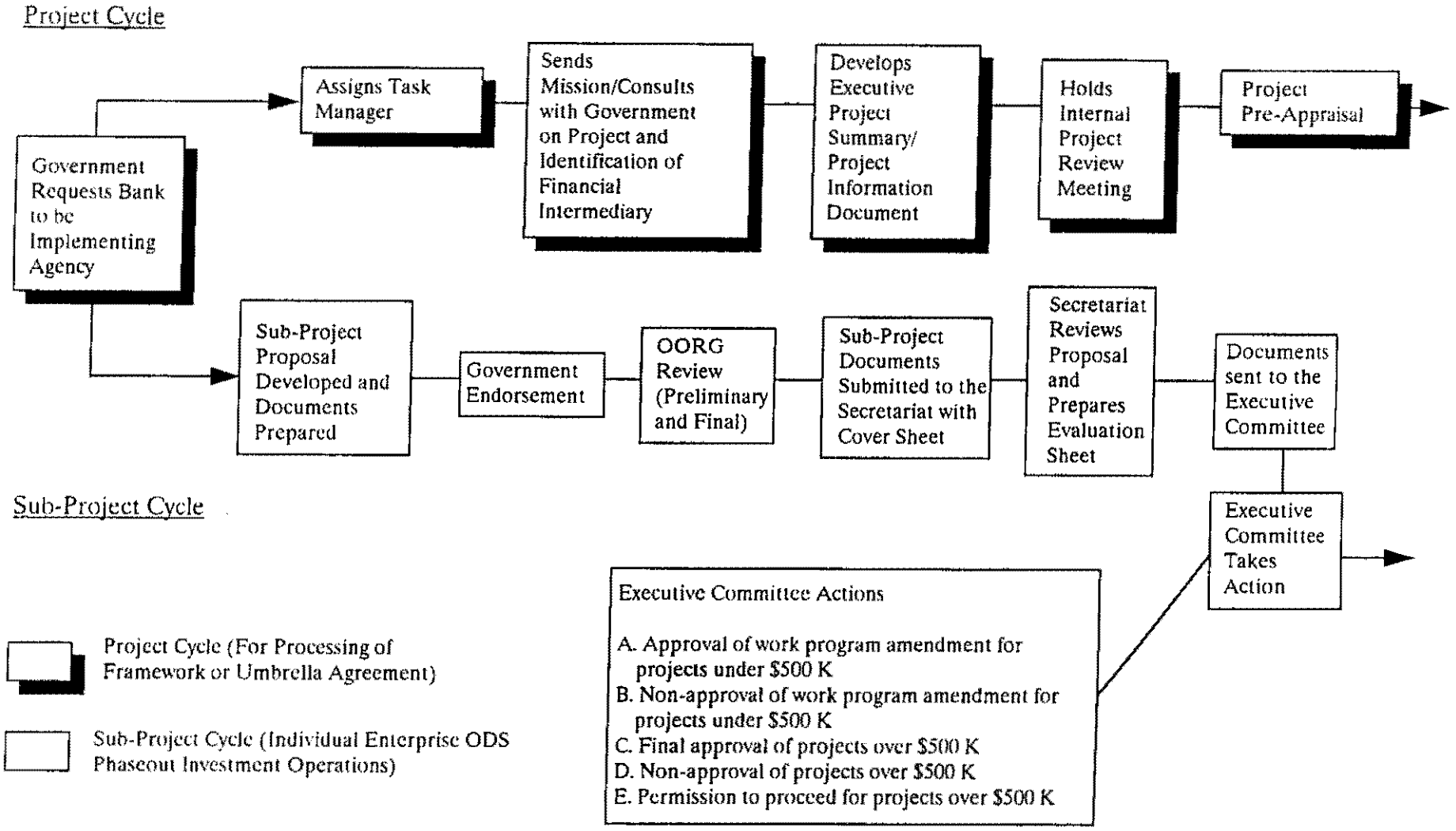
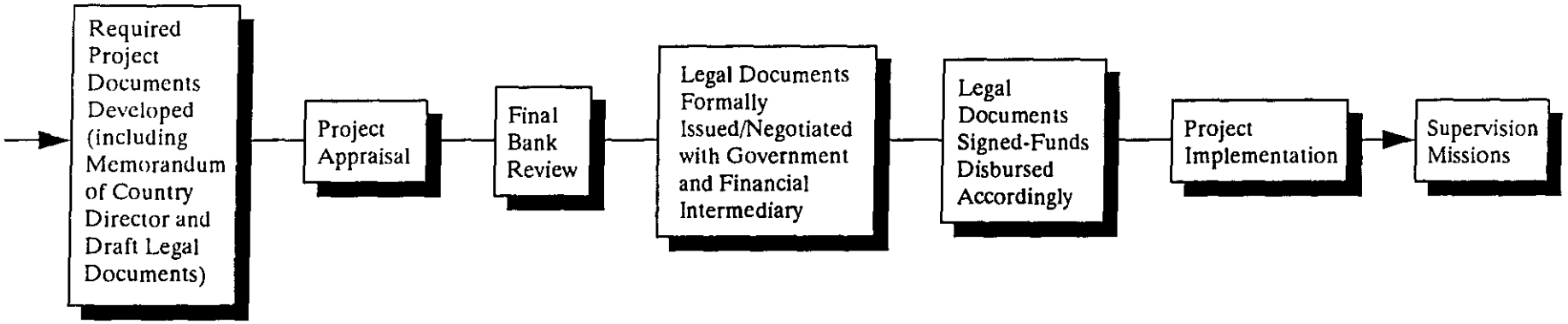


Exhibit IBRD-1 (continued)
World Bank Montreal Protocol
Project Implementation Following
Executive Committee Review

Project Cycle (continued)



Sub-Project Cycle (continued)

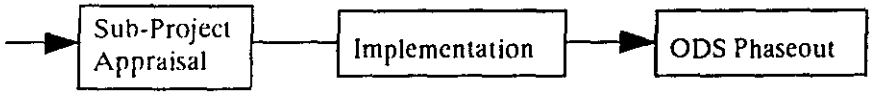


Exhibit IBRD-2

Summary Description of International Bank for Reconstruction and Development

International Bank for Reconstruction and Development (World Bank)	
Role	• Enables developing countries to implement comprehensive ODS phaseout programs through the empowerment of local officials to assume responsibility for project identification, preparation, and implementation. • Assists with the identification, evaluation, provision of resources and supervision of investment projects, technical training, and institutional strengthening to contribute to ODS elimination. • Helps develop country programmes for large ODS consumers and producers in the developing world.
Organization	• A permanent staff and an established network of independent environmental consultants. • The Montreal Protocol Operations Team is located within the Global Environment Coordination Division (ENVGC) which is itself part of the Central Environment Department. The coordination function which was previously in the region has been centralized in the ENVGC. The MP Operations Team consists of an Operations Coordinator, a Technical Coordinator and two Regional Operations Coordinators. Task Management responsibilities are handled mainly by the Country Department, with assistance from the MP Operations Team. • To improve performance, the Bank created the Ozone Operations Research Group (OORG), improved project documentation, made managers more accountable and streamlined its organizational structure. • The OORG provides external reviews of country programmes and project preparation/implementation by recognized independent experts. • The Global Environment Steering Committee consists of senior regional managers who advise on operational and policy issues.
Operating Philosophy	• Enable client countries to develop the capacity to receive large scale transfer of resources through "umbrella" grant agreements leading to a sustained level of support for ODS phaseout activities.
Coordination	• The World Bank enjoys established relations with all of the countries with which it works on Fund activities. • Coordination with the other Implementing Agencies which was informal and ad hoc has been consolidated through annual work programme coordination sponsored by the Fund Secretariat as well as regular communications and mission coordination among Implementing Agencies. The World Bank and UNDP have clarified their responsibilities to reduce overlap.
Process	• Established procedures are effective in lending activities. These have been adapted to the small size and unconventional features of Fund activities. Changes in reporting have been made to adapt to the EC's requirements.
Constraints	• Traditionally financing very large projects, involvement in the Montreal Protocol has required that the Bank adapt to smaller initiatives consisting of numerous small projects in a new and evolving sector.

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.

Exhibit UNDP-1

UNDP Procedures For Project Development and Implementation Under the Montreal Protocol

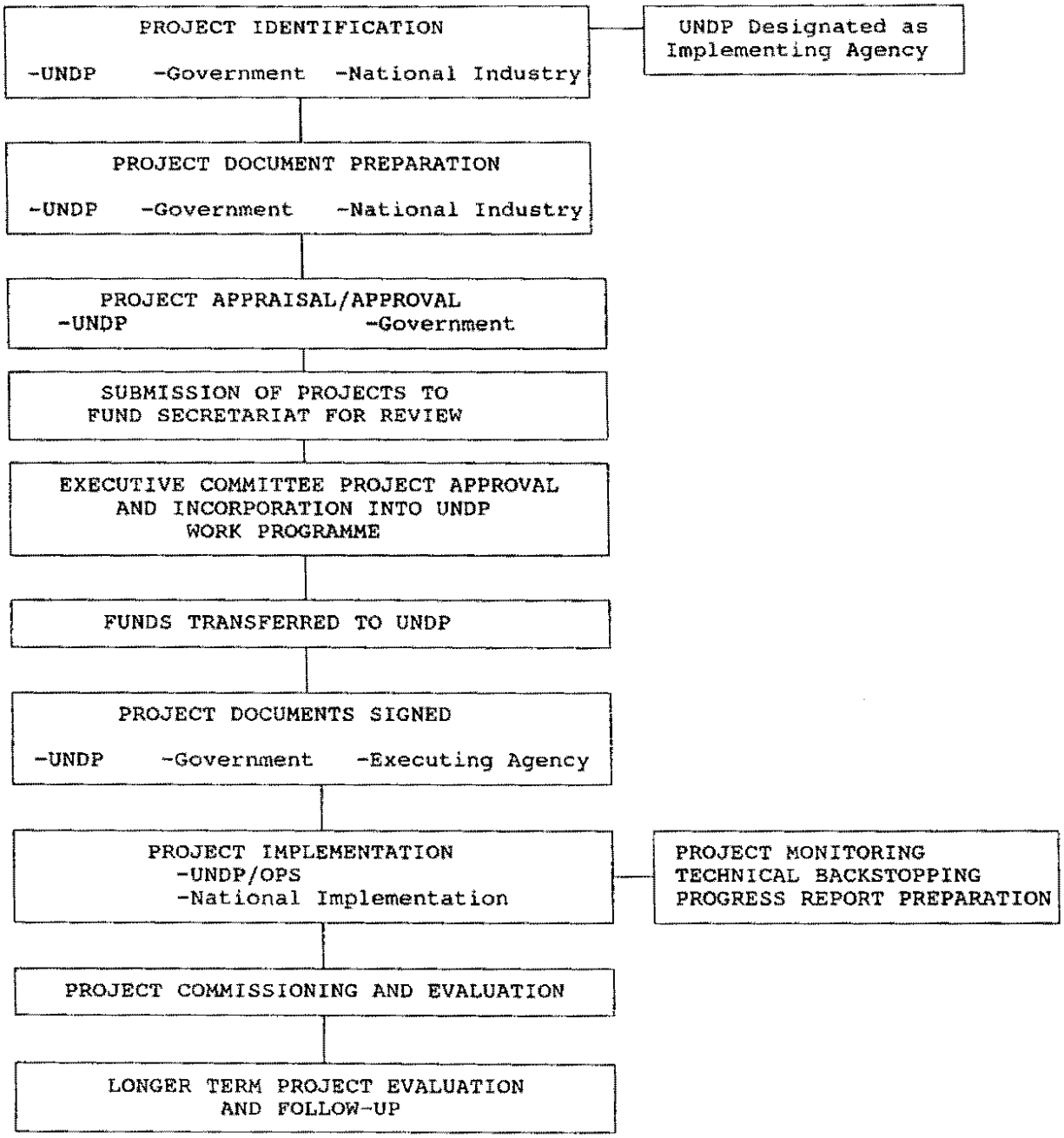


Exhibit UNDP-2

Summary Description of United Nations Development Programme

United Nations Development Programme (UNDP)	
Role	• By its mandate, UNDP is a funding and coordinating agency for UN system activities. UNDP designates UN system agencies, UNDP/OPS, or national governmental agencies to implement various projects and programmes. • Under the Multilateral Fund, UNDP assists countries in the formulation of country programmes, and supports technical assistance and pre-investment activities including feasibility studies, technology transfer evaluation, demonstration projects, and national/regional technical training programmes. • At country request, UNDP is increasingly involved in investment project design and implementation in the foams, refrigeration and solvents sectors. • UNDP is also designing sectoral phaseout strategies for low ODS-consuming countries in the foams and halons sectors.
Organization	• UNDP is highly decentralized with 130 country offices supporting UNDP Montreal Protocol activities where such programmes exist. Its Standard Basic Assistance Agreement with most countries give UNDP country offices financial, legal and administrative authority to act. No additional legal, financial or grant agreement is necessary for implementation of UNDP projects under the Montreal Protocol. • UNDP has a Montreal Protocol Unit to manage its Montreal Protocol activities. It has five full-time staff including the Unit Manager. UNDP has 5 world-recognized sectoral experts on retainer contracts in the aerosols, foams, solvents, refrigeration and halons sectors, utilizes over 30 consultants (international/national) at present and has a roster of 200 consultants. • The Montreal Protocol Unit is part of the Energy, Climate and Pollution Group within SEED (Sustainable Energy and Environment Division). SEED, which also encompasses UNDP's Global Environment Facility, its sustainable natural resources management programme, and the UN Sudano-Sahelian Office, is responsible for coordinating all environmental activities in UNDP.
Operating Philosophy	• Assists countries only on their specific request. Focuses on developing local human resources and institutional capacities and uses local expertise wherever possible. For project design and implementation, UNDP utilizes its roster of international, regional and national consultants, contracted on a project by project basis.
Coordination	• UNDP acts as coordinator of UN system operational activities. • Cooperates with a wide range of partners including national governments of both developed and developing countries, bilateral programmes, NGOs, and other international bodies. Close coordination with other implementing agencies (UNEP, UNIDO, World Bank) including joint missions when feasible.
Process	• Emphasis on team building with the recipient industry/plants, local consultants, international experts and government decision makers, coordinated by regional coordinators within MPU. • Internal process reflects its role as a financing agency. Improvements have resulted in streamlined processes for project preparation, internal approvals, and project implementation and commissioning.
Constraints	• Building local capabilities to ensure ownership of ODS phaseout programmes is time-consuming but the net result - the creation of locally managed, self-sustaining programmes - is well worth the effort and cheaper in the long run.

EXHIBIT UNIDO-1
UNIDO PROJECT CYCLE